G. A. Kluge

Photographed in 1949

bryozoa of the northern seas of the ussr

G. A. KLUGE

Translated from Russian

Amerind PUBLISHING CO. PVT. LTD.

New Delhi *Bombay* *Calcutta* *New York*

Translation of:
Mshanki Severnykh Morei SSSR,
Akademiya Nauk Publishers,
Moscow-Leningrad, 1962

Translator: Dr. B. R. Sharma
General Editor: Dr. V. S. Kothekar

Published by Mohan Primlani, Amerind Publishing Co. Pvt. Ltd.
66 *Janpath, New Delhi* 110001, *and printed at*
Prem Printing Press, Lucknow 226001

FOREWORD

The present identification key is a presentation of all our knowledge about the Bryozoan fauna of the northern seas (Polar Basin). This fundamental work is a product of about fifty years of research carried out by the scientist, German Avgustovich Kluge, and is based on sizable collections from several Soviet Arctic expeditions beginning from the first investigations of the expedition for Scientific Fishery Research at the coasts of Murmansk (ENPIM) which was organized at the end of the last century and the beginning of the present one, and the Russian Polar Expedition on the schooner *Zarya* in 1900-1902, and the subsequent high latitude expeditions of recent years on expedition ships *Sadko, Sibiryakov, Sedov, Litke,* and others, as well as the Drifting Polar Stations (SP 1-4), which had collected sizable and extremely rich material from all regions of our northern seas. German Avgustovich Kluge personally worked for many years in the White Sea and Barents Sea, headed the Murmansk Biological Station in Kol'sky Bay (Bay of Kola) for twenty-five years, and was on the staff of the Murmansk Biological Station to the last day of his life (now the Murmansk Marine Biological Institute of the Academy of Sciences of the USSR) in Dal'nie Zelentsy. He was appropriately considered as the foremost authority on Bryozoa and did a fundamental analysis of their complicated synonymy. About 340 species and subspecies of Bryozoa have been described in the present identification key, and the majority of them have been illustrated by original figures; for the first time a new suborder (*Isoporina* Kluge) has been identified here, together with 4 new families, 4 new genera, and 19 new species and varieties. In total, about 100 new species of Bryozoa were described by G. A. Kluge.

Unfortunately, G. A. Kluge did not have the opportunity to see his work of many years published. He died on the 25th of December, 1956, in the 86th year of his life while completing the last pages of his manuscript. Hence, the manuscript was prepared for publication after his death, which explains the delay in its publication. The greater part of the work in preparing the manuscript for publication was done by his student, M. G. Gostilovskaya (Murmansk Marine Biological Institute of the USSR Academy of Sciences) who collected the matter for about 200 rare sketches, wrote the legends for them, corrected the reference citations, and composed the list of references. All the figures were made by specialist-artists under the guidance of T. F. Belotsvetovaya (N. L.

Orshanskaya, G. E. Pozgeevaya, Yu. A. Podlesnovy) from the objects preserved in the Zoological Institute of the USSR Academy of Sciences (Leningrad). The general editorial work of the manuscript was done by Prof. A. A. Strelkov.

The publication of the present identification key would appear to be the basis for encouraging further study of this important group of marine invertebrates, and should serve as a reference not only for those who are specifically studying Bryozoa, but also for all marine hydrobiologists and zoologists.

EDITORIAL BOARD

CONTENTS

LIST OF THE SPECIES OF BRYOZOA OF THE NORTHERN SEAS OF THE USSR[1]

[1] The present index includes those species which were found in the Barents, White, Red, Laptev, East Siberian, and Chukotsk seas. In addition to the species listed in the identification key, some others from neighboring but more distant seas, because of the close affinity of dwelling conditions, have been included. Such species have been marked with an asterisk just before their names.

LIST OF ABBREVIATIONS

a. – aperture
alv. – alveoli
anc. – ancestrula
ano. – anozooid
ap. – apophysis
art. – articulation
asc. – ascophore
aut. – autozooid
av. – avicularium
av. ad. – avicularium, adventitious
av. an. – avicularium, angular
av. ch. – avicularian chamber
av. f. – avicularium, frontal
av. b. (*av. l.*) – avicularium, lateral
av. ma. – avicularium, marginal
av. mi. – avicularium, middle (median)
av. v. – avicularium, vicariating
ava. – avicularia
b. br. – base of the branches
b. t. – basal tube
cav. – pore(s)
ch. – chamber
col. – collar
con. – condyles
cr. – cryptocyst
d. zo. – daughter zoarium
den. – denticle
e. – egg
ect. – ectooecium
end. – endooecium
ep. – epitheca
g. – gonozooid
gym. – gymnocyst
h. – hood
int. – internode
k. – knob
ken. – kenozooid
m. – mandible
ma. pl. – marginal plate
mu. – mucro
n. – node
oest. – oeciostome
op. – operculum
op. br. ch. – opening of brood chamber
ops. – opesium
opsl. – opesiule
or. z. – orifice of the zooid
ov.; *a. z.* – ovicell
p. – pore (s)
p. pl. – pore plate
pap. – papillae
per. – peristome
pol. – polypide
pr. d. – primary disc
pr. o. – primary orifice
prim. z. (*pr. z.*) – primordia of zooids
prot. – protuberance
psp. – pseudopores
r. (*reb.*) – rib (rebra)
rad. f. – radicular fiber
rad. t. – radicular tube
rh. – rhizooids
ros. – rostrum
s. d. – secondary disc
s. o. – secondary orifice
sc. – scutum
sin. – sinus
sl. – slits

sp.	– spines
sp. b.	– spine base
spir.	– spiromen
stl.	– stolon
stm.	– stem
sub.	– substrate
subt. sur.	– sub-tentacular surface
t. l.	– tooth of lyrule
tb. h.	– tubular hood
v. z.	– vestige of zooid
vibr.	– vebraculum
z.	– zooid

PART I

INTRODUCTION

INTRODUCTION

Class **BRYOZOA** Ehrenberg, 1831

Polyzoa Thompson, 1830 : 92; *Bryozoa* Ehrenberg, 1831 : (39); sub-class *Gymnolaemata* Allman, 1856 : 10; sen *Stelmatopoda* van der Hoeven, 1850 : 94.

For a long time *Bryozoa* were included in zoophytes along with hydroids, corals, and others. Thompson (1830) in Ireland, and Ehrenberg (1831) in Germany, independently discovered that these animals differed from hydrophytes by the presence of a peculiar alimentary canal which occupies a large part of the body cavity. Thompson called them *Polyzoa,* and Ehrenberg, *Bryozoa.* This group is customarily called *Bryozoa* in the European continent and America, but is referred to as *Polyzoa* in England. In 1870, Nitsche found that this group includes a few forms which, although similar to other *Bryozoa* in external appearance, differ by an anal orifice or vent situated within the tentacular corolla, as well as by other characteristics. Hence, Nitsche called them *Bryozoa entoprocta* to distinguish them from the other forms, *Bryozoa ectoprocta.*

In 1888, Hatschek, on the basis of embryological data, isolated *Entoprocta* from the group *Bryozoa* and included them in the group *Scolecida;* the remaining *Ectoprocta* thus became the only representatives of the group *Bryozoa* which, together with *Brachiopoda* and *Phoronis,* were combined into the class *Tentaculata* by Hatschek. Now these groups have been raised to the status of classes, forming part of the *Tentaculata* type. In 1856, Allman divided all the Bryozoans into two sub-classes: *Phylactolaemata* and *Gymnolaemata.* In *Phylactolaemata* a peculiar mobile appendage (epistome) exists above the oral orifice, which is capable of closing the mouth like a lid; along with this their corolla of tentacles has a bend in the middle in the form of a horseshoe and is situated on a peculiar lobe called a lophopore; therefore, they are also known as *Lophopoda* (Dumortier, 1835). The representatives of this group dwell in fresh waters. In *Gymnolaemata,* i.e., gymnostomats, the epistome is absent and the crown of tentacles is in the form of a round corolla; therefore, they are also known as *Stelmatopoda* (van der Hoeven, 1850). Except for a few *Paludicellea* (*Victorella, Paludicella*), these are sea dwellers. The Bryozoa described in the present volume belong to the group *Gymnolaemata* and in the succeeding descriptions we shall be concerned only with characteristics of Bryozoa belonging to the subclass *Gymnolaemata.*

Brief description of the morphology of Bryozoa

External appearance. These are colonial animals which adhere to the substrate as sessile forms. Their larvae, after swimming in water for a short time, settle down to the bottom where they adhere to the substrate and undergo a metamorphosis, and subsequently are converted into a primary individual or *ancestrula.* The latter form individuals by a repetitive process of secondary budding, which gives rise to a colony that does not separate from the maternal individual, or the zoarium. Zoaria are quite varied in form; sometimes they are excrescences growing on the substrate, sometimes independently growing branches, bushes, or tree-like branched formations, and sometimes just various types of lumps. Zoaria, in spite of the microscopic size of their constituent individuals, may be of different sizes varying from a few millimeters in length and width to several dozen centimeters. Thus, Andersson (1902) reports *Alcyonidium gelatinosum* (L.) from the northern part of the Barents Sea, as reaching a height of 150 cm. The size of an individual specimen is, on the average, 0.3 to 0.4 mm, and in species of the genus *Nolella,* 5 mm. The number of individuals in a colony varies from a few dozen to several thousands; thus Loppens (1905) cites an example of a colony of *Flustra foliacea* (L.) with a weight of 13 g, which had as many as 1,333,000 individuals.

Bryozoa exhibit different colors, varying from colorless transparency to dark brown. For example, among those which are found in our waters, *Cribrilina spitzbergensis* Norman and *Escharelloides spinulifera* (Hincks) are pale-yellow-greenish; in *Callopora derjugini* Kluge, the cystids are pale and the embryos a dense blue-violet; *Hippodiplosia harmsworthi* (Waters) are pale-reddish-violet while the cystids are yellow; embryos of *Cheilopora sincera* (Smitt) are orange, while in *Caberea ellisi* (Fleming) they are red, and in *Porella saccata* (Busk) and *Rhamphostomella radiatula* (Hincks), crimson. The cystids are pale and the embryos bright orange in *Reteropora cellulosa* (Linne) and *Rhamphostomella spinigera* Lorenz; the cystids are sandal colored and the embryos orange in *Schizoporella lineata* (Nordgaard) and *Stomachetosella cruenta* (Busk), but violet in *Lichenopora hispida* (Fleming), and dark brown in *Tegella nigrans* (Hincks). Often the color of the cystid is due to the color of the intestine or to the pigmentation of cells which are located under the surface cuticle; the embryo color is caused by the coloration of the nutritional yolk (vitellus).

Bryozoa are bilaterally symmetrical animals, the primary organization of which has undergone changes to suit an adherent or sessile mode of life.

These changes took place at a different rate in different orders, but for all of them the following outlines of structure are typical. In the frontal portion of the body a tentacular crown is located which has an oral orifice situated in the middle of its base (Figure 1). From the latter starts the loop-shaped bent alimentary canal, the vent of which opens in the vicinity of the oral orifice, but is devoid of the crown of tentacles. The whole frontal part of the body, along with the tentacles and the intestine, is

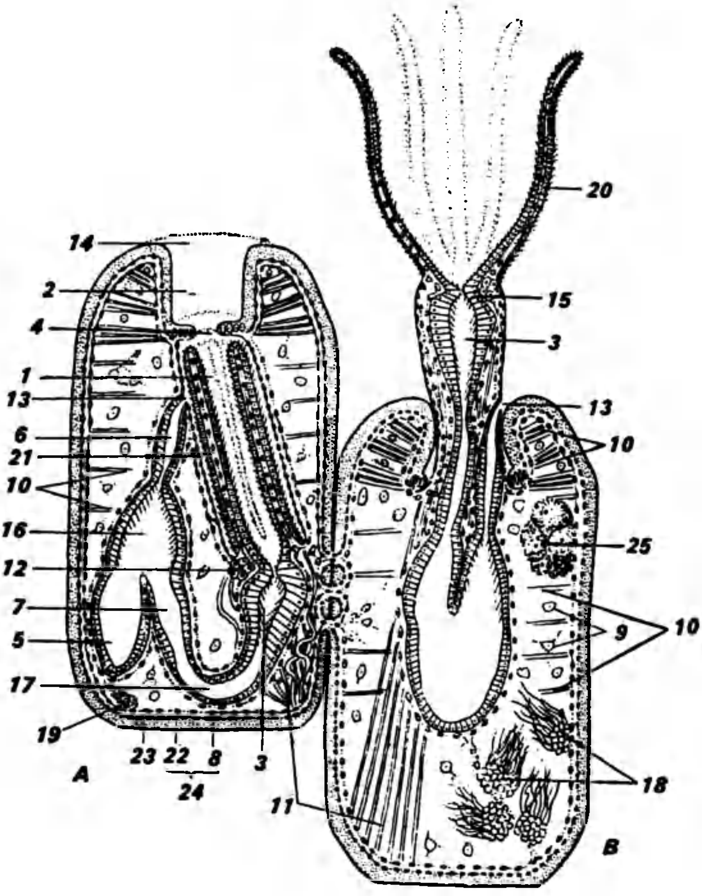


Figure 1. Drawing of zooids of *Gymnolaemata* with *A*—a retracted; polypide and *B*—an extended polypide:

1—*atrial chamber;* 2—*vestibule;* 3—*pharynx;* 4—*diaphragm;* 5—*stomach* (*ventricle*) 6—*rectum* (*posterior intestine*); 7—*cardinal part of the stomach;* 8—*mesoderm;* 9—*mesodermal free elements;* 10—*parietal muscles;* 11—*retractor muscles;* 12—*nerve ganglion;* 13—*anal orifice;* 14—*orifice of the zooid;* 15—*oral orifice;* 16—*pylorus;* 17—*esophagus;* 18—*testis;* 19—*funiculus* (*funicle*); 20—*tentacles;* 21—*tentacular sheath;* 22—*ectoderm;* 23—*ectocyst;* 24—*endocyst;* 25—*ovary.*

known as the polypide; it may be withdrawn into the hind part of the body which is called the cystid.[1]

The orifice through which the polypide can be invaginated into the cystid, or protrudes out, is known as the orifice of the zooid and should not be confused with the oral orifice. The zooid has a cylindrical or tubular form, or the form of a four- or multi-angular small low prism. The zooids touching each other have their own side walls and, with few exceptions, a common transverse wall separating the daughter zooid from the maternal one.

The body wall of the Bryozoa consists, in the majority of cases (*Cyclostomata, Cheilostomata*), of two layers: an outer chitinous one, and an inner saturated with calcium carbonate and a mixture of magnesium salts (the so-called ectocyst of earlier authors). In some (*Ctenostomata*), the chitinous layer is simple, non-calcified, and may take the form of a jelly (gelatine). The main ectodermal cellular layer under the chitinous layer, first appears as a chitinous secretion, and is later impregnated by the calcareous layer.

The ectodermal layer in Bryozoa consists of lower cells. The mesodermal layer, situated below it, is very poorly developed in the form of separate cells. Both layers, ectodermal and mesodermal, constitute the endocyst referred to by earlier authors. The calcareous layer is not always adjacent to the chitinous layer, but when it is, it forms a single unit with it, and is then called the gymnocyst; when there is space between the calcareous and chitinous layers, called the hypostegial cavity which is lined with an endocyst and filled with cavity fluid, then such a calcareous layer is known as a cryptocyst. The cavities of the neighboring cryptocysts are joined together by the cords of a mesenchymatous tissue which passes from one zooid to the other through the pores of the adjoining walls. In *Cyclostomata,* these pores are simple and numerous; in *Cheilostomata* and *Ctenostomata,* they are limited in number and are located in the lateral and transverse walls of neighboring zooids or form either simple pores or porous plates (referred to as rosette-like plates by earlier authors), or porous chambers (see the chapter on *Cheilostomata*). These pores should not be confused with pseudopores which cover the outer wall of the tubes in *Cyclostomata* and the frontal surface of several walls in *Cheilostomata*

[1] Cystid and polypide are the original terms used in Bryozoan literature, reminiscent of the opinion prevailing at one time (Nitsche, 1871) that Bryozoans were twin animals consisting of a polypide fastened in the cystid (because the polypide may be destroyed and, after some time in the same cystid, a new polypide may be rehabilitated); now this view has been rejected as a mistaken one, and the terms have been retained exclusively for the purpose of brevity of expression which makes the description easier. Thus polypide and cystid together make one single unit or individual which is called an autozooid, abbreviated to zooid.

[*Electra pilosa* (L.) and others]; the calcareous layer does not exist in these places, and the chitinous cuticle covering it protects the internal cavity from the external environment.

The wall of the frontal part of the body which protrudes out of the cystid is covered with a very thin elastic cuticle. When the frontal portion of the body is withdrawn into the cystid, its wall is inverted like the finger of a glove and the tentacles are enclosed in what is called a tentacular sheath. When the tentacular apparatus expands, the tentacular sheath is also outwardly inverted, but the latter is not totally turned outward in *Cheilostomata* and *Ctenostomata*, and consequently forms a narrow round plait in the region of the orifice—the diaphragm (duplicature, according to earlier authors). During the inverse withdrawal of the polypide into the cystid this diaphragm, because of the annular musculature, or the atrial sphincter, closes the entrance to the undesirable cavity for the tentacular sheath, i.e., the atrial cavity (Figure 2). The

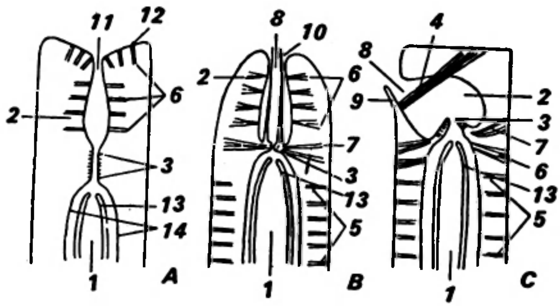


Figure 2. Sketch of the construction of the fore end in a stretched polypide of *A—Cyclostomata; B—Ctenostomata;* and *C—Cheilostomata*:

1—*atrium;* 2—*vestibule;* 3—*diaphragm with sphincter;* 4—*muscle, closing the operculum;* 5—*parietal muscle;* 6—*parietal-vaginal muscle;* 7—*parietal-phrenic muscles;* 8—*orifice of the zooid;* 9—*operculum;* 10—*collar;* 11—*terminal pore;* 12—*terminal membrane;* 13—*tentacles;* 14—*tentacular sheath* (*from Cori,* 1941).

space between the diaphragm and the orifice of the zooid is called the vestibule (Figures 1 and 2).

The musculature of the body wall has undergone significant changes under adaptive influences toward a sessile mode of life. Thus, in the frontal part of the body, an abundant layer of longitudinal muscles exist, while the circular muscles are poorly developed; in the hind portion, or the cystid, the circular muscles predominate though not fully enclosed, while the longitudinal are almost totally atrophied. The strongest muscles in the body of the Bryozoa are the paired muscles of the transversely striped retractors which pull the frontal part of the body into the hind part. They are fixed anteriorly to the pharynx, and posteriorly to the lateral or hind wall of the body.

The nervous system consists of a epipharyngeal ganglion situated between the oral and anal orifices, and contains the nerves which spread out toward the tentacles and intestines. Sensory organs, except for the tactile, are absent.

The frontal part of the body in the Bryozoa described by us, is made of a round tentacle crown which serves for nutrition and respiration, and acts as a tactile organ as well. The number of tentacles in different species differs, fluctuating within the limits of 8 (some *Crisia* and *Bowerbankia*) to 30 (*Flustrella*).

The tentacles are triangular in form in the cross section and the height of the triangle is inverted into the crown. The ectodermal layer located outside the tentacles contains bundles of cilia on the lateral and internal margins. The main structureless membrane is located under the ectoderm, and the mesodermal layer is situated above it enclosing the internal cavity, which is stretched along the entire length of the tentacles. Because the longitudinal muscles cover the cavity of the tentacles, which are present in two bundles, one along the inner sharpened side and the other more developed one along the outer side, the tentacles bend independently of each other inward and outward in all directions. When the animal straightens, the tentacles form a wide funnel. As was demonstrated by the findings of Borg (1923) and Marcus (1926a), the large lateral cilia move from inside toward the outside and slightly downward. As a result of this the flow of water in the funnel is directed toward the oral orifice; the flow is greatly facilitated by the downward movement of the cilia on the inner margin of the tentacles. Nanoplanktons and detritus, the primary food items for Bryozoa, are drawn in by the water current.

Digestive organs. The loop-shaped alimentary canal starts from the oral orifice (Figure 3). It has three sections—anterior, middle, and posterior—separated from each other by constrictions.[a] The anterior section is composed of an expanded pharynx and a more or less oblong esophagus. The pharynx wall consists of high cells, supplied with strong cilia in the distal part, which facilitate the movement of food from mouth

[a] In accordance with the generally accepted divisions of the alimentary canal in other animals, these sections have also been called, by the majority of authors of Bryozoological literature, stomodeum, mesenteron, and proctodeum. Considering that the stomodeum and proctodeum originate from the ectodermal cells, and the mesenteron develops from the endodermal cells, and all three sections arise from ectodermal cells in Bryozoa blastogenically, Silen (1944a) is right in saying that these sections cannot be separated on the basis of ontogenetic development, but only on the basis of their morphology, histology, and physiology.

to pharynx; in the expanded part, these cells are strongly chitinized and gathered in three groups, taper toward the middle of the chamber, and separated from each other by depressions lined with lower cells. The cells go on lowering gradually in the esophagus, although the difference between the prominent (raised) cell groups and the depressed ones is maintained over a certain period of time. This anterior section serves as a region for the fragmentation and grinding of the food received. The middle section, or the stomach, consists of the tubular cardia, the central part of the stomach, the large cecum, and the pylorus. The cardia and central parts of the stomach, as well as the cecum, are covered with glandular cells, used for the dissolution and digestion of food, and the pylorus, covered with cilia, helps push the undigested particles out by forceful contractions of the cecum; these particles are collected into spindle-shaped pellets because of the rotating movement. The continuing peristalsis of the cecum throws out the pellets into the posterior section which consists of the rectum opening into the anus. In the rectum, these pellets are converted into larger fecal balls with the help of the mucus secreted from the rectal walls, and these balls are thrown out through the anus at the time of the unfolded condition of the animal. The section on *Ctenostomata* should be referred to for the development of the peculiar masticatory ventricle or the gizzard (see p. 213). The gut is surrounded by an external mesodermal muscular system which consists of poorly developed longitudinal muscles and more strongly developed circular muscles, particularly in the region of the esophagus and cecum. The proximal end of the latter is connected, with the help of a special cord of mesodermal origin, or the funiculus, to the body wall.

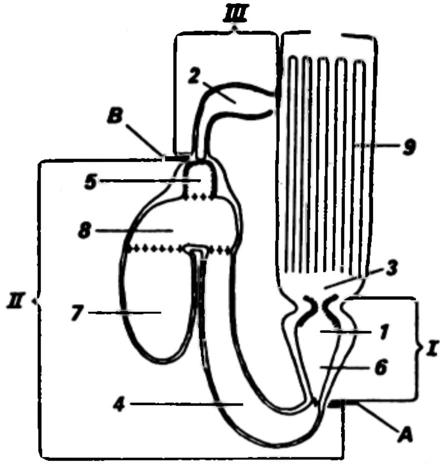


Figure 3. Sketch of the alimentary canal:

I, II, III—sections of the canal: (*I*) *anterior,* (*II*) *middle, and* (*III*) *posterior. A and B—points of constriction:* (*A*) *first,* (*B*) *second:* 1—*pharynx;* 2—*rectum;* 3—*oral orifice;* 4—*cardia;* 5—*pylorus;* 6—*esophagus;* 7—*cecum;* 8—*middle part of the stomach;* 9—*tentacles* (*from Silen,* 1944a, *with additions*).

Blood circulation organs are absent in Bryozoa. Their role is played by the body cavity fluid or haemolymph, whose main constituent is sea water with a very small quantity of dissolved proteinous substances in which amoebacytes float in large numbers. The periodical extensions and retractions of the polypide and the peristaltic contractions of the intestine, push the cavity fluid to all parts of the zooid as well as to all the other components of the zoarium which feed independently, or are incapable of feeding. This is facilitated by the loose mesenchymatous, or the so-called funicular, tissue which fills the zooids and passes through the pores and simple canals to all the component parts of the zoarium.

Respiration takes place through the skin, mainly in the least chitinized and calcified parts such as the tentacles and the tentacular sheath, in a stretched position. The parts covered with a calcareous layer are not devoid of respiration as the pore canals with cavity fluid pass through the calcium layer, and are protected from outer environmental conditions by a cuticle through which the gas exchange takes place.

A specific excretory system is also absent; this function is mainly performed by the amoebacytes floating in the cavity fluid, collecting the waste material and passing it out through the ectodermal cells of the tentacles, the budding zone, or through the intestinal wall together with the fecal masses (Harmer, 1892). According to the observations of Marcus (1926b), the excretion of waste material also takes place by the inter-tentacular organ in fertile zoöids of *Membranipora membranacea* (L.), *Electra pilosa* (L.), and in many species of the genus *Alcyonidium*. Moreover, according to Marcus, the formation of a brown body on degeneration of the polypide, also has an excretory significance.

Polymorphism is a very distinct feature of the Bryozoan group, and leads to a large systematic ramification of this group. In Bryozoa, as in other sessile or fixed animals, not all the individuals perform a single function, nor have a similar structure. Besides the main independently feeding and reproducing autozooids or zooids, heterozooids and kenozooids also exist. The heterozooids include gonozooids, avicularia, and vibracula; the kenozooids include the internodes of the stolons and tubes or plates used for the affixing of the zoarium.

The autozooids are the basis from which all these different forms of individuals originate because of the varying degrees of undeveloped polypides in them. Some authors also include the frequently occurring formations in *Cheilostomata* called ovicells or oecia in heterozooids. But this is incorrect because, as we will see in succeeding parts of this work (see *Cheilostomata,* p. 300), they do not represent the changed forms of zooids, as they are only a part of the latter.

The gonozooids of *Cyclostomata,* among the heterozooids, are closest in form to the autozooids. Although they strongly differ in the form of cystid by their middle part as compared to the one in autozooids, in the proximal region they are very similar to the tubes of autozooids, and their main similarity is that in the beginning of their development they are real autozooids equipped with an intestine and a tentacular crown, and only with the development of sexual products does this polypide degenerate; in some (*Crisiidae*), it degenerates before the maturity of sexual products, while in others (*Tubuliporidae*), it degenerates after the maturity of sexual products. With regard to other heterozooids, particularly avicularia and vibracula, since they are devoid of an alimentary canal, they, in the best of conditions, preserve only the traces of the polypide in the form of a small cellular structure equipped with a bundle of cilia at the apex. Their chamber, representing the cystid of the autozooid, includes in itself a strongly developed musculature, with the help of which the jaw or the mandible corresponding to the operculum of the zooid opens and closes its own orifice; these are avicularia. When this jaw goes beyond the limits of the orifice and acquires the form of a long flagellum, vibracula appear.

However, there is no distinct boundary between these two types of heterozooids. As these formations are found only among members of the order *Cheilostomata,* they will be examined in greater detail in the corresponding section (see *Cheilostomata,* p. 287).

Lastly, the kenozooids are not only devoid of polypides or their traces, but also of the external orifice. These tubular or plastic-like structures consisting of a chitinous coating, calcified or uncalcified, live off their ectodermal layer and are filled with loose mesenchymatous tissue. Usually these structures serve as a fixative for holding the zoaria to the ground, strengthening them, and causing the fusion of zooids. But in some groups, such as *Crisiidae,* in the order *Cyclostomata,* and particularly *Stolonifera* in the order *Ctenostomata,* they also play another more important role—the formation of autozooids; this is possible, of course, owing to the fact that their living, filled tissue is undifferentiated, has an embryonic nature, and possesses a great capacity for tissue formation.

Kenozooids are found in all three orders of *Gymnolaemata*; these are described separately in greater detail. All the structures referred to as kenozooids and heterozooids here, being devoid of an alimentary canal, cannot feed independently. They live and grow, and even regenerate, at the cost of the food material of neighboring autozooids, thanks to the existence of a communication system among all members of a zoarium in the form of small openings or pores, or pore plates and pore chambers. If even a large part or almost all of the zooids in the zoarium are devoid of polypides, and the zoaria appear to be non-living, life is still preserved in the zoarium due to the few palpable zooids or the endocyst in the cystids, which make it possible for the zoarium to withstand unfavorable conditions in the external environment.

Reproduction of Bryozoa

Bryozoa reproduce by sexual as well as asexual methods. The first method is used in the formation of new colonies, or the zoaria; the second is used for the further development of newly formed colonies. The majority of Bryozoa are bisexual or hermaphrodite, and usually the male and female sex organs develop simultaneously; but such cases are also not rare when a clearly expressed protandry is observed, i.e., spermatozoa develop first, and only then do the eggs develop. A few cases are definitely known in which the Bryozoa are dioecious, particularly the species of the genera *Crisia* and *Tubulipora* among *Cyclostomata* (Harmer, 1891, 1898a, 1898b). A few Bryozoa [*Membranipora membranacea* (L.), *Electra pilosa* (L.) among *Cheilostomata,* and certain other species of the genera *Alcyonidium* and *Flustrella* among *Ctenostomata*] release fertilized eggs outside where they develop in the sea.

Egg laying in the aforementioned form takes place through the inter-tentacular organ developed before the maturation of the sexual products in fertile zooids. The inter-tentacular organ is situated near the base between two media-tentacles on the dorsal side; with the thickened margin of the orifice it appears canaliculate and is internally lined with cilia (Figure 93, B). The eggs are laid when the zooid is in a stretched condition. According to the observations of Marcus (1926b), in *Electra pilosa* (L.) eggs pass through the canal in a period of not more than 30 seconds and, approaching the outer orifice, are exposed to the current created by the tentacular cilia, and thus ejected into the water. The eggs, while passing through the canal, are more or less deformed, but after some time they acquire a round shape.

In a very few Bryozoa, such as *Alcyonidium mytili* Dalyell, *Farella repens* Farre, and *Hypophorella expansa* Ehlers, a permanently open orifice of the body cavity exists between the mouth and tentacles in the fertile as well as sterile zooids, through which their sex products are excreted.

Egg development

In the majority of Bryozoa, eggs develop in the body cavity of fertile zooids, the atrial cavity, or in special brooding chambers. Sex products originate from the mesodermal layer of the zooidal wall; their location varies, but usually the testis are located in the proximal region of the zooid at the funiculus (funicle) or at the body wall near the funiculus, and the ovaries are formed on the lateral or basal walls of the distal half of the zooid. Having been released on maturity from the surrounding funicular cells, the egg falls into the body cavity where it is fertilized by the sperm.

Further development of the egg takes place either in the body cavity or outside it. Eggs develop inside the body cavity in many *Cheilostomata* which do not have ovicells, and in *Ctenostomata,* while in *Cyclostomata* this takes place in the changed fertile zooids, i.e., gonozooids (cf. *Cyclostomata,* p. 84). Larvae develop inside the body cavity, fall into the atrial cavity via the sucking action of its wall, and from there move out through the orifice of the zooid. This mode of development is often accompanied by a degeneration of the polypides in the corresponding fertile zooids.

Outside the body, eggs develop either in the atrial cavity, true only in a few forms like *Flustrella hispida* (Fabricius), *Alcyonidium mytili* Dalyell, and others, or in special structures called ovicells. In the first instance, due to the shedding of a part of the tentacular sheath, the egg penetrates into the atrial cavity where it develops to a larval stage (in *Flustrella hispida* Fabricius, up to 4 to 5 eggs); the polypides frequently degenerate during this process. A larger part of the eggs in *Cheilostomata* develop in special structures which form a part of the zooid adapted for carrying embryos; these are the so-called ovicells or the oecia (cf. *Cheilostomata,* p. 300).

In most members of *Gymnolaemata,* eggs are subjected to a total uniform cleavage and, as a result, a 32-celled plate is formed, the cells of which are arranged in two layers. The blastocoel which appears by separation in the middle of these layers soon after the introduction of entodermal cells into the cavity, becomes a gastrulá (Vigelius, 1886-88) (Figures 4 and 5). In *Flustrella hispida* (Fabricius), in which eggs are rich in yolk,

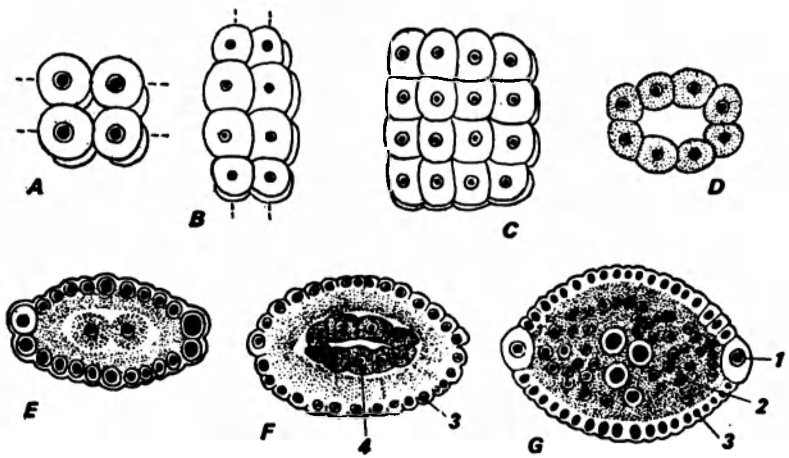


Figure 4. Embryonic development in *Cheilostomata* (*Bugula calathus* Norman). From *A* to *C* cleavage (8, 16, and 32 blastomeres)—typical discoidal arrangement of the blastomeres; *D*—cross section of blastula; *E* and *F*—gastrula; *G*—blastocoel filled with a cellular mass which consists of a small part of the abortive entodermal cells: 1—*crown cells;* 2—*mesoderm;* 3—*ectoderm;* 4—*entoderm* (*from Cori,* 1941).

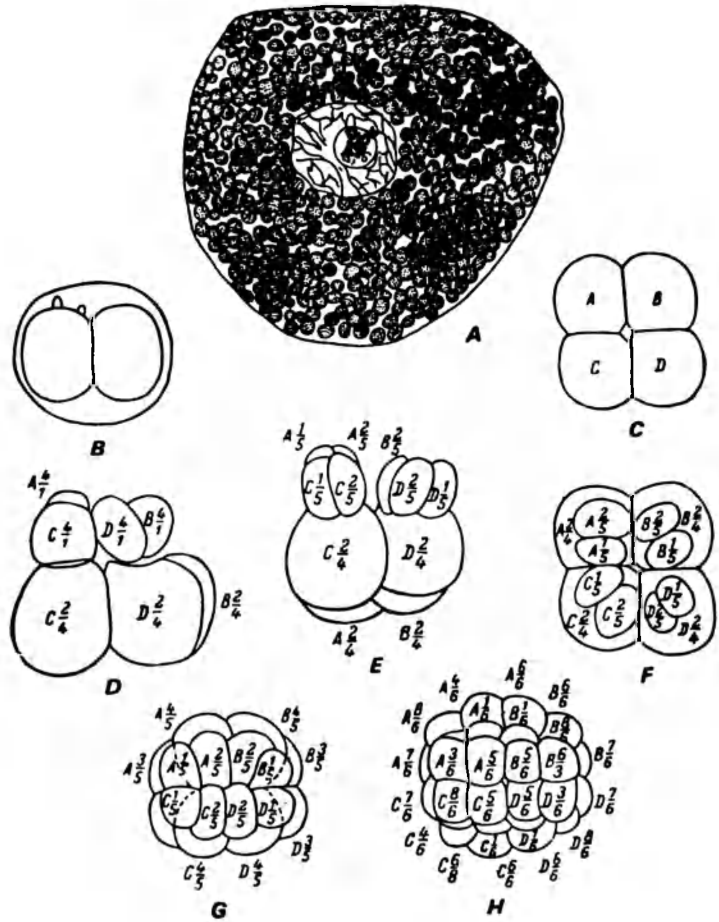


Figure 5. Cleavage of an egg rich in yolk (*Flustrella hispida* Fabr.). *A*—cross section of a mature egg ($\times 65$); *B*—stage 2 of the cells ($\times 65$); *C*—Stage 4 of the cells—each cell has been labeled with a specific letter *(A, B, C, D)*; the cells originating from them are also marked with the same letters with a division, which indicates the generation (denominator) to which a cell belongs, and the number of cells (numerator) in the progeny at the time of formation of any of the given cells; *D*—stage 8 of the cells with 4 micro- and macro-spores, arranged in two layers, lateral view ($\times 90$); *E*—stage 12 of the cells, lateral view; *F*—same, aboral view ($\times 90$); *G*—stage 16 cells, aboral view ($\times 90$); *H*—stage 32 of the cells, aboral view (from Pace, 1906).

4 macromeres and 4 micromeres are formed at the 8-celled stage and arranged in 2 layers. Micromeres, by a further division, grow over the macromeres to form an ectoderm; macromeres form the entoderm of the embryo (Pace, 1906; Figure 6). Cells of the mesoderm develop from the

entoderm forming mesenchymatous tissue filling the primary cavity of the embryo. During further development, as derivatives of the larval ectoderm, a wide strip of large cubical cells originates which is covered with cilia—the so-called corona (crown) separating the upper aboral or neural half from the lower frequently invaginated oral half. This corona is morphologically the pre-oral ciliated ring, which is typical of all Bryozoa. On the surface of the lower half, or the hyposphere, the blastopore appears, and the ectoderm on the top of the surface of the upper half of the episphere, thickens forming the parietal plate or organ which has large and strong cilia, and forms the nerve center. The parietal

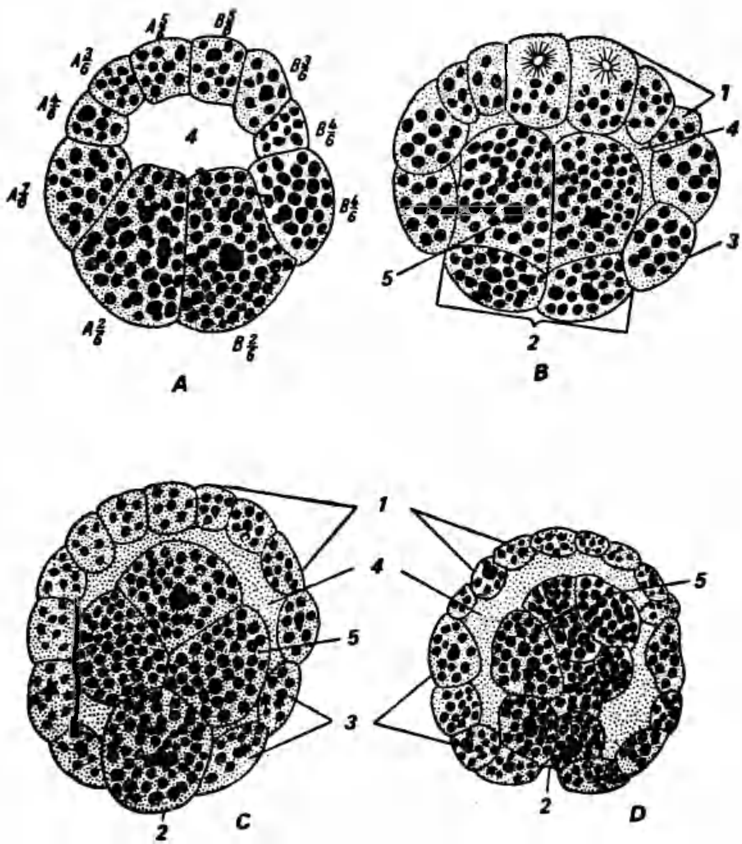


Figure 6. Formation of embryonic layers (*Flustrella hispida* Fabr.). *A*—section through blastula at stage 20 of the cells (×250); *B*—longitudinal section at the stage of gastrulation (×205); *C*—continuing gastrulation; *D*—cross section of gastrula, blastopore open (×225): 1—*aboral ectoderm;* 2—*blastopore;* 3—*oral ectoderm;* 4—*cleavage cavity;* 5—*entoderm or mesoderm* (*after Pace,* 1906).

organ in the course of further development of the larvae, is fused by the muscular bundle with the tactile organ located before the pyriform organ.

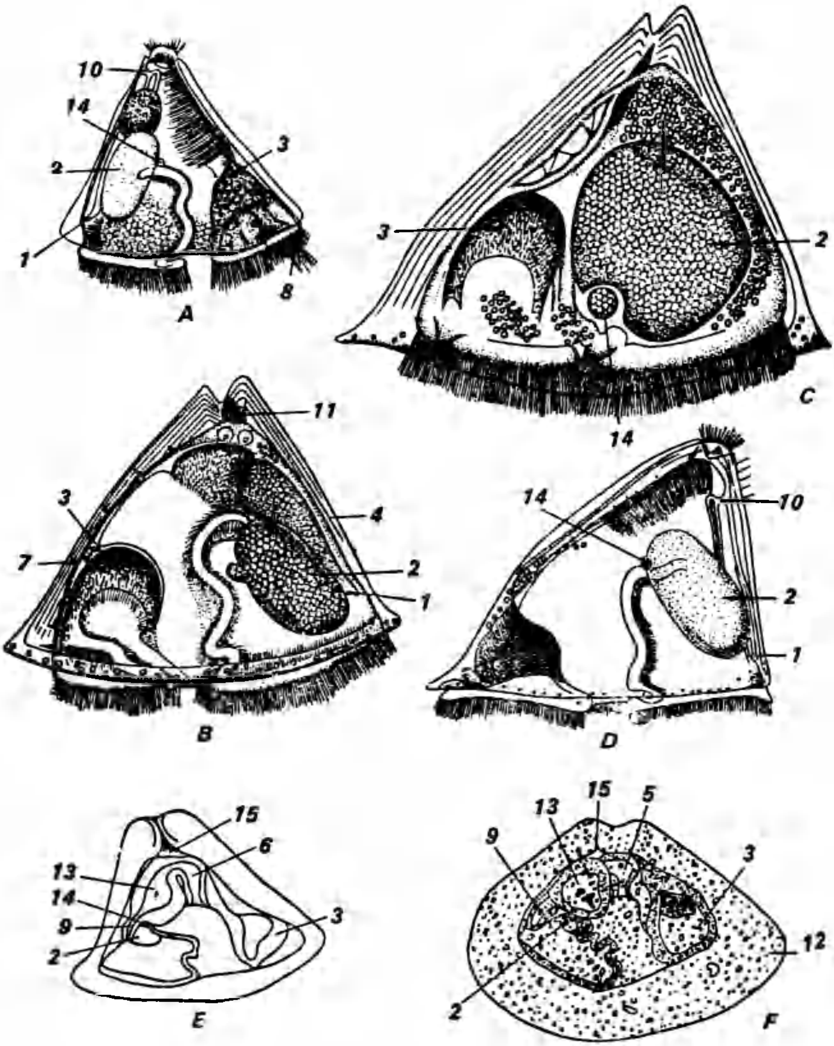


Figure 7. Larvae of Bryozoa. *A—Cyphonautes compressus* Ehrenb. (from Schneider, 1869); *B—C. schneideri* Lohm.; *C—C. borealis* Lohm. (from Claparede, 1863); *D*—same (from Schneider, 1869); *E—C. balticus* Lohm.; *F—C. barroisi* Lohm. (from Lohmann, 1911):

1—*anus;* 2—*primordium of the basal plate;* 3—*pyriform organ;* 4—*hind margin of the shell;* 5—*esophagus;* 6—*foregut;* 7—*fore margin of the shell;* 8—*ciliary bundle of the pyriform organ;* 9—*rectum;* 10—*oral orifice;* 11—*retractor of the parietal organ;* 12—*valve;* 13—*stomach;* 14—*closing muscle of the valves;* 15—*parietal organ.*

Behind the oral orifice but before the anal opening, the invaginated primordium of the basal plate develops which is known as a sucker (Figure 7). The structure of the trochophores is more or less common for all larvae of *Gymnolaemata,* but in the different orders and genera, they are distinguished by a different form and structure in the ectodermal cover as well as by the degree of their intestinal development.

Larvae

The larvae of *Cyphonautes,* as well as the larvae of *Flustrella hispida* Fabricius, are equipped with a bivalved (bicuspid) chitinous shell, the valves of which are combined on the dorsal side, and with the help of transversely extended adductor muscles, may come close, or even totally close, for the sake of protection. These larvae differ from the adult animals to such an extent in their structure and outer appearance that originally they were considered bivalved mollusks. A specific generic name, *Cyphonautes,* was coined ("Buckelfischchen"), which is even now preserved for the larvae, the relationship to whose species is not known. Only the egg-laying species, *Cyphonautes,* e.g., larvae of *Electra pilosa* (L.), *Alcyonidium albidum* Alder, *Hypophorella expansa* Ehlers, *Farella repens* Farre, and others, has a completely developed intestine consisting of all the three parts—esophagus, stomach, and proctodeum (rectum)—and an opening mouth and vent; these larvae feed on diatoms and other small pelagic animals. The remaining larvae of the viviparous Bryozoa either possess a rudimentary intestine without the proctodeum (rectum) and the vent (e.g., in *Alcyonidium mytili* Dalyell, *Flustrella hispida* Fabricius, and others), or they are totally devoid of an intestine (e.g., in the species of the genera *Bugula, Lepraliella,* and others).

Of all the larvae of the Bryozoa, the most studied ones are the larvae *Cyphonautes* as the duration of their freely floating (swimming) stage continues for about two months; therefore, they are frequently found in plankton. Other larvae have been studied to a much less degree as they are rarely included in plankton, and many, e.g., the intestineless larvae, are never found in plankton. Since the study of larvae carries great significance for understanding the biology of Bryozoa and the question of their geographical distribution, we will provide the description and sketches of those which may be found in the region examined by us. This includes a small number of the known species of the adult Bryozoa, and the task before future investigators will be to study the biology of the larvae found in the Bryozoa of our waters.

Larvae that develop freely in water, or in the body cavity, or in the ovicells, behave differently, primarily because of their feeding. Larvae provided with a developed intestine and capable of independent feeding (*Cyphonautes*) lead a pelagic mode of life, mainly in the coastal waters for about two months; while larvae with undeveloped intestines swim (float) for only 12 to 24 hours, or even less, and that too mainly on the bottom layers in the vicinity of the maternal colonies. After floating for a short duration, the larva settles down to the bottom and attaches to the substrate. This fixation takes place with the help of the sucker which turns outward in advance and then closely attaches, as far as possible, to a smooth surface on the substrate. This is facilitated by the pyriform organ which, while slipping over the substrate, searches for a suitable place for fixation by its sensory cilia.

On fixation to the substrate, the metamorphosis of the larva begins. It commences with the histolysis of the intestine and a part of the mesenchymatous tissue; the remaining part of the latter forms a mesodermal layer, lined with the ectodermal layer of the larva on the inner side, because of which the secondary body cavity is formed. The external cilia of the ectodermal layer disappear, and the latter is covered with a cuticle. In the body cavity of the larva, on the upper or neural side, a bud forms which gives rise to the polypide, i.e., to the alimentary canal along with the tentacles, and in this manner the ancestrula or the primary zooid originates. Normally in the larva of *Gymnolaemata,* as distinguished from *Phylactolaemata,* only one polypide develops, and rarely two, which can be seen in the zoaria; this polypide forms not from one but from two ancestrulas. This metamorphosis, from the moment of larval attachment up to the first invagination of the polypide of the ancestrula in *Alcyonidium,* and a few other Bryozoa, lasts about 5 days.

As the main representatives for describing *Cyphonautes,* those larvae can be taken which, in their developed condition, have calcified valves on their sides, and the larvae belonging to the ectoproct *Electra pilosa* (L.) (*Cyphonautes compressus* Ehrenb., description given according to Marcus, 1940: 334; cf. Figure 7, A).

A larva has an oral surface bordered with a crown of cilia (corona) and its aboral (hind) side is frequently very narrow. In the middle of the hind side is located the sensory or parietal organ (lid or operculum), which is capable of inward retraction. The larva floats, bent on its front side from the hind side, swinging in a motion similar to the flight of an aerial snake; the valves are very frequently horizontally placed. The valves are combined with the help of the closing muscle, which is situated between the entrance to the intestine (vestibulum) and the hind gut. The saccate organ is also situated there, which is the primordium of the basal plate, the internal cavity having an exhalant orifice on the oral surface. At the time of fixation, the larva in the internal cavity is totally turned outward and converted into the basal plate, with the help of which it becomes attached. But the primordium of the basal plate forms only gradually at the time of the free marine life of the larva. The place suitable for attachment is probably selected with the help of the pyriform organ, the cilia of which feel all around the underlying surface. Moreover, the aforesaid secretes a gummy substance which facilitates fixation of the larva. Two peculiarities of *Cyphonautes compressus* are the smooth triangular valves with rounded oval angles, and the stomach which forms a fornix near the esophagus. The length of the oral margin of the shell is 430 to 485 microns. In the German Sea and in the western part of the Baltic Sea, these larvae are located in a large number of plankton during the winter.

Borg (1930a: 126-27) has given a description of *Cyphonautes*, though without naming them as such. The aboral half of the larva, pressed on the sides, is covered with two chitinous valves of a triangular form which have a groove on each aboral pole for the passing of the contracting parietal organ, separated from the curved oral half by the ciliary belt or the corona (prototroch). The pyriform organ, consisting of glandular and ciliate cells, is pre-orally located, but this organ attains a complete development only when the larva has led a pelagic life for some time; the so-called sucker is post-oral and, at the same time, pre-anal in relation to the horseshoe-like bent intestine, i.e., the invaginated sucking organ (primordium of the basal plate which is still not developed in the beginning of the platonic mode of life). In the majority of Bryozoa, because of the large part of their larval development, either inside the body cavity or in the ovicells, the larval type *Cyphonautes* has a more or less changed form. In the majority of the species belonging to this group, the chitinous valves are not developed, and probably a marked change in the shape of their larvae is associated with this; their intestines are rudimentary and blocked, or are completely absent. As a result of this, the larvae do not float for a long time and the pyriform organ (if present), and the sucker are completely developed in these larvae when they leave the maternal zooid or the ovicell. Lohmann (1911) has identified the following 5 forms of *Cyphonautes* in which, for systematic grouping, he has placed the form and species of the shell first.

1. *Cyphonautes schneideri* Lohmann (=*C. compressus* Ehrenb.) (Lohmann, 1911: 36) (Figure 7, B). In the Northern Seas, this is the largest larva. The fore and hind margins of the shells are almost equal in length. The nodules on the oral margin of the shell are scattered and few in number. It is not yet known to which species of Bryozoa this larva belongs. It is found in the North Sea. The shells are smooth and of triangular form with a slightly bent oral margin. The oral margin of the shell is provided with small nodules. The angles of the oral margin are sharp. The frontal margin of the shell is only slightly longer than the hind one, as a result of which the aboral pole is slightly tilted backward; the oral margin of the shell reaches 0.78 mm in length.

2. *Cyphonautes borealis* Lohmann (Lohmann, 1911: 36) (Figure 7, C

and D). Because of the strongly backward tilted aboral pole, the larva has the form of a clearly expressed non-equilateral triangle. The length of the oral margin of the shell is from 0.55 to 0.69 mm. The nodules are almost evenly distributed on both ends of the oral margin. The parent species of this kind of larva is also not yet known. It is found in the North Sea. The shells are smooth and triangular with an almost straight oral margin. The oral margin is provided with small nodules which are more dense on both ends. The frontal margin is significantly longer than the hind one, because of which the aboral pole is tilted backward.

3. *Cyphonautes compressus* Ehrenberg (Borg, 1930a: 129) (Figure 7, A). The smooth shells, triangular with a weakly bent oral margin, are rounded. The hind margin of the shell is straight or mildly bent, without a round protuberance at the terminal end. The oral margin is from 0.430 to 0.485 mm in length. The pharynx is short and wide. This was the first larva to be discovered by Schneider (1869). This larva is often found in the North Sea and in the western part of the Baltic Sea, similar to the Belt Sea, and it appears here in particularly large numbers during the winter, from November to February, while from June to September it is rarely recovered in plankton samples.

4. *Cyphonautes balticus* Lohmann (Lohmann, 1911: 38) (Figure 7, E). The shells are smooth and triangular with a slightly bent oral margin. The oral margin is devoid of nodules and its angles are rounded. The oral margin on the hind end of the shell has a round protuberance. The aboral pole is wide and almost directly truncated. The length of the oral margin of the shell is from 0.21 to 0.39 mm, i.e., the smallest of all the previous larvae.

This larva is frequently found in the western part of the Baltic Sea, from which it should be concluded that it belongs to the Bryozoa distributed in this region, and Lohmann is inclined to believe that it is converted into *Membranipora* (*Electra*) *crustulenta*. If this is confirmed, then it becomes difficult to explain the presence of the rough *Cyphonautes* discovered by Levander (1914: 516) in the eastern part of the Baltic Sea, where the aforementioned *Membranipora* live. In any case it has not been established to which species of Bryozoa *C. balticus* belongs.

5. *Cyphonautes barroisi* Lohmann (Lohmann, 1911: 38) (Figure 7, F). The shell at first glance appears to be very similar to the small bivalved mollusks, and hence in many cases it could have been overlooked. Encrustation on the surface of the shell is very characteristic; the surface is covered with minute tubercles (knobs). The stomach is of considerable width, and the hind gut is pushed far behind. Both valves of the shell are closely knitted and therefore, strictly speaking, one could describe it as a single shell. The length of the oral margin of the shell is from 0.16 to 0.20 mm. The species was discovered by Lohmann near Kiel.

Probably the *Cyphonautes* discovered by Levander (1914: 516) in the Baltic Sea, in the Gulfs of Finland and Bothnia up to 63°30′ N, belongs to this species of larva, which in this case should be the larva of *M.* (*Electra*) *crustulenta*. On the other hand, Lohmann has stated that possibly *C. barroisi* is the fully developed larva of *Hypophorella expansa*, which has been questioned by Borg (1930a) on the basis of the distribution of the latter species. Similarly there have been doubts raised about the hypothesis of Levander (1914), that *C. barroisi* represents a younger stage of *C. compressus* or some other species of *Cyphonautes*.

Now we shall describe the changed forms of *Cyphonautes* found in a number of other *Ctenostomata*.

Flustrella hispida (Borg, 1930a: 131) (Figure 8, A). This is a viviporous species and the larva, after leaving the maternal zooid, is like a typical *Cyphonautes* with two chitinous valves strongly pressed from the sides, but it does not have a triangular profile; it is low like a flat cap. It is yellow-gray in color. Similar to the other *Cyphonautes*, it is provided with an intestine of a very rudimentary nature; communication between the fore-part of the intestine and the stomach does not take place; the anal opening is also not developed; the whole of this organ degenerates even before the fixation of the larva to the substrate. The pyriform organ and the sucking organ are well-developed even at the time of release of the larva from the maternal individual.

Farella repens (Marcus, 1926b: 82) (Figure 8, B). The eggs laid in water develop within 50 hours, or a little more, up to the stage of freely floating young larvae which, in structure as well as in body form, are typical *Cyphonautes*. They have a triangular profile. The pyriform organ is distinctly clear; on the contrary, the rudiments of the adhesive organs have not appeared by this time. The young larvae do not have a shell; however, it is clear that they form two valves, observed at a later stage as well as at this time. They swim forward with the help of the parietal organ with a simultaneous right turn of the body.

Hypophorella expansa (Marcus, 1940: 339) (Figure 8, C). The larva has a wide oral margin which is also a margin of the corona with the cilia, similar to the brim of a hat. The intestinal canal is completely developed, the parietal organ is present, and so is the primordium of the pyriform organ. In the known young specimens of this larva, neither the valves nor the inner cavity are developed (Eastern Frisian Islands). They are found among plankton in May and August to September.

The intestineless larvae of *Cheilostomata*, or those with only a rudimentary intestine, swim in water only for a short time. In this stage they usually remain near the maternal zoarium and, therefore, are rarely found in plankton and, sometimes, are not found at all in the open sea. It should not be forgotten while describing the form of these larvae, that they are

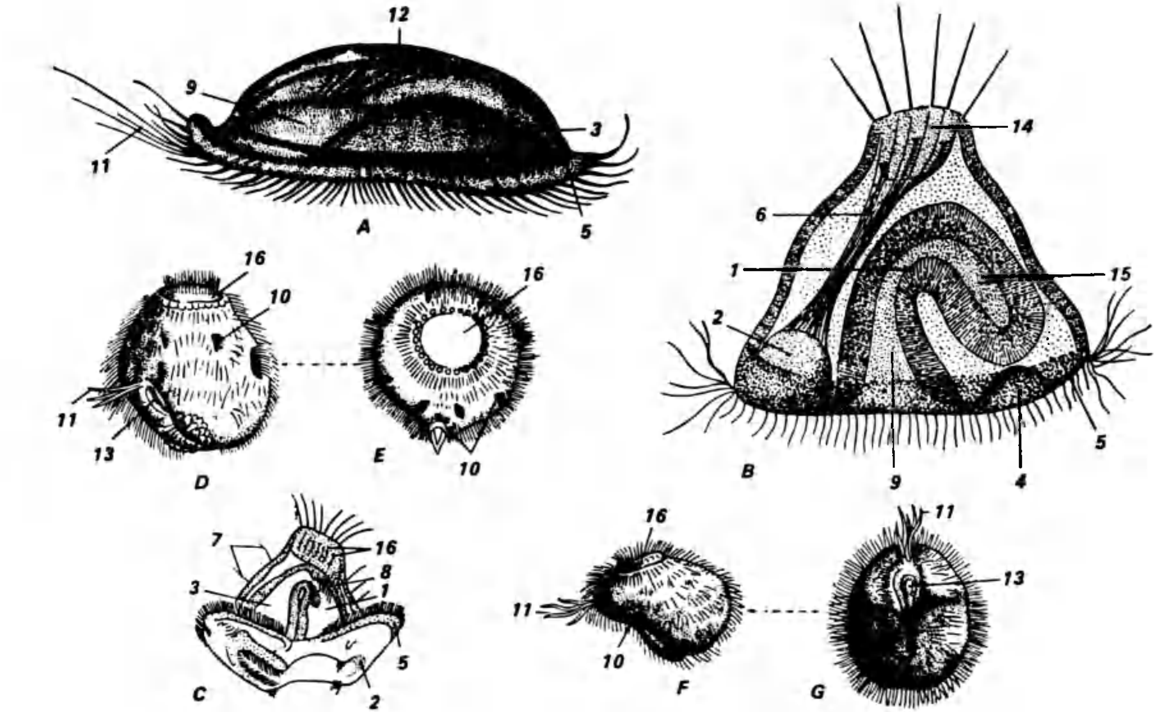


Figure 8. Larvae of different Bryozoa. *A—Flustrella hispida* (Fabr.) (from Barrois, 1877); *B—Farella repens* (Farre) (from Marcus, 1926b); *C—Hypophorella expansa* Ehl. (from Prouho, 1892); *D—Bugula flabellata* Thomps., lateral view; *E*—same, view from top; *F—Bicellariella ciliata* (L.), lateral view; *G*—same, bottom view (from Nitsche, 1870):

1—*pharynx;* 2—*pyriform organ or its place;* 3—*stomach;* 4—*hind gut;* 5—*corona;* 6—*muscular and neural cords between the parietal and pyriform organs;* 7—*tactile cilia;* 8—*esophagus;* 9—*rectum;* 10—*pigment spots;* 11—*ciliary bundle of the pyriform organ;* 12—*sucker;* 13—*oral orifice;* 14—*retractor of the parietal organ;* 15—*mid-gut;* 16—*parietal organ.*

capable of strong contractions and, consequently, their form may be strongly changed. The description below concerns only the living uncontracted larvae. Three forms have been examined from *Anasca.*

Bugula flabellata (Nitsche, 1870: 7) (Figure 8, D and E). Larvae are yellowish in color with not less than 5 pairs of red pigmented spots, of which 2 pairs are located above the bundle (Wimperschopf) of cilia of the pyriform organ. All the spots have a lanceolate form.

Bicellariella ciliata (Nitsche, 1870: 7) (Figure 8, F and G). Larvae are light gray in color. Pigmented spots are absent. Nitsche has compared the form of the larva to a peach with a depression (Kerbe) on the front and downward, and from top to bottom strongly flattened; the flattening is stronger from the front side than from the back. The parietal organ is relatively larger.

Membraniporella nitida (Borg, 1930a: 135) (Figure 9, A). This larva is more flattened than the 2 earlier forms. It similarly consists of 3 sections, the upper of which consists of a larger parietal organ; the second, i.e., the middle one, consists of a narrower ciliary girdle (corona); the third is made of the oral section of the larva with the pyriform organ and the invaginated sucking (adhesive) section. It is pale colored, somewhat grayish-orange, but the corona is quite orange in color. A large number of minute gray-brown spots and grains are located on the oral side, partly forming the ring around the orifice, leading into the suckers (Barrois, 1877). Larvae leave the ovicells in April, June, and July.

From *Ascophora,* 6 forms of larvae will be described.

Hippothoa hyalina (Borg, 1930a: 135) (Figure 9, B). The larva is flattened quite strongly on both the poles. The fore and particularly the hind part of the body, is rounded and strongly projected out, because of which the larva has a peculiar form reminiscent of the larva of *Bicellariella ciliata.* It is distinguished from the larva of *Membraniporella nitida* by the size of the parietal organ, the width of the corona, and its division into 3 sections. The color is bright yellow with 4 pairs of rounded red pigmented spots (according to Barrois, the larvae leave the ovicells during May to July).

Escharoides coccinea (Borg, 1930a: 136) (Figure 9, C). This larva has the greatest similarity to the larva of *M. nitida* in appearance and structure, but it is larger, the corona is wider, and the parietal organ is a little smaller. The larva is rose in color with a yellowish oral part and 4 pairs of red pigmented spots, of which 2 pairs are on both sides of the parietal organ, and the other 2 are on the oral side, 1 on each side of the ciliary groove (sulcus). The sucker is surrounded by a crown of minute brownish granules.

Microporella ciliata (Barrois, 1877: 149) (Figure 9, D). This larva is similar to *Membraniporella nitida* in body form, but its corona is slightly

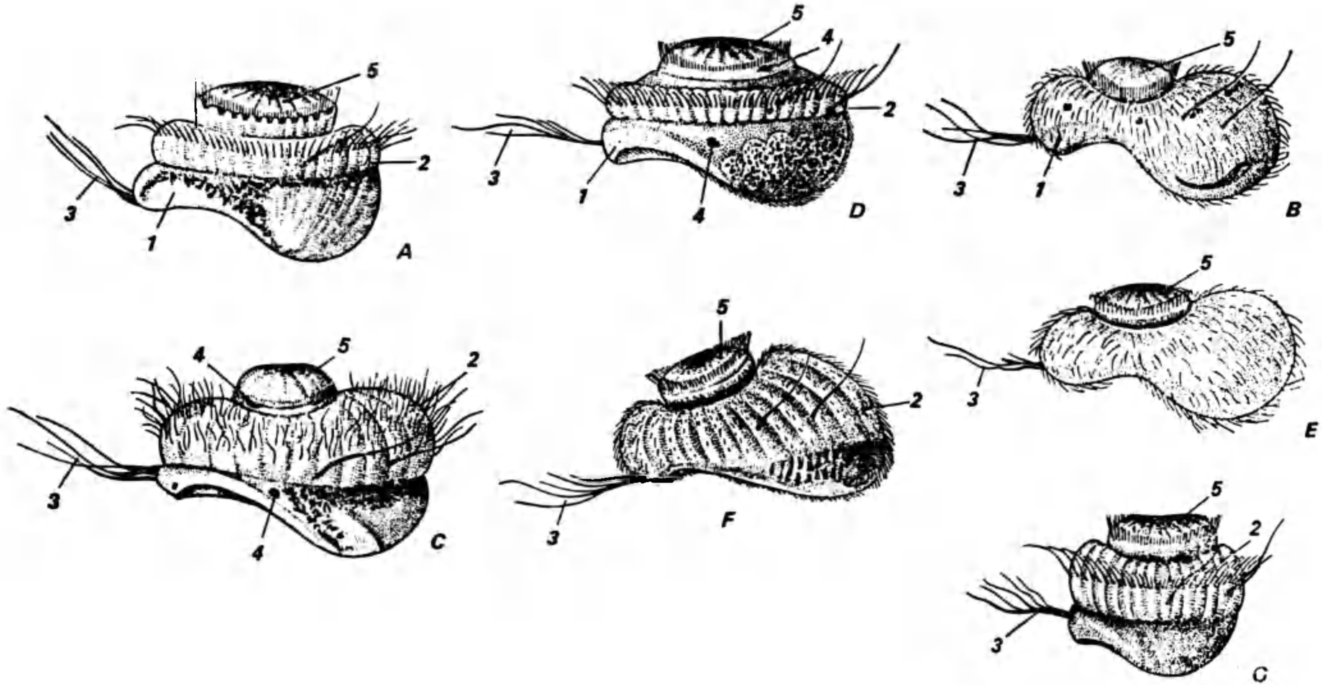


Figure 9. Larvae of *Cheilostomata*. *A—Membraniporella nitida* (Johnst.); *B—Hippothoa hyalina* (L.); *C—Escharoides coccinea* (Abildg.); *D—Microporella ciliata* (Pallas) (from Barrois, 1877); *E—M.* (*Haplopoma*) *impressa* (Aud.) (from Marcus, 1940); *F—Cellepora pumicosa* (L.); *G—Porella concinea* (Busk) (from Barrois, 1877):

1—*pharynx;* 2—*corona;* 3—*ciliary bundle of the pyriform organ;* 4—*pigment spots;* 5—*parietal organ.*

narrower. The color of the larva is bright orange, strongly expressed in the central part and along the radial grooves of the parietal organ. In the oral part, on the wall of the sucker, a large number of groups of reddish grains and spots are located. Besides these, 2 pairs of red pigmented spots are located on the larva, 1 pair on either side of the parietal organ, and the other pair on the oral side, 1 spot on each side of the ciliary groove.

Microporella (*Haplopoma*) *impressa* (Marcus, 1940: 345) (Figure 9, E). The larva is quite similar to *Hippothoa hyalina,* but its color is yellowish-red, and brown-red on the parietal organ; red spots are absent. Furthermore, in the larvae of *H. impressa,* the tissue is denser than in *H. hyalina* and not as transparent. The larvae swim in the month of July (Roskov).

Cellepora pumicosa (Borg, 1930a: 136) (Figure 9, F). In appearance the larva is similar to that of *Escharoides coccinea,* but it differs in that the corona is wider and not so distinctly demarcated from the oral part, so that one might say there are 2 and not 3 sections in the larval body. The larva is bright yellow-red in color; the parietal organ, particularly in its central part, is more red, and in the oral side around the sucker (adhesive) orifice, a circle of strongly colored red spots and grains are sketched (Barrois recorded the larvae in the months of May and June).

Porella concinea (Marcus, 1940: 343) (Figure 9, G). The most noticeable characteristic of these larvae is the very wide ciliary crown. The middle of the parietal organ is colored carmine-red. The ciliary crown is rose colored, but the color of the remaining part of the body gradually changes from rose to orange. The larvae swim from spring up to June (French coast of the Channel).

The following laıvae of *Ctenostomata* will be described.

Alcyonidium polyoum (Borg, 1930a: 137) (Figure 10, A). The larva strongly flattened, discoid, with a wide discoidal parietal organ, a rather narrow corona, and a clearly expressed ciliary groove on the oral side. Its basic color is white, the color being darker and reddish in the center of the parietal organ; a crown of reddish granules is located on the oral side around the ciliary groove. Directly behind the sucker, a small reddish spot is visible. The corona also acquires a reddısh or reddish-violet tinge. Although the alimentary canal is formed, the vent is absent and the whole intestine starts degenerating almost simultaneously with the release of the larvae (numerous in May and June).

Alcyonidium albidum (Marcus, 1940: 330) (Figure 10, B). The larva has a triangular form, and the intestinal canal is fully developed. The parietal organ is normally developed, but as the larva is known only in the earliest stage of its development, nothing is known about the pyriform organ or the organ of fixation (internal cavity). Valves are also not found in the young larvae; however, it can be expected that the cuticle is

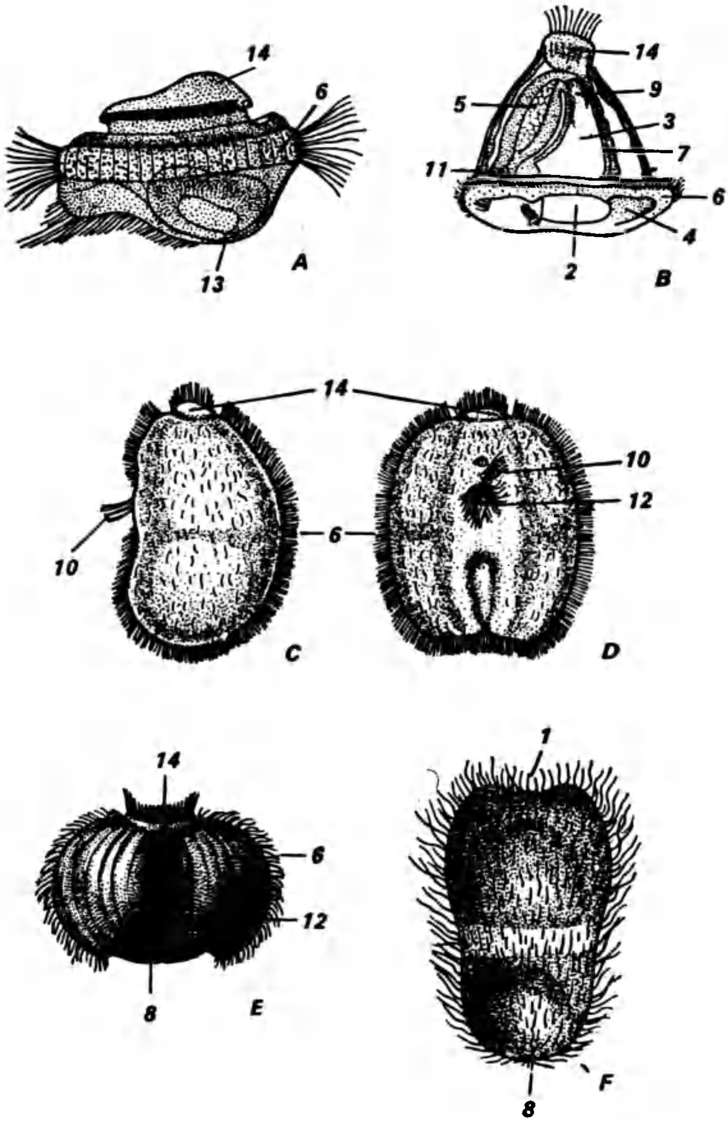


Figure 10. Larvae of *Ctenostomata* and *Cyclostomata*. *A—Alcyonidium polyoum* (Hassall) (from Seeliger, 1906); *B—A. albidum* Alder (from Prouho, 1892); *C—Bowerbankia pustulosa*. (Ellis and Solander), lateral view; *D*—same, viewed from front (from Calvet, 1900); *E—Valkeria uva* (L.); *F—Crisia eburnea* (L.) (from Barrois, 1877):

1—*aboral side;* 2—*entrance into the intestinal canal;* 3—*pharynx;* 4—*pyriform organ;* 5—*stomach;* 6—*corona;* 7—*muscular-neural cord;* 8—*oral side;* 9—*esophagus;* 10—*ciliary bundle of the pyriform organ;* 11—*rectum;* 12—*ciliary groove;* 13—*oral orifice;* 14—*parietal organ.*

calcified when advanced life occurs (French coast of the Mediterranean Sea).

Bowerbankia pustulosa (Calvet, 1900: 350) (Figure 10, C and D). The larva is exactly of the same structure as in the case of *B. imbricata,* and this is also true for the larvae of other *Stolonifera.* Only the color differs. The larva of *B. pustulosa* is translucent and whitish, with 3 pairs of meridianally located bright yellow and long stripes joined together by an equatorial belt of the same color. The stripes, from which the second pair beginning from the pyriform organ are least pronounced, originate, according to Calvet, because of the presence of a sub-epithelial fibrillar complex.

Valkeria uva (Barrois, 1877: 202) (Figure 10, E). This larva also belongs to the same type of larvae as *Stolonifera,* having a very wide corona which occupies most of the surface of the larval body. The body of the larva is shaped like a lemon, and yet is almost round. The larva is yellowish in color, has a white stripe around the parietal organ, and numerous small white dots around the orifice of the sucker.

Because of polyembryony and the development within the brood chamber inside the gonozooids or in the zoarial cavity, the larvae of *Cyclostomata* underwent a great simplification in structure. There are no traces of an intestine nor of a pyriform organ; the parietal organ, surrounded by a pyriform groove, is barely noticeable, while the wide ciliary girdle, or corona, occupies almost the whole of the lateral surface between both poles. The orifice located in the oral end leads to the cavity of the well-developed sucking (adhesive) organ. In most *Cyclostomata* the larva is shaped like a lemon blunted on both ends, and in *Crisia eburnea* (Borg, 1930a: 127) (Figure 10, F), the larva, reaching a size of 0.07 mm, swims forward by its aboral end, while rotating around its axis all the time. The larvae of *Lichenopora* are more spherical and so similar in different species, that it is difficult to distinguish between them.

Asexual reproduction

Asexual reproduction in Bryozoa takes place by budding. In all *Gymnolaemata,* two types of budding are observed: zooidal (or zoecial, according to the old terminology) and stolonial. In zooidal budding, the autozooids or the zooids produce buds from each other; this form is very widely distributed among *Cheilostomata, Cyclostomata,* and partly in *Ctenostomata* (in sub-orders *Carnosa* and *Paludicellea*). Budding starts after the formation of the ancestrula. In *Cheilostomata* the ancestrula usually produces 3 buds, 1 on the front and 2 on the sides, and frequently each of the latter produce an additional one. The zooids arising out of them preserve the original properties to a maximal degree, especially the formation of many buds and a large number of spines in comparison with the future zooids, if the given species possesses spines. In successive generations, usually from each freshly forming zooid, 1 or 2 and, rarely, 3 new zooids form. The development of the bud takes place in such a manner that a thin, transverse, vertical fold (duplicature, ridge) is formed near the distal end of the maternal zooid or at its side, which continues from the frontal wall to the basal one, and separates a part of the body cavity in the maternal zooid. An intensive reproduction of the ectodermal and mesodermal cells takes place in the separated cavity which, ultimately, forms the sexual outgrowth. In this outgrowth parts of the future zooid start to form: first the basal and lateral walls, followed by the frontal and distal walls, and then the region of the zooidal orifice. Only after this does the polypide start developing in the almost formed cystid. On one of the walls of the proximal part of the cystid, usually near the pore plate, a thickening of the ectodermal cells takes place giving rise to a bud covered with a mesodermal layer. This bud grows out at the cost of the nutritive material entering through the pore plate; and on the side facing the cavity of the cystid, first a depression appears and then invagination develops, which separates the frontal larger part from the smaller hind one. The tentacular sheath and the forepart of the intestine develop out of the frontal part with tentacles, and the posterior region of the intestine develops from the smaller hind part. The final formation of the intestine takes place during further development, and the latter bends in such a manner that the hind gut comes near the fore end, i.e., toward the atrial cavity. The final formation of the region of the zooidal orifice, i.e., the formation of the lid or operculum, also takes place toward the end of the development of the polypide. A very good illustration for this description is provided by Marcus (1926a) given in Figure 11, together with a sketch of the degeneration and regeneration of the polypide which take place in the developed part of the zoarium. For budding in *Cyclostomata* the section on *Cyclostomata* should be referred to (p. 83).

In stolonial (stolonate) reproduction, the newly formed zooids originate not from the other developed zooids, but from the so-called stolon which consists of uncalcified or calcified chitinous tubes lined with an ectodermal layer on the inner side excreting chitin, and a mesodermal layer in the form of a loose mesenchymatous tissue which fills its cavity. These tubes are intersected at definite intervals by transverse septa on separate areas or on internodes provided with holes. These latter are devoid of an external orifice and polypide, and are called kenozooids. From the internodes, in some cases regularly and in others irregularly, vertically uprising cylindrical tubes start to form an orifice and polypide, i.e., autozooids. Such a method of reproduction is found to occur in *Cyclostomata* in the sub-order *Articulata* and among *Ctenostomata* in the sub-order *Stolonifera.*

The mechanism of budding does not play as large a role in any other group of animals as it does in Bryozoa. It leads not only to the asexual formation of the fertile zooids, but also to the origin of polymorphism.

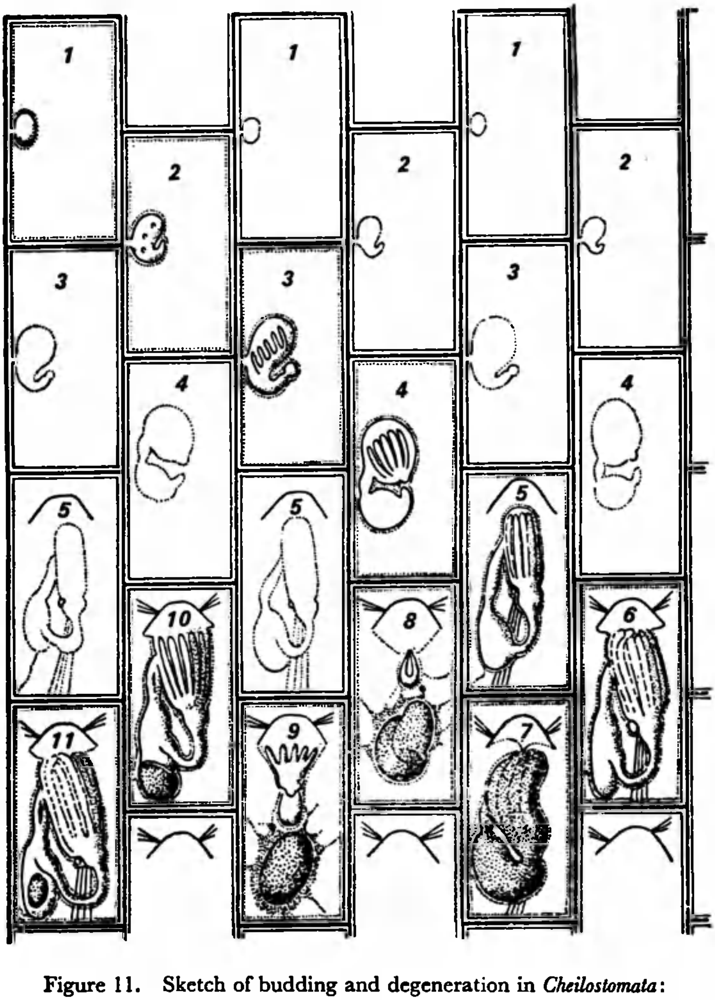


Figure 11. Sketch of budding and degeneration in *Cheilostomata*:

1—*ectodermal thickening with the surrounding mesoderm;* 2—*initiation of the tentacles and atrium; formation of the anal opening and intestine;* 3—*continuation of the formation of the tentacles and alimentary tract;* 4—*beginning of the separation of the bud from the body wall of the zoecium; formation of the esophagus;* 5—*almost completely formed bud which is unable to emerge;* 6—*a formed bud, capable of projection;* 7—*beginning of the polypide's degeneration;* 8—*degeneration of the polypide (formation of the brown body); setting (initiation) of the regenerated bud;* 9—*the brown body surrounded with phagocytes and a markedly outgrown bud;* 10—*location of the brown body in the blind sac of the bud;* 11—*established bud capable of projection with the brown body in the blind sac (from Marcus,* 1926a).

It is characteristic of Bryozoa that even during sexual reproduction, autonomous metamorphosis in which this larva could have directly become a completely developed animal does not take place; for this it is essential that for the formation of all the internal organs of the larva a new bud be formed from which all the internal organs or the polypide could develop, and by this the initiation of the formation of the first individual or ancestrula could be laid. Thus bud initiation is the strongest leading factor in the life of Bryozoa.

How great the reproductive capacity of budding in marine Bryozoa is, can be judged from the experiments of Friedl (1925) in the harbor of Rovinew, from which he established that the zoarium of *Schizoporella sanguinea* Norman, with a width of 12 cm, consisted of approximately 38,000 zooids, all of which had developed from one ancestrula in the course of 5 months. In this study he made an interesting observation: the buds in the zoarium do not grow to their full size at a uniform rate. It appears that the rate of bud development increases with an increase in the growth of the zoarium which, in turn, depends upon the number of zooids capable of participating in the feeding of the buds. On the basis of observations on zoarial formation in *Electra pilosa* (L.), Marcus (1926b) has reported data on the growth rate of the bud up to its full development, depending upon the continuation of growth in the zoarium (in days):

Continuation of zoarium growth	1	2	3	4	5	6	8	10
Continuation of bud growth	8-13	9-10	6-11	7-8	4-7	5-6	3-5	1-3
Average	10	9.5	8.5	7.5	5.8	5.5	4	2

Degeneration and regeneration. The phenomena of degeneration and regeneration play an important role in the life of Bryozoa; both operate in close association with the phenomenon of budding. Complete and partial degeneration and regeneration are distinguished from each other. In many *Ctenostomata,* such as *Bowerbankia, Valkeria, Triticella,* and others, complete zooids, i.e., polypides together with cystids, fall away from the stolon under the influence of external environmental conditions. After a definite interval, similar new zooids appear in their place which originate from the stolon by regeneration. According to Harmer (1891), complete regeneration is observed in the fertile branches of *Crisia* which, after the development of larvae in their gonozooids and their release, degenerate, fall away, and are again restored (being already devoid of gonozooids). Levinsen (1907) was the first to draw attention to the fact that such cases are not rare when zooids somehow die or degenerate in the zoaria of *Cheilostomata,* leaving in their place only a calcareous wall, while a new zooid appears in the latter with its own wall; it so happens that instead of an ordinary zooid, an avicularium regenerates there or, in an opposite case, an ordinary zooid regenerates in a dead vicariating avicularium (Figure 12, A to E). Sometimes, for want of space for the regeneration of a complete zooid, a kenozooid is regenerated, and then the old orifice of the zooid through which destructive external elements could exert influence, is closed by forming a calcareous plate under it. Such calcareous plates are not rare among representatives of *Cyclostomata* and *Cheilostomata.* Levinsen could even record a phenomenon of double and triple regeneration, when three avicularian skeletons were fastened one in the other, and again, when two skeletons of autozooids followed one after the other, followed by the skeleton of the avicularium (Figure 12, F). In all these cases the repeatedly regenerating zooids, or the avicularia, originate either from the proximal zooid or from the closest neighboring zooid, which supplies material for the regenerating bud through connecting pores or pore plates. Buchner (1918, 1924) assumed that vicariating avicularia could originate because in the architectonics of the zoarium they occupy a place of an ordinary autozooid, surrounded by the latter, which may send new regenerating buds in their place; but this does not concern such highly organized avicularia as, for example, those of *Bugula,* i.e., the so-called dependent or adventitious avicularia (as if related to the zooids), particularly the avicularia fixed on peduncles or stems which are not capable of further reproduction. While analyzing the data collected in the expedition "Vega" in 1878-79, I found a zoarium of *Cauloramphus intermedius* Kluge in the Yugorki Shar on which pedunculated (stalked) avicularia on two zooids formed similar new avicularia on the frontal surface, which had completely developed, chitinous, and sharp mandibles pointed upward (Figure 12, G). In principle, this phenomenon of regeneration is the same as the phenomenon of budding; the only difference is that here the zooids do not bud when young in the budding zone, but at a later stage when they are already surrounded by similar, neighboring, calcified zooids, and it would appear that there could be no more space available for budding. All this suggests that the zooid, whether normal or changed in form, has an inherent capacity for budding, to a smaller or greater degree, throughout its life.

Partial degeneration and regeneration is much more distributed in the life of Bryozoa. The partial degeneration and regeneration imply disintegration of the intestine together with the tentacles, i.e., the polypide, and the restoration of the latter inside the old and intact wall of the zooid or the cystid. Throughout the zoarium, in its older parts, the presence of a so-called "brown body" can be seen in many zooids. As was indicated earlier, the excretory function in Bryozoa is performed by amoebacytes and the cells of the blind sac and pyloric part of the intestine. Together with the accumulation of excreta, the intestinal cells lose their capacity to digest food and start degenerating; then the funiculus and the

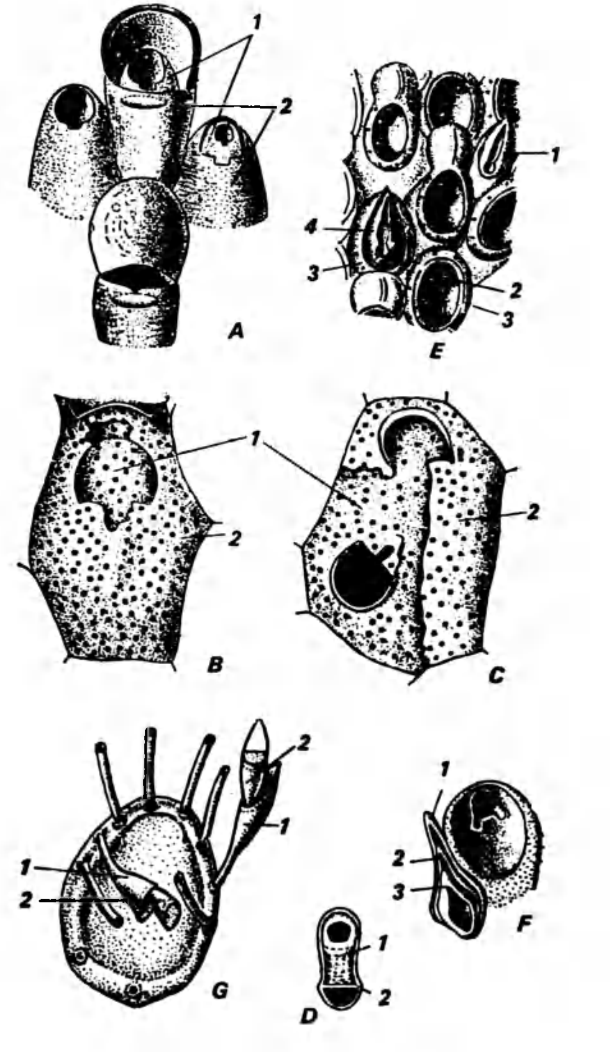


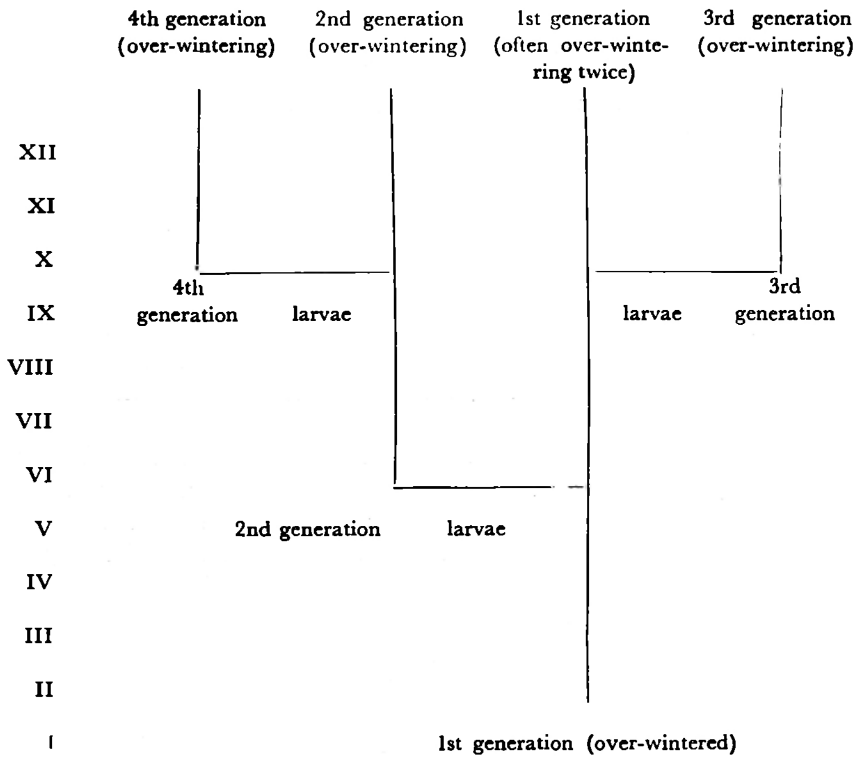
Figure 12. Degeneration and regeneration in *Cheilostomata.* Regeneration of zooids: *A—Hippothoa* sp.; *B* and *C—Schizoporella cecilii* Aud.; *D—Cribrilina labiata:* 1—regenerated (new) zooid; 2—old, degenerated (dead) zooid with an entire frontal wall and open orifice, without ovicell, or with ovicell without a frontal wall (*A*); with the accompanying orifice (*B*); and with the destroyed frontal wall (*C*); 3—avicularium; *E—Membranipora carinata* Lev., regeneration of oecium and avicularia: 1—vicariating avicularium; 2—old zooid; 3—regenerated zooid; 4—regenerated avicularium; *F—Rhagasostoma galeatum* Hag., double regeneration of the avicularia: 1—maternal avicularium; 2—daughter avicularium; 3—granddaughter avicularium; *G—Cauloramphus intermedius* Kluge: 1—maternal avicularium; 2—daughter avicularium. (*A, B,* and *C* from Buchner, 1918; *G* from Kluge; *D, E,* and *F* from Levinsen, 1907).

tentacular sheath, together with the tentacles and nerve nodes, are destroyed. In short, the whole polypide degenerates turning into a formless brown body. At this time it is surrounded by a multiplicity of amoebacytes which absorb the still consumable organic matter and, as a result, the brown body decreases in volume. By this time two primordia are initiated in the body wall along the sides of the proximal margin of the orifice of the zooid which, by coming closer and fusing along the medial line, form a bud from which the new polypide develops. As this bud is initiated from a pair of primordia, it frequently happens that each primordium develops independently, and then two polypides form in the zooid which either fuse or grow independently. Waters (1913) observed in *Membranipora armata* Haswell, freshly obtained from the sea, up to 30 zooids in the zoarium with such twins. A loose mesenchymatous cord stretches from the brown body to the developing bud, together with a large number of amoebacytes which surround the brown body. All authors share the opinion that these amoebacytes, or phagocytes, play a large role in the regeneration of the new polypide. The latter, while developing further, comes closer and closer to the brown body by its blind sac, until it ultimately encircles the brown body. The brown body, falling into the blind sac, is surrounded by a thin, structureless coating, and remains there up to such time as the new polypide is completely formed; then, with the help of the cilia in the pyloric part of the intestine, it reaches the hind gut from which it is ejected through the vent. This process of degeneration and regeneration of the polypide is very clearly shown in the sketch by Marcus given in Figure 11, and is easily observed in living specimens and slides of *M. membranacea* (L.) and species of *Flustra*. But the brown body does not always fall into the blind sac to be ejected; in many *Cyclostomata* and *Ctenostomata*, as well as in some *Cheilostomata*, this brown body, surrounded by a structureless shell, remains in the zooid; 2 to 3 brown bodies can be seen in *Cheilostomata*, and a much greater number in *Heteropora*, indicating that degeneration and regeneration of the polypide has taken place in the zooid. According to the observations of Harmer (1896), in *Flustra papyrea* Pallas the whole process of degeneration and regeneration of the polypide, from the final projection of the polypide to the release of the residue of the brown body through the vent, continues for 35 days; but sometimes this process is still not fully completed even after 68 days. This process of partial degeneration and regeneration takes place at more or less regular intervals in the life of Bryozoa, but what factors lead to it have not been explained up to now. Harmer (1892), on the basis of experimental findings (by injecting indigo-carmine, Bismarck-brown, and ammonia-carmine into the bodies of *F. papyrea* Pallas, *Bugula neritina* L. and *B. avicularia* L.), came to a conclusion which confirmed the prediction of Ostroumoff (1886) namely, that the degeneration of the polypide in Bryozoa takes place due to the absence of a special excretory organ in them and, together with other elements (amoebacytes, funicular tissue), this role is played to a greater extent by the intestinal walls, especially that of the blind sac from which brown bodies start to form. This view is also shared by Prouho (1892) who pointed out the difference in the metamorphosis between larvae possessing an excretory organ, *Pedicellina,* and those which have no excretory organ, *Cyphonautes.* In the former there is an intestine in the adult animal, but in the latter this degenerates and forms again by budding. But according to Marcus (1926b), in addition to the internal factors, the phenomenon of partial degeneration is also guided by external factors such as deficiency of food and oxygen, increased and decreased temperature beyond the normal limits, increased or decreased salt concentration in the marine water, the addition of different chemical substances to the water, and the sedimentation of the residue; all these external factors give rise to unfavorable conditions to which Bryozoa react by degeneration, which is associated, perhaps, with the definite cyclic mode of life of Bryozoa in the course of the year.

Life cycle

Friedl (1925) was the first to conduct experiments in Rovinew Harbor (Adriatic Sea) with a view to studying the growth and life span of zoaria and the life cycle of Bryozoa; for this he used planks (boards) sunk to the bottom of the sea on which swimming larvae were set. The object of the study was *Schizoporella sanguinea* Norman. Friedl came to the conclusion that the duration of life of the zoaria in this species is not more than 6 months, since most of the individuals in the large zoaria contain extremely brown bodies, and such zoaria are hardly capable of continuing their life in the following spring. The greatest significance in this regard concerns the zoaria which developed during the prior autumn, in which a fairly large number of zooids still remained that had survived the winter and continued growing during the spring in the month of April. In May to June ovicells appeared in them, a proof of the development of sex products. Larvae developed from May to July from which the zoaria of the summer generations originated. These latter gave rise to the second generation of larvae, which produced new zoaria in September and October. Thus, Friedl came to the conclusion that there are two periods of growth during which the free larvae develop: first, in late spring or early summer (May to July), and second, in autumn (September to October). Zoaria developed from the larvae fixed from the end of May, grew in the course of 4 particularly favorable months, and the number of zooids increased at a rapid rate in the 5th month; in October the growth declined as a result of the accumulation of reserves related to the beginning of sexual reproduction in September; thereafter they remained in a more or less dormant state up to the following spring, provided they were able to survive the winter. The colonies developed from larvae attached from the end of July, had only 2 favorable months at their disposal (August and September), and the number of zooids increased slowly; in the month of October the growth was still slower, and toward the end of the 4th month the zoaria were only half the size of those which had developed in the first 3 summer months.

Marcus (1926a), while not belittling the significance of Friedl's experiments, believes his conclusions cannot be considered generally acceptable, because the life cycle of the Adriatic species does not coincide with that of any other species living in other seasonal conditions. Marcus adduces contradictory findings from different authors with regard to the time of appearance (month) of the larvae *Cyphonautes*, which make it difficult to accept the general picture of the yearly cycle in marine Bryozoa. On the basis of his own experiments, Marcus (1930) has given the following scheme of generation replacement in *Electra* (*Membranipora*) *pilosa* (L.) in the North Sea. This scheme should be understood as showing in essence not 4, but 2 generations replaced; in particular, his 3rd and 4th (autumn)



progenies over-winter, and the survivors of these constitute his 1st generation, which produced larvae in the spring, and a new summer progeny of zooids in May. The latter, just like some of the over-wintered zooids, developed larvae in September which gave rise to a new autumn generation of zooids in the month of October.

These zooids repeated the scheme after over-wintering. Thus, two generations, spring and autumn, were replaced in a year, and here (as in Friedl's scheme) the freely swimming larvae developed and settled down twice in the year, in the spring and in the autumn. Marcus believes that many of the Bryozoa in the North Sea live for a number of years, terminating their growth in winter and initiating it again in the following spring. For the Barents Sea this was demonstrated experimentally by Kuznetsov (1941), who conducted studies during the years 1937-38 in the Dalnezelenetskaya Inlet, on the dynamics of the biocenosis of *Microporella ciliata* (Pallas), which lives on the under side of stones at a depth optimal for its growth, 3 to 6 m. In this work Kuznetsov has given a somewhat different picture of the life cycle of Bryozoa. Based on observations of the period of larvae release and the destruction of ovicells, Kuznetsov concluded that Bryozoa included in this biocenosis can be divided into 3 groups. The first group, having 3 generations a year, is the largest in numbers. It includes the following species of those studied by him: *Callopora* (*Membranipora*) *craticula* (Alder), *Escharella* (*Mucronella*) *immersa* (Fleming), *Smittina* (*Porella*) *concinna* var. *belli* (Dawson), *Schizoporella auriculata* var. *lineata* (Nordgaard), *Stomachetosella* (*Schizoporella*) *cruenta* (Busk), *Hippothoa hyalina* (L.), *Microporella ciliata* (Pallas), *Cylindroporella* (*Porina*) *tubulosa* (Norman), *Escharopsis* (*Escharoides*) *sarsi* (Smitt), *E.* (*Escharoides*) *rosacea* (Busk), and *Cellepora ventricosa* Lorenz. The maturity of the sex products, and the development of larvae in them, takes place in February to April, May to August, and October to December. The fixation of larvae takes place during May to June, August to October, and January to February. Compared with the data of previous authors here, the winter generation wedges in, and the release of its free larvae takes place in winter during December to February.

The largest number of settled larvae fall in the autumn months (August, September, and October) because a greater number of zooids participate in the development and formation of larvae during the summer months. The lowest number of larvae settle during the winter months (January and February).

From the species indicated for this group, Kuznetsov gives a detailed description of the life cycle of *Microporella ciliata* Pallas. As shown in the graph prepared by him, the autumn larvae, fixed to the substrate, gives, on the average, 50 zooids in a zoarium and further growth stops at this stage up to spring (May) of the following year. The zoaria again grow and, up to autumn, they have as many as 800 zooids, when they again terminate their growth until the spring (May) of the next (second) year. At this time some of the zooids (15 to 20%) of such colonies, begin sexual reproduction, participate in the formation of the spring generation, and subsequently die soon after. Toward the autumn of the second year, these zoaria multiply to the extent of 2,000 zooids; some of these reproduce, taking part in the formation of the autumn progeny, and die soon after. In the spring of the third year, the zoaria again start growing, taking part in the formation of the spring and autumn progenies of this year, after which the dying off of zooids increases; thus the ratio of living zooids to dead ones is only about 10%. These zoaria reproduce for the last time in the spring of the fourth year and all the zooids die toward autumn. Thus the autumn progeny of *M. ciliata* Pallas live for about four years, giving rise to three spring and two autumn progenies during this period, and according to Kuznetsov, individual zoaria may take part in the formation of the third autumn progeny. But according to his observations not more than 1% of all zoaria pass through such a life cycle, the remaining 99% die at different stages of development, with the majority dying after the second reproduction, i.e., the span of their life is about two years.

M. ciliata Pallas is the most studied representative of this group, but since the authors, while talking of its development, exclusively describe the reproduction of zooids in the spring and autumn periods, perhaps the winter periods play no role; it may be assumed then that reproduction and settling down of larvae in the winter months (December to February) take place at different times, possibly depending upon specially favorable conditions; therefore, I feel that *M. ciliata* Pallas cannot be considered an important link in the life cycle of this group of Bryozoa.

The following species belong to the second group which has two generations in a year: *Crisia eburnea* (L.), *Dendrobeania pseudomurrayana (murrayana)* var. *fessa* Kluge, *Scrupocellaria scabra* (van Beneden), *Caberea ellisi* (Fleming), *Cylindroporella (Porina) tubulosa* Norman, *Schizoporella pachystega* Kluge, *Sch. porifera* (Smitt).

The autumn period of reproduction is dropped in this group, together with the winter period of release and settling of the larvae. They complete their life cycle after the first autumn reproduction and thus live for about two years.

Lastly, Kuznetsov has included the following species in the group living for one year: *Tegella arctica* (d'Orbigny), *Callopora craticula* Alder, *Lichenopora crassiuscula* Smitt, *Cribrilina punctata* (Fabricius), *Harmeria scutulata* (Busk), *Hippothoa hyalina* (L.).

Their autumn progeny reproduce twice, in the following spring and in the autumn; the spring issue produce only once in autumn, after which the zoaria of these species die out.

Thus, the normal life cycle of Bryozoa is represented perhaps, by the scheme proposed by Friedl, i.e., 2 periods exist in a year in the course of which free larvae develop (or grow very intensively), particularly in spring and autumn. The periods in months could, of course, fluctuate in the direction of earlier or later release depending upon external conditions, as was demonstrated by Kuznetsov for Eastern Murmansk. Comparing the curve of intensity of larval fixation to the substrate with the curve of the average monthly temperature at water surface, which has a very close correspondence, he concludes that temperature is an important factor in regulating the onset and duration of the most important processes like reproduction, growth, fixation to the substrate, and so forth.

I have described the most interesting findings of Kuznetsov in detail because, up until now, they are the only findings of this type covering a large number of species; one wishes that these observations had been repeated for each species individually. It is also essential to keep in mind the recent observations of Silen (1944c) about the fact that in one ovicell the larvae do not develop all at one time, as was thought earlier, but often one after the other; the development period is 2 weeks for each larva. These observations were recorded in 1943 and were conducted at the Biological Station in Kristineberg (western Coast of Sweden).

Ecology of Bryozoa

General conditions of living. Marine Bryozoa are widely distributed in all the seas, particularly in the tropical and subtropical regions. They live at different depths from the belt of ebb and flow (high and low tide) to 5,715 m (*Cribrilina monoceros* Busk and *Bifaxaria abyssicola* Busk, north of the Sandwich Islands). But most Bryozoa are coastal animals, the largest number of species being distributed in the area of the mainland (continental) shelf up to a depth of 250 to 300 m, and the number of species drastically reduces on the continental shelf or precipice up to a little more than 1,000 m; they are seen in insignificant numbers in the Babyrsals (abyssal zone). The typical inhabitants of the dry strip in the temperate zone are *Flustrella hispida* (Fabricius) and *Alcyonidium hirsutum* (Fleming). Some species found in our waters appear to be very widely distributed at depths, for example *Eucratea loricata* (L.) lives at a depth from 0 to 2,300 m; *Kinetoskias smitti* Danielssen, from 65 to 1,210 m; *K. arborescens* Danielssen, from 19 to 1,229 m; *Pseudoflustra solida* (Stimpson), from 5 to 1,159 m; *P. sinuosa* (Andersson), from 1.5 to 1,000 m; and *Tessaradoma gracilis* (M. Sars), from 72 to 3,500 m.

Bryozoa are associated with the specific substrate on which they live; they prefer hard grounds such as rocks, stones, and shell deposits, as well as the algae fixed on these; only a very few live on soft sand and silt, or silt.

Many Bryozoa are commensal and live on other animals such as hydroids, tubes of worms, bivalved shells and gastropod mollusks, barnacles (*Cirripedia* subclass), crabs, and ascidians.

Many Bryozoa, particularly among the free-growing, calcified, and ramified forms such as *Microporina, Hornera, Retepora,* and others, may grow around other Bryozoa providing protection at the same time. A majority of Bryozoa grow freely around the substrate, but a few representatives of the order *Ctenostomata* from the suborder *Stolonifera* bore their way into the tubes of worms, such as *Hipophorella expansa* Ehl., into the tubes of *Terebella conchylega* (Ehlers, 1876), into bivalved shells and gastropod mollusks, such as *Penetrantia concharum* Silen, in the shells of *Cardium edule* (L.), *Mytilus edulis* (L.), *Buccinum undatum* (L.), and others (Silen, 1946, 1947).

Bryozoa live under different temperatures from 2 to 29° (in the Red Sea). Some of the littoral forms like *Flustrella hispida* (Fabricius) and *Alcyonidium hirsutum* (Fleming) living on fucus, can tolerate still lower temperatures during winter months, up to 15°C, in a state of anabiosis. Different species of Bryozoa can tolerate temperature fluctuations in the water surrounding them; some live in narrower ranges while others live in wider ones. Thus, some of the high-Arctic forms live under exceptionally unfavorable temperatures, for example *Berenicea arctica* Kluge from −1.2 to −1.12°C, *Stegohornera arctica* Kluge from −1.96 to −1.11°C, *Alcyonidium gelatinosum* var. *pachydermatum* Kluge from −1.6 to −1.24°C, *Uschakovia gorbunovi* Kluge from −1.40 to −0.9°C, *Smittina glaciata* Waters from 1.48 to −0.82°C; they have an amplitude of fluctuation less than 1°C. The purely Arctic forms have an amplitude of fluctuation from 2.8 to 4°C, for example: *Tubulipora ventricosa* Busk from −1.65 to 1.95°C, *T. soluta* Kluge from −1.7 to 1.58°C, *Idmonea atlantica* var. *gracillima* Busk from −1.68 to 1.5°C, *I. fenestrata* Busk from −1.6 to 1.74°C, *Alcyonidium mamillatum* var. *erectum* from −1.7 to 2.2°C, and *Cribrilina spitzbergensis* from −1.27 to 2.2°C. The amplitude of fluctuation for the widely distributed Arctic-boreal species in the Barents Sea ranges from 5.6 to 12.95°C, and in the White Sea from 15.2 to 20.0°C: *Alcyonidium gelatinosum* (L.) from −1.9 to 11.05°C, *Eucratea loricata* (L.) in the Barents Sea from −1.82 to 5.6°C, in the White Sea from −1.5 to 18.5°C; *Electra pilosa* (L.) in the Barents Sea from −1.5 to 5.2°C; and in the White Sea −1.15 to 15.0°C; *Smittina concinna* (Busk) in the Barents Sea from −1.9 to 3.7°C, in the White Sea from −1.2 to 14°C.

Most Bryozoa live under normal salinity, from 34 to 35‰, but some live under a low salt concentration, such as *Electra crustulenta* var. *baltica* Borg which lives in the Baltic Sea in a salt concentration of 4.16 to 5.68‰; in the Bay of Finland (Knipovich, 1909; Kluge det.) they live even under 2‰, and some may even enter the estuary of a river such as *Crisia eburnea* (L.) in the estuary of the Elba (Borg, 1930a); others live in a higher saline concentration, such as the Bryozoa of the Red Sea in 38 to 40‰. Just as some species can tolerate fluctuations in temperature, so different species can tolerate fluctuations in salinity. Thus *Electra pilosa* (L.) lives in the Barents Sea under 34.88 to 32.21‰, and in the White Sea under 29.56 to 25.99‰, and *Electra crustulenta* var. *arctica* Borg lives in the Barents Sea under 34.92 to 32.84‰, and in the White Sea under 28.92 to 26.88‰. In this regard some interesting experiments were conducted by Marcus (1926b) with *Electra pilosa* (L.) and *Farella repens* (Farre) at the Biological Station on Bisum Island in the North Sea, where the average salt concentration is 35‰. The salinity was increased or decreased gradually and the Bryozoa remained in each new concentration for sometime in order that they could be accustomed to a changed condition before being transferred to a solution differing greatly from the normal. The experiments showed that the amplitude of salt concentration within which both the investigated species could adapt themselves is probably from 53 to 17.5‰ for *Electra pilosa* (L.), and from 59 to 14‰ for *Farella repens* (Farre). A littoral species, and particularly the one found in estuaries, is exposed to marked fluctuations in salinity in natural conditions, and *F. repens* (Farre) belonging to the order *Ctenostomata* is probably more resistant to estuary conditions than others. This is fully confirmed by the observations of Borg (1930b) collected on the fauna of the saline waters in Schelder-vinken (northwestern coast of Sweden); in 1936 he stated that uncalcified *Ctenostomata* are often found in saline waters and more easily adapt to such than *Cheilostomata* and *Cyclostomata* in which the strongly calcified forms are totally absent. Borg's statement is confirmed by the studies done by Osburn (1932) on the fauna in the highly fresh water bay of Chizapik (eastern coast of North America); he recorded 19 species of Bryozoa, of which one belonged to *Cyclostomata,* 9 to poorly calcified *Cheilostomata,* and 8 to *Ctenostomata.*

The experiments conducted by Marcus with these same species showed that Bryozoa do not reflect either a positive or a negative phototropism, as the direction of budding and the formation of branches did not change in light or darkness, but an increase in the number of buds, and consequently the growth rate of the zoaria, was observed when the specimens were placed in darkness.

Bryozoa have many enemies, including the active ones which feed on them directly such as many turbellarias, segmented worms (Annelida), gastropod mollusks, and fishes, as well as the passive ones which do not feed upon them but mix into their zoaria in abundance and thus block the life of many individuals, such as the larvae of many bottom-dwelling animals which settle on the Bryozoan zoaria. The more or less strongly calcified skeleton in the calcareous Bryozoa, and the strongly developed spines with a membranous frontal surface in other species, serve as defense mechanisms against the enemies of the first category; the fairly distributed avicularia in different places on the zooids, particularly near the orifice where their significance is increased when they are arranged on the various types of protuberances or rostrums, serve as defenses against enemies of the second type. At the same time it should be pointed out that in some species with a fairly well-developed scutum and vibracularium (*Scrupocellaria scabra* var. *paenulata* forma *orientalis* Kluge, and others), or with well-developed avicularia on the conical protuberances or rostrums near the oral orifice (*Rhamphostomella scabra* Fabricius, *Rh. costata* Lorenz, and others), a large number of *Loxosoma* from the group *Endoprocta* or *Kamptozoa* are frequently found; these sit with their stalks inserted into the depth of the secondary orifice, their bodies and tentacles remaining above the surface of the orifice. Although these *Loxosoma* probably restrict the process of extension of the zooidal tentacular crown, nevertheless the latter is placed in a normal condition and the development of the larvae in the ovicells takes place normally. No basis has been found as yet to explain the frequently occurring symbiosis with Bryozoa of the different species of *Loxosoma,* as well as a few representatives of segmented worms from the family *Aphroditidae.*

Biocenosis. Many Bryozoa are frequently found to occur in a particular organism combination and can be seen on a particular substrate. Thus on blade kelp (*Laminaria*) the following species are almost always found: *Membranipora membranacea* L., *Electra pilosa* (L.), *Hippothoa hyalina* (L.), *Cribrilina annulata* (Fabricius), *Crisia eburnea* (L.), *Alcyonidium mytili* Dalyell; on fucuci, *Flustrella hispida* (Fabricius) and *Alcyonidium hirsutum* (Fleming) are found; on hydroids, often the various species of *Crisia, Tricellaria, Scrupocellaria, Bugula, Cellepora,* etc., are found; on ascidia (for example, *Phallusia obliqua* Ald.), *Flustra membranaceo-truncata* Smitt, *F. securifrons* Pallas, *Dendrobeania pseudomurrayana* Kluge, *D. fruticosa* (Packard), *Caberea ellisi* (Fleming), *Callopora craticula* (Alder), *C. lineata* (L.), *Doryporella spathulifera* (Smitt), *Cheilopora sincera* (Smitt) and species of *Retepora* and *Rhamphostomella, Crisia eburneo-denticulata* Smitt and *Idmonea atlantica* Forbes are found; on stones and shells, most frequently *Pecten islandicus* (Müller), *Smittina concinna* (Busk), *S. rigida* Lorenz, *S. mucronata* (Smitt), *Porella compressa* (Sowerby), *P. groenlandica* (Norman), *P. princeps* Norman, *P. struma* Norman, *Schizoporella pachystega* Kluge, *Sch. crustacea* (Smitt), *Onceusoecia diastoporides* (Norman), and *O. canadensis* (Osburn) are found. Quite frequently symbiosis can be observed between Bryozoa and nematodes. For example, Schurmans-Stekhoven (1933) frequently found up to 9 different species of minute nematodes in *Membranipora membranacea* var. *erecta* Loppens (=*Electra crustulenta* Borg), but a more detailed investigation of the interactions between them has not yet been conducted.

Variability. It could be expected that in the development of the zoarium by blastogeny, the variability of the constituent zooids should be insignificant; but this is far from true as the zooids in a zoarium are subject to a marked variability. This variability is observed in the size and form of individual zooids, and in the sculpture of their surface: in young zooids the frontal surface is often smooth and convex, the margins have depressions, and along the margin there is a clearly expressed, transverse or radial, costate structure with depressions and orifices between the rebra; in the older zooids the surface is usually more or less evenly tubular, the costate formation is not noticeable, and only small openings remain along the margin. In place of the clearly demarcated primary orifice of the young zooids, one frequently sees in older zooids a secondary orifice with a clearly different demarcation; sometimes it is possible to view the primary orifice in the water but with difficulty. Clearly noticeable, and sometimes even strongly protruding avicularia, located in the proximal margin of the orifice of the young zooid, become less prominent in the old; sometimes they are totally hidden in the orifice, and in cases where a similar outline of a secondary orifice exists, it is difficult to differentiate between two species with similar types of zoaria, e.g., *Porella compressa* (Sowerby) and *Escharopsis sarsi* (Smitt); only the color of their zoaria provides a basis for differentiation. All such changes in zooids in one and the same zoarium, are the result of calcification of the frontal wall which is so strongly expressed in many species that the zooids become inconspicuous near the base of the zoarium, and the whole of this portion looks like a continuous, calcareous mass. This has been observed in *Cyclostomata* and in *Cheilostomata*. In this case the zooids change back into kenozooids, to serve as a supporting element in the zoarium. The conversion of zooids into kenozooids in the lower basal part of the zoarium takes place not only because of calcification for the purpose of developing the supporting organ, but also by other means such as the formation of the storage place of the nutritional material for further development of the zoarium (a few species of *Alcyonidium* among *Ctenostomata*, and especially *Uschakovia gorbunovi* Kluge among *Cheilostomata*; Figure 228). The factor responsible for variability in zooids is the disappearance in adult zooids of certain characteristics present in the young, such as the spines along the distal margin of the orifice, and the disappearance of avicularia in some avicularia-carrying species, sometimes in the entire zoaria as, for example, in *Schizoporella elmwoodiae* Waters, *Porella princeps* Norman, *Cheilopora sincera* (Smitt), *Escharoides jacksoni* (Waters), and others. Bryozoa undergo a marked amount of variation depending upon external environmental factors. The observations made by Friedl (1925) at the harbor of Rovinew are interesting in this regard. In the genus *Scrupocellaria* a changed spine or scutum was located on the internal lateral margin of the aperture which covered the aperture. This scutum or fornix was shaped like a rounded or oval plate in some species, but was ramified in others. Friedl found that in *Scrupocellaria reptans* (L.), in which the scutum was branched, the zoaria of the summer progeny had a well-ramified scutum (form *typica*). The scutum in the autumn progenies became less and less ramified, and in late autumn the young zoaria had weak and simply forked scutums. Such forms were described as independent species by some authors, e.g., *S. bertholletti* (Audouin), *S. capreolus* (Heller), and *S. scruposa* (L.). In a similar series, a few different forms of the scutum can be found in one and the same zoarium.

Bryozoa demonstrate not only a marked individual variability but also a group or intraspecific variability. Thus many species considered earlier to be monotypic, appeared to be polytypic on detailed examination. Among those Bryozoa found in our waters, the following species deserve special mention: *Crisia denticulata* (Lamarck) with the varieties *borgi* Kluge and *arctica* M. Sars; *Alcyonidium gelatinosum* (L.) with the varieties *anderssoni* Abrikosov, *diaphanum* Farre, *pachydermatum* Kluge, *radicellatum* Kluge; *Eucratea loricata* (L.) with the varieties *arctica* Kluge, *cornuta* Osburn and *macrostoma* Ortmann; *Electra crustulenta* (Pallas) with the varieties *arctica* Borg, *baltica* Borg, and *catenularia similis* Kluge; *Dendrobeania* with a whole series of species and varieties (see p. 391); and others.

Food value. Osburn (1921) has reported data which suggest that Bryozoa can serve as food for certain birds and fishes. Thus in the stomachs of the eider in the Pribilof Islands, the residue of *Crisia* sp., *Menipea pribilovi* Robertson, *Leieschara* (*Myriozoum*) *coarctata* M. Sars, and *Cellepora surcularis* (Packard) was found. In the stomachs of some of the commercial fishes in the coastal waters of North America he found the residue of *Bugula territa* (Des.), *Lepralia pallasiana* Moll, *Smittina trispinosa* (Johnston), and *Schizoporella unicornis* (Johnston). Undoubtedly, the soft and slightly calcified, branched and bushy *Cheilostomata* like *Eucratea loricata* (L.), species of *Bugula* and *Dendrobeania*, as well as poorly chitinized *Ctenostomata* like the species *Bowerbankia*, *Valkeria*, and *Alcyonidium*, and other genera, serve as prey for many fishes; their larvae become food for young fishes and oysters on the oyster shoals. All this suggests that to a certain extent Bryozoa play a useful role as food material.

Significance in rock formation. Bryozoa have played a role in rock formation since ancient times, starting from the Lower Silurian in the form of the now extinct groups of *Cryptostomata* and *Trepostomata*. At the end of the Paleozoic, in the Permian period, these groups disappeared and in their place appeared *Cyclostomata* which reached their maximum peak in the Cretaceous period, then began to die off leaving a few types in the Modern period. *Cheilostomata* began in the Cretaceous period, attaining their development peak in the Tertiary and Modern periods. The Sarmatian deposits, in the form of large Bryozoan reefs, serve as an example of the energetic development of *Cheilostomata* in the Tertiary period; these reefs constitute complete hills on the Krech and Taman peninsulas, consisting almost exclusively of *Membranipora reticulum* L. (Andrussov, 1909-11).

Methods of preserving and studying Bryozoa

For studying marine Bryozoa it is best to use 80% ethyl alcohol. If the latter is not available, a 3% solution of Formalin may be used but the specimen should be transferred to alcohol as early as possible. It is advisable to rinse the colony in fresh water before placing it in alcohol, in order to remove the salts deposited on its surface. The small or large stones surrounded by the Bryozoan overgrowth should first be washed thoroughly with fresh water and then preserved in a dry condition. This, of course, refers to the calcified forms. Preserving Bryozoa devoid of calcium in a dry condition is not recommended as they shrink drastically, and it is very difficult to restore them to original size by soaking. The material fixed in alcohol should be transferred to fresh alcohol after some time. The discarded alcohol can be re-used for preserving fresh material, if it is not to be used for purely systematic purposes. If the material preserved is to be used for morphological studies, 90% alcohol should be used; the delicate uncalcified colonies of *Ctenostomata* from the group of *Stolonifera* may be fixed in a 3 to 4% solution of Formalin, but it is advisable to transfer them later to 80% alcohol. To remove calcium during subsequent investigations of its morphological structure, the preparation should be dipped in 80% alcohol to which hydrochloric or nitric acid is added at the rate of 0.5 ml for every 100 ml of alcohol.

For taxonomic studies, the material fixed in alcohol should first be carefully cleaned of the sand particles attached to it with a brush, using a harder brush for the thick calcified material, and a softer one for the thin and soft or uncalcified colonies. If dry material is being investigated, it should first be moistened thoroughly, cleaned with a brush, and then dried again for study. To obtain a clear picture of the sculpture of the frontal surface of the zooids, and to establish a possible investigation of the connective process between individual zooids in the colony through pore plates or pore chambers, it is recommended that preparations be treated with Javel solution ($KCl+KClO$ in water, or $NaCl+NaClO$ in water), by submerging them in the water after alcohol. $KClO$ works gently in water. Thinner calcified preparations of jointed colonies should be treated with a less concentrated solution. If it is difficult to obtain such a solution, the preparation may be treated with a solution of potassium iodide or sodium iodide together with heating in a test tube, but this must be done with great care. Lastly, to separate a preparation which has grown around a large or small stone or shell in the form of a crust, prick the preparation and then the crustaceous colony will peel off the substrate. To make permanent slides, glycerine or Canada balsam should be added; Harmer (1903) recommended that the slides be transferred directly from absolute alcohol to a Canada balsam solution made in absolute alcohol. The white dullness which develops while preparing the solution disappears by placing it in a water bath at 60°C for a few days. Earlier authors fixed permanent calcareous preparations in Canada balsam, but as the balsam dries out with time, the slide can be studied in only one position. In order to examine calcareous preparations from more than one position, it is better to make a dry preparation by the method given above. The dry preparation should then be mounted in a dry chamber made from cardboard cut in the form of a slide that is 7.5 cm × 2.5 cm. Another alternative would be to cut a round hole of 20 mm diameter in the cardboard and cover it with a paper ring which can move freely on the glass slide. An even better method of handling small preparations is to mount them on cardboard, fix them on the cardboard slide plate, and paste them with black paper in such a manner that it is possible to insert a cover glass between the paper and the cardboard. The cover glass closes the chamber. This method of preservation is doubly convenient because the preparation can be examined from all sides.

Finally, in order to observe the internal cavity in strongly calcified species, Harmer (1900: 240) recommends embedding the sample in paraffin, cutting the basal wall carefully with a scalpel, and then removing the paraffin by dissolving it in acid or toluene (methyl benzene).

To study soft colonies of *Ctenostomata* from the group *Stolonifera*, preparations stained with boric carmine and haemalaun should be passed slowly through absolute alcohol and clove oil. It is strongly recommended that Bryozoa be studied first in a live state, for which they should be kept on shallow plates and observed in a straightened condition with tentacles extended; this makes it possible to record the structural details for a few littoral, more or less transparent, forms such as *Membranipora membranacea* (*L.*), *Electra pilosa* (L.), *Alcyonidium hirsutum* (Fleming), and others.

Table of distribution of Bryozoa in Arctic seas[1]

Species	Arctic region: North Atlantic region	Barents Sea	White Sea	Kara Sea	Laptev Sea	East Siberian Sea	Chukotsk Sea	American sector	North Pacific region	Remarks
I. Order Cyclostomata										
Family **Tubuliporidae**										
Stomatopora granulata (Milne-Edwards)	+	+	+	+	—	—	—	+	—	
Proboscina gracilis (Kluge)	—	+	—	—	—	—	—	—	—	
P. fecunda Kluge	—	—	—	—	—	+	—	—	—	
P. major (Johnston)	+	+	—	—	—	—	—	—	—	
P. incrassata (Smitt)	+?	+	—	+	+	—	—	+	—	
Oncousoecia diastoporides (Norman)	+	+	+	+	—	—	+	+	+	
O. canadensis Osburn	+	+	+	—	+	—	+	+	+	
O. polygonalis (Kluge)	—	+	—	—	—	—	+	+	+	
Tubulipora flabellaris (Fabricius)	+	+	+	+	+	+	+	+	+	
T. maris-albi Gostilovskaya	—	—	+	—	—	—	—	—	—	
T. eminens Kluge	—	—	—	—	—	+	—	—	—	
T. dilatans (Johnston)	+	+	+	+	—	—	—	+	—	
T. fructuosa Gostilovskaya	—	—	+	—	—	—	—	—	—	
T. smitti Kluge	—	+	—	—	—	—	—	—	—	
T. uniformis Gostilovskaya	—	+	+	—	—	—	—	—	—	
T. aperta Harmer	—	—	+	—	—	—	—	—	—	
T. minuta (Kluge)	—	+	+	—	—	+	—	—	—	
T. liliacea (Pallas)	+	+	—	—	—	—	—	+	+	
T. borgi Kluge	—	—	—	—	—	+	—	—	—	
T. murmanica Kluge	—	+	—	—	—	—	—	—	—	
T. ventricosa Busk	—	+	+	+	+	+	—	+	+	
T. soluta Kluge	—	+	—	+	+	+	—	—	—	
T. nordgaardi Kluge	—	—	—	—	—	+	—	—	—	
T. penicillata (Fabricius)	+	+	—	—	—	—	—	+	—	
T. fruticosa Kluge	—	+	+	+	—	+	—	—	—	
Family **Idmoneidae**										
Idmonea atlantica Forbes	+	+	—	+	+	+	—	+	+	
I. atlantica var. *gracillima* Busk	—	+	—	+	+	+	—	—	—	

[1]Asterisked species were not found in the northern Russian seas.

Species	Arctic region									Remarks
	North Atlantic region	Barents Sea	White Sea	Kara Sea	Laptev Sea	East Siberian Sea	Chukotsk Sea	American sector	North Pacific region	
I. fenestrata Busk	—	+	—	+	+	—	—	+	+	
I. tumida (Smitt)	—	+	—	+	—	+	—	—	—	
I. bidenkapi Kluge	—	+	—	—	—	—	—	—	—	
Idmoneoides arctoflabellaris (Kluge)	—	+	—	+	+	+	—	—	—	
I. simplex Kluge	—	+	—	—	—	—	—	—	—	
Family **Entalophoridae**										
Entalophora clavata Busk	+	+	—	+	+	+	—	+	—	
E. harmeri (Osburn)	—	+	—	+	—	—	—	+	—	
Family **Diastoporidae**										
Diplosolen obelia (Johnston)	+	+	—	—	—	—	—	—	+	
D. obelia var. *arctica* (Waters)	+	+	+	+	+	+	+	+	+	
D. intricarius (Smitt)	+	+	—	+	+	—	—	+	+	
Berenicea arctica Kluge	—	+	—	+	—	—	—	—	—	
B. oblonga Kluge	—	+	—	+	—	—	—	—	—	
**B. patina* (Lamarck)	+	—	—	—	—	—	—	+	—	
B. meandrina (S. Wood)	—	—	—	—	—	—	+	+	+	
Family **Corymboporidae**										
Domopora stellata (Goldfuss)	+	—	—	—	—	—	—	—	—	
Defrancia lucernaria M. Sars	+	+	—	+	+	+	—	+	—	
D. lucernaria var. *prolifera* Kluge	—	+	—	+	—	—	—	—	—	
Family **Fascigeridae**										
Fasciculiporoides americana (d'Orbigny)	—	—	—	—	+	+	+	+	—	
Family **Crisiidae**										
Filicrisia geniculata (Milne-Edwards)	+	+	+	—	—	—	—	+	—	
F. smitti (Kluge)	+	+	—	+	—	+	—	+	—	
Crisidia cornuta (Linnaeus)	+	+	—	+	—	—	—	+	+	
**C. orientalis* Kluge	—	—	—	—	—	—	—	+	—	
**Bicrisia abyssicola* Kluge	+	—	—	—	—	—	—	—	—	
Crisiella diversa (Kluge)	—	+	—	+	—	—	—	—	—	
C. producta (Smitt)	+	+	+	+	—	—	—	+	—	
C. complecta (Kluge)	—	+	—	+	—	—	—	—	—	
**Crisia aculeata* Hassall	+	—	—	—	—	—	—	—	—	
C. aculeata var. *bathyalis* Kluge	—	—	—	+	—	—	—	—	—	

Species	Arctic region: North Atlantic region	Arctic region: Barents Sea	Arctic region: White Sea	Arctic region: Kara Sea	Arctic region: Laptev Sea	Arctic region: East Siberian Sea	Arctic region: Chukotsk Sea	American sector	North Pacific region	Remarks
C. eburnea (Linnaeus)	+	+	+	+	+	+	+	+	+	
C. eburneo-denticulata Smitt	+	+	+	+	+	+	−	+	+	
C. constans Kluge	−	−	−	+	−	−	−	−	−	
C. denticulata (Lamarck)	+	−	−	+	−	−	+	+	+	
C. denticulata var. *borgi* Kluge	+	+	+	+	+	+	−	+	−	
C. denticulata var. *arctica* M. Sars	+	+	−	+	+	−	+	+	+	
Family **Horneridae**										
Stegohornera violacea (M. Sars)	+	+	−	−	−	−	−	+	−	
**S. violacea* var. *proboscina* (Smitt)	+	−	−	−	−	−	−	−	−	
S. arctica (Kluge)	−	+	−	+	−	+	−	−	−	
Hornera lichenoides (Linnaeus)	+	+	−	+	+	+	−	+	−	
Family **Lichenoporidae**										
Lichenopora verrucaria (Fabricius)	+	+	+	+	+	+	+	+	+	
L. multicentra Kluge	−	−	−	−	+	−	−	−	−	
L. sibirica Kluge	−	−	−	−	+	−	−	−	−	
L. radiata (Audouin)	+	−	−	−	−	−	+	−	+	
L. hispida (Fleming)	+	+	+	+	−	−	−	+	−	
L. crassiuscula Smitt	+	+	−	+	+	−	+	+	+	
Family **Heteroporidae**										
Heteropora pelliculata Waters	−	−	−	−	−	−	−	+	+	
Borgella tumulosa Kluge	−	−	−	−	−	−	−	−	+	
Family **Fungellidae**										
Fungella dali Kluge	−	−	−	−	−	−	+	−	−	
II. Order **Ctenostomata**										
Family **Alcyonidiidae**										
Alcyonidium gelatinosum (Linnaeus)	+	+	+	+	+	+	+	+	+	
A. gelatinosum var. *diaphanum* (Farre)	+	+	−	−	−	−	−	−	−	
A. gelatinosum var. *anderssoni* Abrikosov	−	+	−	+	+	+	+	+	−	
A. gelatinosum var. *pachydermatum* Kluge	−	+	−	+	−	−	−	−	−	
A. radicellatum Kluge	−	+	−	+	+	+	−	−	−	
A. vermiculare Okada	−	−	−	−	−	−	−	−	+	
A. excavatum Hincks	−	+	−	−	−	−	−	−	−	
A. hirsutum (Fleming)	+	+	+	−	−	−	−	−	+	

Species	Arctic region									Remarks
	North Atlantic region	Barents Sea	White Sea	Kara Sea	Laptev Sea	East Siberian Sea	Chukotsk Sea	American sector	North Pacific region	
A. mytili Dalyell	+	+	+	+	+	+	+	+	+	
A. irregulare Kluge	—	+	—	—	—	—	—	—	—	
A. mamillatum Alder	+	+	+	+	+	—	+	+	+	
A. mamillatum var. *erectum* Andersson	+	+	+	+	+	+	—	+	+	
A. proboscideum Kluge	—	+	—	—	—	—	—	—	—	
A. albidum Alder	+	+	—	+	—	—	—	—	—	
A. disciforme Smitt	+	+	—	+	+	+	+	+	+	
A. parasiticum (Fleming)	+	—	—	—	—	—	—	—	—	
Family **Flustrellidae**										
Flustrella hispida (Fabricius)	+	+	+	—	—	—	—	+	+	
F. corniculata (Smitt)	+	+	—	—	—	—	—	+	+	
F. cervicornis (Robertson)	—	—	—	—	—	—	—	+	+	
F. gigantea Silen	—	—	—	—	—	—	—	+	+	
F. vegae Silen	—	—	—	—	—	—	—	—	+	
Family **Arachnidiidae**										
Arachnidium clavatum Hincks	+	+	—	—	—	—	—	—	—	
A. hippothoides Hincks	+	+	—	—	—	—	—	—	—	
A. simplex Hincks	—	+	—	—	—	—	—	—	—	
Arachnoidea barentsia Kluge	—	+	—	—	—	—	—	—	—	
Family **Nolellidae**										
Nolella dilatata (Hincks)	+	+	—	—	—	—	—	+	+	
Family **Vesiculariidae**										
Bowerbankia pustulosa (Ellis et Solander)	+	+	—	—	—	—	—	—	—	
B. imbricata (Adams)	+	+	+	—	—	—	—	+	+	
B. arctica Busk	+	+	+	+	+	+	—	+	+	
B. caudata (Hincks)	+	+	+	—	—	—	—	+	—	
B. composita Kluge	—	+	—	—	—	—	+	—	+	
Family **Valkeriidae**										
Valkeria uva (Linnaeus)	+	+	+	—	—	—	—	+	—	
Family **Triticellidae**										
Triticella pedicellata (Alder)	+	+	—	—	—	—	—	+	—	
Family **Buskiidae**										
Buskia nitens Alder	+	+	+	+	—	+	—	+	—	

Species	Arctic region: North Atlantic region	Barents Sea	White Sea	Kara Sea	Laptev Sea	East Siberian Sea	Chukotsk Sea	American sector	North Pacific region	Remarks
III. Order Cheilostomata										
Family **Scrupariidae**										
Eucratea loricata (Linnaeus)	+	+	+	+	+	+	+	+	+	
E. loricata var. *arctica* (Kluge)	+	+	—	+	+	+	+	+	—	
E. loricata var. *cornuta* (Osburn)	—	—	—	—	+	+	+	+	+	
E. loricata var. *macrostoma* (Ortmann)	—	—	—	+	+	—	+	—	+	
Family **Membraniporidae**										
Membranipora membranacea (Linnaeus)	+	+	—	—	—	—	—	+	—	
Electra pilosa (Linné)	+	+	+	+	—	—	—	+	—	
E. pilosa var. *dentata* (Ellis et Solander)	+	+	+	+	—	—	—	—	—	
E. crustulenta (Pallas) *f. typica* Borg	+	—	—	—	—	—	—	—	+	
E. crustulenta var. *baltica* Borg	+	+	+	+	—	—	—	—	—	
E. crustulenta var. *arctica* Borg	—	+	+	+	+	—	+	+	+	
E. crustulenta var. *catenularia-similis* Kluge	—	+	+	—	—	—	—	+	—	
E. catenularia (Jameson)	+	—	—	—	—	—	—	—	+	
Tegella unicornis (Fleming)	+	+	—	—	—	—	—	+	—	
T. armifera (Hincks)	+	+	+	+	+	+	+	+	+	
T. armiferoides Kluge	—	—	—	—	—	+	—	—	—	
T. kildinensis Kluge	—	+	—	—	—	—	—	—	—	
T. spitzbergensis (Bidenkap)	+	+	+	+	—	+	+	+	+	
T. arctica (d'Orbigny)	+	+	+	+	—	—	+	+	+	
T. arctica var. *retroversa* Kluge	—	+	—	+	—	+	+	—	+	
T. nigrans (Hincks)	+	+	+	+	+	+	+	+	+	
T. anguloavicularis Kluge	—	—	—	—	—	—	+	—	+	
T. inermis Kluge	—	—	—	—	—	—	—	—	+	
T. amissavicularis Kluge	—	—	—	—	—	—	—	—	+	
T. norvegica (Nordgaard)	+	—	—	—	—	—	—	—	—	
Callopora lineata (Linnaeus)	+	+	+	+	+	+	+	+	+	
C. craticula (Alder)	+	+	+	+	+	+	+	+	+	
C. craticula var. *sedovi* Kluge	—	+	—	—	—	—	—	—	—	
C. aurita (Hincks)	+	+	+	—	—	—	—	+	—	
C. smitti Kluge	—	+	—	+	+	+	—	+	—	
C. whiteavesi Norman	+	+	+	+	+	+	+	+	—	

Species	Arctic region: North Atlantic region	Barents Sea	White Sea	Kara Sea	Laptav Sea	East Siberian Sea	Chukotsk Sea	American sector	North Pacific region	Remarks
C. lata (Kluge)	+	+	+	+	+	+	—	+	—	
C. obesa Kluge	—	—	—	—	—	—	—	—	+	
C. deryugini (Kluge)	—	+	—	—	—	—	—	—	—	
Cauloramphus spiniferum (Johnston)	+	+	+	—	—	—	+	+	+	
C. intermedius Kluge	—	+	+	+	—	—	+	+	—	
C. cymbaeformis (Hincks)	+	+	+	+	+	+	+	+	+	
Ramphonotus minax (Busk)	+	+	—	—	—	—	—	+	+	
R. gorbunovi Kluge	—	—	—	—	—	+	—	—	—	
Amphiblestrum flemingii (Busk)	+	+?	—	—	—	—	—	+	—	
A. septentrionalis (Kluge)	+	+	+	—	—	+	—	+	—	
A. trifolium (S. Wood)	+	+	—	—	—	—	—	+	+	
A. trifolium var. *quadrata* (Hincks)	+	+	—	—	—	—	+	+	—	
Larnacicus corniger (Busk)	+	+	—	—	—	—	—	—	—	
Megapora ringens (Busk)	+	+	—	—	—	—	—	—	—	
Doryporella spathulifera (Smitt)	+	+	+	+	—	—	+	+	+	
Reussina impressa (Reuss)	—	+	—	—	—	—	—	—	—	
Family **Flustridae**										
Flustra carbasea (Ellis et Solander)	+	+	—	+	+	+	+	+	+	
F. nordenskjoldi Kluge	—	—	—	—	+	+	+	—	+	
F. membranaceo-truncata Smitt	+	+	+	+	+	+	+	+	+	
F. serrulata Busk	—	+	—	+	+	+	+	+	+	
F. barleei Busk	+	+	—	—	—	—	—	—	—	
F. securifrons (Pallas)	+	+	+	+	+	—	+	+	+	
F. foliacea (Linnaeus)	+	+	+	+	—	—	—	—	+	
Sarsiflustra abyssicola (G. Sars)	+	+	—	+	+	+	—	+	—	
Family **Onychocellidae**										
**Smittipora solida* (Nordgaard)	+	—	—	—	—	—	—	+	—	
Family **Microporidae**										
Microporina articulata (Fabricius)	—	+	—	—	—	—	—	+	+	
Family **Bicellariidae**										
Dendrobeania murrayana (Johnston)	+	+	+	+	—	—	+	+	+	
D. pseudomurrayana Kluge	+	+	—	—	—	—	+	+	—	Novaya Zemlya

Species	North Atlantic region	Arctic region						American sector	North Pacific region	Remarks
		Barents Sea	White Sea	Kara Sea	Laptev Sea	East Siberian Sea	Chukotsk Sea			
D. pseudomurrayana var. *tenuis* Kluge	—	+	—	—	—	—	—	—	+	
D. pseudomurrayana var. *fessa* Kluge	+	+	+	+	—	—	+	+	+	
D. fruticosa (Packard)	+	+	+	+	+	—	+	+	+	
D. fruticosa var. *quadridentata* (Loven)	+	+	—	+	+	—	—	+	+	
D. fruticosa var. *frigida* (Waters)	—	+	—	—	—	—	—	—	—	
D. levinseni (Kluge)	—	+	—	+	+	+	+	—	+	
D. pseudolevinseni Kluge	—	—	—	—	—	—	—	—	+	
D. flustroides (Levinsen)	—	—	—	+	—	—	+	—	+	
D. murmanica (Kluge)	—	+	—	—	—	—	—	—	—	
Bugula harmsworthi Waters	+	+	—	+	+	—	—	+	—	
B. tricuspis Kluge	—	+	—	—	—	—	—	—	—	Novaya Zemlya
B. fastigiata Dalyell	+	+	—	+	+	—	—	—	—	
B. tschukotkensis Kluge	—	—	—	—	—	—	+	—	—	
**B. avicularia* (Linnaeus)	+	—	—	—	—	—	—	—	—	
B. elongata Nordgaard	+	+	—	+	+	—	—	+	—	
**B. calathus* Norman	+	—	—	—	—	—	—	—	—	
Kinetoskias arborescens Danielssen	+	+	—	+	+	+	—	+	—	
K. smitti Danielssen	+	+	—	+	—	+	—	+	—	
**K. mitsukurii* Janagi a. Okada	—	—	—	—	—	—	—	—	+	
K. beringi Kluge	—	—	—	—	—	—	—	—	+	
Bicellariella ciliata (Linnaeus)	+	—	—	—	—	—	—	+	—	
Bicellarina alderi (Busk)	+	+	—	—	—	—	—	—	+	
Corynoporella tenuis Hincks	—	+	—	—	—	—	—	+	+	
Semibugula birulai Kluge	—	+	—	+	+	—	+	—	+	
Family **Sadkoidae**										
Uschakovia gorbunovi Kluge	—	—	—	+	—	+	—	—	—	
Family **Scrupocellariidae**										
Bugulopsis peachi (Busk)	+	+	+	+	+	+	+	+	+	
B. peachi var. *beringia* Kluge	—	—	+	—	—	—	+	+	+	
Notoplites jeffreysii (Norman)	+	+	—	—	—	—	—	—	—	
N. sibirica (Kluge)	—	+	—	+	+	—	+	—	—	
N. smitti (Norman)	+	+	—	+	+	—	—	+	—	

Species	Arctic region: North Atlantic region	Barents Sea	White Sea	Kara Sea	Laptev Sea	East Siberian Sea	Chukotsk Sea	American sector	North Pacific region	Remarks
N. normani (Nordgaard)	+	+	—	+	—	—	—	—	—	
Tricellaria ternata (Ellis et Solander)	+	+	+	+	—	—	—	+	+	
T. gracilis (van. Beneden)	+	+	+	+	+	+	+	+	+	
T. gracilis var. *inermis* Kluge	+	+	—	+	—	—	+	—	+	
Scrupocellaria intermedia Norman	+	+	—	—	—	—	—	—	—	
S. scabra (van. Beneden)	+	+	+	+	—	—	+	+	+	
S. scabra var. *paenulata* Norman	+	+	+	+	+	—	+	+	+	
S. scabra var. *paenulata f. orientalis* Kluge	—	—	—	—	—	+	—	—	—	
S. minor Kluge	—	+	+	—	—	+	—	+	—	
S. arctica (Busk)	—	+	+	+	—	—	—	+	+	
Caberea ellisi (Fleming)	+	+	+	—	—	—	+	+	+	
Family **Cribrilinidae**										
Membraniporella nitida (Johnston)	+	+	—	—	—	—	—	—	—	
Gephyrotes nitido-punctata (Smitt)	+	+	—	—	—	—	—	—	—	
Cribrina annulata (Fabricius)	+	+	+	+	—	—	+	+	+	
C. spitzbergensis Norman	+	+	+	+	+	+	+	+	+	
C. punctata (Hassall)	+	+	+	—	—	—	—	+	—	
C. cryptooecium Norman	+	+	—	—	—	—	—	—	—	
C. watersi Andersson	+	+	—	+	+	+	—	+	—	
C. spiculifera Kluge	—	—	—	—	—	+	—	—	—	
Family **Escharellidae**										
Escharella immersa (Fleming)	+	+	+	+	—	+	—	+	+	
E. variolosa (Johnston)	+	—	—	—	—	—	—	—	—	
E. ventricosa (Hassall)	+	+	+	+	+	+	+	+	+	
E. ventricosa var. *peristomata* Kluge	—	+	+	—	—	—	—	—	—	
E. dijmphnae (Kluge)	+	+	+	+	+	+	+	—	+	
E. indivisa Levinsen	+	+	—	+	+	+	—	+	—	
E. laqueata (Norman)	+	+	—	—	—	—	—	+	—	
E. abyssicola (Norman)	+	+	—	—	—	—	—	+	—	
E. microstoma (Norman)	+	+	+	+	—	+	—	+	—	
E. octodentata (Hincks)	+	+	—	—	—	—	—	—	—	
E. latodonta Kluge	—	+	—	—	—	—	—	—	—	
E. macrodonta (Levinsen)	+	—	—	—	—	+	—	—	—	

Species	Arctic region: North Atlantic region	Barents Sea	White Sea	Kara Sea	Laptev Sea	East Siberian Sea	Chukotsk Sea	American sector	North Pacific region	Remarks
Escharelloides spinulifera (Hincks)	−	+	+	+	−	−	−	+	−	
E. cancellatum (Smitt)	−	+	−	−	−	−	−	−	−	
E. stenostoma (Smitt)	+	+	−	−	−	−	−	−	−	
E. simplex (Kluge)	−	−	−	+	−	−	−	−	−	
Hemicyclopora polita (Norman)	+	−	−	−	−	−	−	−	−	
H. emucronata (Smitt)	−	+	−	+	−	−	−	+	−	
Lepralloides nordlandica (Nordgaard)	+	+	−	+	−	+	+	+	−	
Phylactella labiata (Boeck)	+	+	−	+	+	−	−	+	−	
Ph. pacifica O'Donoghue	−	−	−	−	−	−	−	+	+	
Family **Smittinidae**										
**Smittina reticulata* (MacGillivray)	+	+	−	−	−	−	−	+	−	
S. landsborovii (Johnston)	+	−	−	−	−	−	−	−	−	
S. majuscula (Smitt)	+	+	+	+	+	+	−	+	+	
S. minuscula (Smitt)	+	+	+	+	+	−	+	+	+	
S. peristomata (Nordgaard)	+	+	+	+	−	−	−	−	−	
S. glaciata (Waters)	−	+	−	+	−	−	−	−	−	
S. rigida Lorenz	+	+	+	+	+	−	+	+	+	
S. mucronata (Smitt)	−	+	+	+	−	−	+	−	+	
S. concinna (Busk)	+	+	+	+	+	−	+	+	+	
S. concinna var. *belli* (Dawson)	+	+	+	−	−	−	+	+	+	
S. pseudoacutirostris Gostilovskaya	−	+	+	−	−	−	−	−	−	
S. muliebris Kluge	−	−	−	+	−	−	−	−	−	
S. smitti (Kirchenpauer)	+	+	−	+	+	+	−	+	+	
S. tuberosa Kluge	−	−	−	−	−	−	−	+	−	
S. beringia Kluge	−	−	−	−	−	−	−	−	+	
S. trispinosa (Johnston)	+	+	−	−	+	−	+	+	+	
S. jeffreysi Norman	+	+	−	+	+	+	+	+	+	
**S. thompsoni* Kluge	−	−	−	−	−	−	−	+	−	
Pseudoflustra solida (Stimpson)	+	+	−	+	+	+	−	+	−	
P. hincksi Kluge	+	+	−	+	+	+	−	+	−	
P. anderssoni Kluge	+	+	−	+	+	+	−	−	−	
P. sinuosa (Andersson)	+	+	−	+	+	+	−	−	−	
P. birulai Kluge	−	+	−	+	−	+	−	−	−	

Species	Arctic region							American sector	North Pacific region	Remarks
	North Atlantic region	Barents Sea	White Sea	Kara Sea	Laptev Sea	East Siberian Sea	Chukotsk Sea			
Porella compressa (Sowerby)	+	+	+	+	+	+	+	+	+	
P. struma (Norman)	+	+	+	+	—	—	—	+	—	
P. aperta (Boeck)	+	+	—	+	+	—	—	+	—	
P. acutirostris Smitt	+	+	—	+	+	+	+	+	+	
P. tumida Kluge	—	—	—	—	—	—	—	—	+	
P. minuta (Norman)	+	+	+	—	—	—	—	+	+	
P. groenlandica (Norman)	+	+	+	+	—	—	+	+	+	
P. princeps Norman	+	+	+	+	—	—	+	+	+	
P. smitti Kluge	+	+	+	+	—	—	—	+	+	
P. prodoscidea Hincks	+	+	+	+	+	+	—	+	—	
P. plana (Hincks)	+	+	—	+	+	+	—	+	—	
P. laevis (Fleming)	+	+	—	—	—	—	—	+	—	
P. saccata (Busk)	+	+	+	+	+	+	+	+	+	
P. saccata var. *beringia* Kluge	—	—	—	—	—	—	+	—	+	
P. fragilis Levinsen	+	+	+	+	+	+	+	+	+	
Palmicellaria skenei (Ellis a. Solander)	+	+	—	+	+	—	—	+	—	
P. skenei var. *tridens* (Busk)	+	+	—	+	—	—	—	+	—	
P. skenei var. *bicornis* (Busk)	+	+	—	—	—	—	—	+	—	
**Umbonula verrucosa* (Esper)	+	—	—	—	—	—	—	—	—	
U. patens (Smitt)	—	+	—	—	—	—	+	+	—	
U. arctica (M. Sars)	+	+	+	+	+	+	+	+	+	
U. inarmata Kluge	—	—	—	—	+	—	—	—	—	
Family **Schizoporellidae**										
**Schizoporella unicornis* (Johnston)	+	—	—	—	—	—	—	+	+	
Sch. biaperta (Michelin)	+	+	+	+	+	—	+	+	+	
Sch. crustacea (Smitt)	+	+	+	+	+	+	+	+	+	
Sch. costata Kluge	—	+	—	—	—	—	—	—	+	
Sch. bispinosa Nordgaard	—	+	—	+	—	—	—	+	—	
Sch. elmwoodiae Waters	+	+	+	+	—	—	—	+	—	
Sch. elmwoodiae var. *mamillata* Kluge	—	+	—	—	—	—	—	—	—	
Sch. alderi (Busk)	+	+	—	—	—	—	—	—	—	
**Sch. auriculata* (Hassall)	+	—	—	—	—	—	—	+	+	
Sch. auriculata var. *lineata* (Nordgaard)	+	+	+	+	—	—	—	+	+	

Species	Arctic region: North Atlantic region	Barents Sea	White Sea	Kara Sea	Laptev Sea	East Siberian Sea	Chukotsk Sea	American sector	North Pacific region	Remarks
Sch. porifera (Smitt)	+	+	+	+	+	—	—	+	+	
**Sch. ortmani* Kluge	—	—	—	—	—	—	—	+	+	
Sch. magniporata Nordgaard	+	+	—	—	—	—	—	+	+	
Sch. pachystega Kluge	—	+	—	+	—	—	+	+	+	
Sch. incerta Kluge	—	+	+	+	+	—	—	+	+	
Sch. limbata Lorenz	+	+	+	+	+	—	—	+	+	
Sch. stylifera (Levinsen)	+	+	—	+	+	—	+	+	+	
Sch. stylifera var. *perforata* Kluge	—	—	—	—	—	—	—	—	+	
Sch. hexagona Nordgaard	+	+	—	—	—	—	—	—	—	
Sch. smitti Kluge	—	+	—	—	—	—	—	—	—	
Sch. thompsoni Kluge	+	—	—	—	—	—	—	—	—	
**Hippodiplossia pertusa* (Esper)	+	—	—	—	—	—	—	+	—	
H. reticulato-punctata Hincks	+	+	+	+	+	+	+	+	+	
H. propinqua (Smitt)	+	+	+	+	—	—	—	+	+	
H. murdochi Kluge	—	—	—	—	—	—	—	+	—	
H. obesa (Waters)	+	+	+	+	+	—	+	+	+	
H. tschukotkensis Kluge	—	—	—	—	—	—	+	—	—	
H. borealis (Waters)	—	+	—	+	—	—	—	—	—	
H. harmsworthi (Waters)	+	+	+	+	+	+	+	+	+	
H. ussowi (Kluge)	—	+	+	+	—	—	—	+	+	
Family **Stomachetosellidae**										
Stomachetosella sinuosa (Busk)	+	+	+	—	—	—	—	+	+	
S. producta (Packard)	—	+	—	—	—	—	+	+	—	
S. cruenta (Busk)	+	+	+	+	+	+	+	+	+	
S. collaris (Kluge)	—	—	—	—	+	—	—	—	—	
Family **Myriozoidae**										
Leieschara coarctata M. Sars	+	+	+	+	—	—	—	+	+	
L. orientalis (Kluge)	—	—	—	—	+	+	+	+	+	
L. subgracilis (D'Orbigny)	+	+	—	+	+	+	+	+	+	
Family **Hippothoidae**										
Hippothoa hyalina (Linnaeus)	+	+	+	+	+	+	+	+	+	
**H. divaricata* Lamouroux	+	—	—	—	—	—	—	+	—	
H. divaricata var. *arctica* Kluge	—	+	+	+	+	—	+	+	+	

Species	Arctic region: North Atlantic region	Arctic region: Barents Sea	Arctic region: White Sea	Arctic region: Kara Sea	Arctic region: Laptev Sea	Arctic region: East Siberian Sea	Arctic region: Chukotsk Sea	American sector	North Pacific region	Remarks
H. expansa Dawson	+	+	+	+	—	—	+	+	+	
Harmeria scutulata (Busk)	—	+	+	+	—	—	—	+	+	
Family **Microporellidae**										
Microporella ciliata (Pallas)	+	+	+	—	—	—	+	+	+	
M. ciliata var. *arctica* Norman	—	+	+	+	—	—	—	+	+	
M. impressa (Audouin)	+	+	—	—	—	—	—	—	—	
M. malusii (Audouin)	+	—	—	—	—	—	—	+	+	
Family **Tessaradomidae**										
Tessaradoma gracile (M. Sars)	+	+	—	+	+	—	—	+	—	
Cylindroporella tubulosa (Norman)	+	+	+	+	—	—	+	+	+	
Family **Reteporidae**										
Retepora cellulosa (Linnaeus)	+	+	+	+	—	—	—	+	+	
R. elongata Smitt	+	+	—	+	+	+	—	+	+	
R. beaniana King	+	+	—	—	—	—	—	+	—	
R. beaniana var. *watersi* Nordgaard	+	+	—	—	—	—	—	—	—	
Family **Hippoponellidae**										
Hippoponella hippopus (Smitt)	+	+	+	+	—	—	+	+	+	
H. fastigatoavicularis (Kluge)	—	—	—	—	—	—	—	—	+	
Lepraliella contigua (Smitt)	+	+	+	—	—	—	+	+	+	
Family **Rhamphostomellidae**										
Rhamphostomella scabra (Fabricius)	+	+	+	+	+	+	+	+	+	
Rh. costata Lorenz	+	+	+	+	+	+	+	+	+	
Rh. costata var. *cristata* Hincks	+	+	—	—	—	+	—	+	—	
Rh. ovata (Smitt)	+	+	+	+	+	+	+	++	+	
Rh. hincksi Nordgaard	+	+	—	+	+	—	+	+	+	
Rh. spinigera Lorenz	+	+	+	+	—	—	—	+	—	
Rh. radiatula (Hincks)	+	+	+	+	—	—	—	+	+	
Rh. plicata (Smitt)	+	+	+	+	—	—	+	+	+	
Rh. bilaminata (Hincks)	+	+	+	+	+		+	+	+	
Rh. bilaminata var. *sibirica* Kluge	+	+	+	+	+	+	+	+	+	
Escharopsis sarsi (Smitt)	+	+	+	+	+	+	+	+	+	
E. rosacea (Busk)	+	+	+	+	—	+	—	+	+	

Species	Arctic region									Remarks
	North Atlantic region	Barents Sea	White Sea	Kara Sea	Laptev Sea	East Siberian Sea	Chukotsk Sea	American sector	North Pacific region	
Family **Celleporidae**										
Cellepora nordenskjoldi Kluge	—	—	—	—	+	+	+	—	+	
C. costazii Audouin	+	—	—	—	—	—	—	—	—	
C. surcularis (Packard)	+	+	+	+	—	+	+	+	+	
C. ventricosa Lorenz	+	+	+	+	—	—	+	+	+	
C. smitti Kluge	+	+	—	—	—	—	—	+	—	
C. nodulosa Lorenz	+	+	+	+	+	+	—	+	—	
C. pumicosa Linnaeus	+	+	—	—	—	—	—	—	—	
C. canaliculata Busk	+	+	+	+	+	+	—	+	—	
C. avicularis Hincks	+	+	—	—	—	—	—	—	—	
**C. ramulosa* Linnaeus	+	—	—	—	—	—	—	—	—	
Family **Hippopodinidae**										
Cheilopora sincera (Smitt)	+	+	—	+	+	+	+	+	+	
**Ch. sincera* var. *praelucida* (Hincks)	—	—	—	—	—	—	—	+	+	
Ch. inermis (Busk)	+	+	—	+	—	—	+	+	+	
Family **Peristomellidae**										
**Escharoides coccinea* (Abildgaard)	+	—	—	—	—	—	—	—	—	
E. bedenkapi (Kluge)	+	+	—	+	+	+	—	—	—	
E. jacksoni (Waters)	+	+	—	+	+	+	—	+	+	
E. jacksoni var. *rostrata* (Kluge)	—	—	—	—	—	+	—	—	+	
E. monstruosa (Kluge)	—	—	—	—	—	+	—	—	—	

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[1]In his work of 1888, Hincks refers on p. 218 to his work of 1877a, and writes that the species referred to here has been wrongly identified as Icelandic; in fact the species was collected in the Devisov Strait, i.e., from Greenland and not Iceland.

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PART II
TAXONOMY

TAXONOMY

Key for Identification of Bryozoan Orders

1 (2). Zoids chitinous, orifices usually round and close with the help of a collar (a thin chitinous membrane with several longitudinal folds). Some have a masticatory stomach or gizzard................................II. Order *Ctenostomata* (see p. 213).
2 (1). Zooids more or less calcified. Collar and gizzard always absent.
3 (4). Orifices of zooids round and covered with a membrane. Membranous sac present. Parietal muscles absent. Polyembryony found to occur...............I. Order *Cyclostomata* (see below).
4 (3). Orifices of zooids usually have a semilunar form and close with a mobile, labial lid or operculum. Membranous sac absent. Parietal muscles present. Polyembryony does not occur...........................III. Order *Cheilostomata* (see p. 266).

I. Order **Cyclostomata** Busk, 1852
(Bryozoa with Round Orifice)

Cyclostomata Busk, 1852a : 345; *et auctt.; Stenolaemata* Borg, 1926 : 490; 1944a : 17.

The zoaria are prostrate, uprising (semi-erect) or free-growing, jointed or disjointed, simple or ramified, and consist of zooids in the form of cylindrical or metatarsal tubes, growing either in single rows, or collectively in simple or branched procumbent plates, or even as free-growing rows, stems, or bundles, which may be simple or branched. The zooids are encircled by a calcified body wall and communicate with each other through simple pores. The zooids in the zoarium do not have equal significance, nor are they similar in structure: there are autozooids and heterozooids among them. The autozooids have an alimentary canal and a tentacular crown, i.e., the polypide. They include the nanozooids or small tubes with a reduced polypide and a solitary tentacle. The heterozooids include gonozooids and kenozooids. The gonozooids are autozooids with a changed form, that is they become organs of multiplication with sexual products developing in them. Outwardly, they seem the same as autozooids, but they have a widened cavity with a different shape, are pysiform or strongly branched, and surround or enclose several zooids. The kenozooids are simple tubes devoid of internal organs, which serve to attach and fix the zoarium to the substrate. In some species, such as *Crisiidae,* the kenozooids (called rhizooids) serve not only to attach the zoarium, but also for reproduction. The autozooids (Figure 13) are tubular structures with a round orifice at the end, and a stretched membrane known as the terminal membrane. In the center of this membrane is an opening called the terminal pore which opens the entrance to the vestibule. This membrane, like the body wall in general, consists of 3 layers: the cuticle, the ectoderm, and the mesoderm. The cuticular layer in the terminal membrane in thin and devoid of calcium; it is thicker in the body wall and has 2 layers which consist of a chitinous outer, and an inner saturated with calcium. The autozooid in *Cyclostomata* is distinguished by the presence of a peculiar organ, the membranous sac which was first described by Borg (1923, 1926); this sac is an apparatus which helps the animal, enclosed in an unbending, calcareous body wall, to extend and draw the tentacular crown. In the invaginated state of the polypide, the terminal pore leads to the cavity which is known as the vestibule, in the proximal end of which another orifice is situated—the atrial orifice which leads to the so-called atrial cavity in which the tentacles are located, surrounded by the tentacular sheath. In some representatives, such as *Crisiidae,* the terminal pore is closed by an annular musculature, or the vestibular sphincter; the latter is absent in others, but in all *Cyclostomata* the orifice leading to the atrial cavity is closed by an annular musculature during the invagination of the tentacles, and this is known as the atrial sphincter. In a stretched condition the whole complex of the internal organs is not only simply contained in the body wall of the zooid, surrounded by the body wall, but enclosed in a peculiar saccate structure called the membranous sac, which is attached at one end to the proximal end of the vestibule near the atrial sphincter, and at the other end to a fixed point in the body wall (Figure 14). The wall of this membranous sac consists of 2 layers: the inner one of irregular and mesodermal cells, and the outer elastic one formed from a structureless membrane secreted by the cells of the inner layer. Under the influence of the muscles stretching the vestibule, and before the projection of the tentacles, the atrial sphincter loosens and the distal part of the membranous

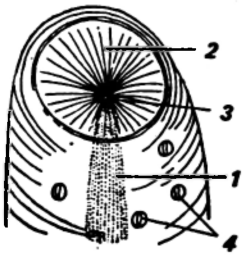


Figure 13. Distal end of an autozooid of *Crisia eburnea* L. (×335): 1—*vestibule;* 2—*terminal membrane;* 3—*terminal pore;* 4—*pseudopore* (*from Borg,* 1926).

sac widens; the cavity fluid is transferred from the upper section of the body cavity to the lower one, as a result of which the pressure increases in the latter and the tentacles push out. Thus the membranous sac in *Cyclostomata* plays the same role as a hydrostatic apparatus; the compensatory sac in the other group of Bryozoa, also having a calcified body wall, particularly in members of the suborder *Ascophora* of the order *Cheilostomata,* performs the same function. Another difference in the structure of *Cyclostomata* is the absence of the parietal muscles which, in the presence of the calcareous wall around their body, are redundant. In addition to the aforementioned muscles stretching the vestibule, retractor muscles also exist in the form of one pair of transversely striped muscles, which pull the tentacular crown inward again. These muscles are shorter in *Cyclostomata.* Lastly, the special feature of the so-called polyembryony which occurs during reproduction in *Cyclostomata* must also be mentioned. A relatively smaller number of zooids in *Cyclostomata* zoaria develop eggs, but in very small numbers; usually only one egg develops. Thus egg feeds and develops in the gonozooid at the cost of the embryophore, i.e., the degenerating polypide. After cleavage of the egg, the embryo, in the stage of morula or ancestrula which is the primary embryo, forms a larger number of secondary embryos by the process of budding; these latter give rise to tertiary embryos in some cases. As a result, the gonozooid is filled with a large number (above 150) of embryos at different stages of development, right up to the fully developed larvae gradually leaving the gonozooid through the orifice of the oeciostome (Figure 15). By this method of reproduction, the small number of fertile zooids found in the zoarium, is compensated. Asexual reproduction takes place through budding. Along the distal margin of the zoarium is located the undifferentiated tissue (so-called "common bud") in which

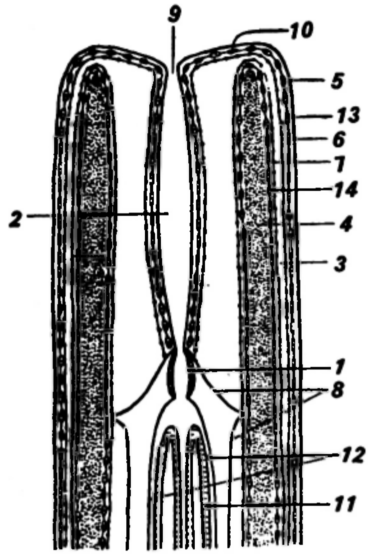


Figure 14. Diagrammatic longitudinal section through the distal part of the zooid in *Pachystega* and *Calyptrostega* (with a double body wall):

1—*atrial sphincter;* 2—*vestibule;* 3—*hypostegial cavity;* 4—*calcareous layer of cryptocyst;* 5—*cuticle of gymnocyst;* 6—*mesoderm of gymnocyst;* 7—*mesoderm of cryptocyst;* 8—*membranous sac;* 9—*terminal pore;* 10—*terminal membrane;* 11—*tentacle;* 12—*tentacle sheath;* 13—*ectoderm of gymnocyst;* 14—*ectoderm of cryptocyst* (*after Borg,* 1930a).

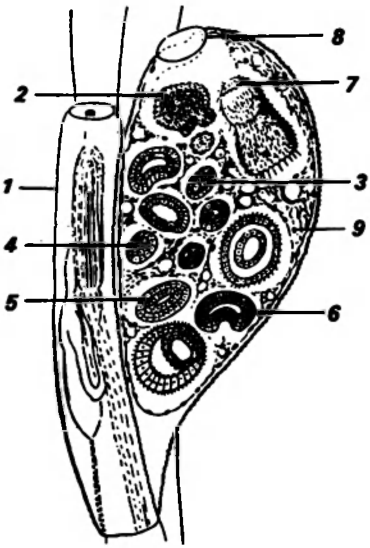


Figure 15. Longitudinal section through a gonozooid of *Cyclostomata*:

1—*neighboring zooid;* 2—*primary embryo;* 3—*secondary embryo at the stage of gastrula with* 4 *enclosed entodermal cells;* 4—*secondary embryo with a large number of entodermal cells;* 5—*secondary embryo with parietal mesoderm;* 6—*secondary embryo with invaginated sucker* (*primordium of basal plate*); 7—*larva;* 8—*oeciostome;* 9—*embryophore* (*from Marcus,* 1926a).

the calcareous septa are formed in a definite regular manner; these parts form new zooids. The primary disc gives rise to the initiation of all types of zoaria. The primary disc, or pro-ancestrula develops from the floating larva affixed to the ground. The pro-ancestrula initiates the first zooid with or without separate chitinous articulation, and from it one or a few other zooids bud; during this process a funnel-shaped structure is formed that is surrounded by a calcified wall and covered with a terminal membrane (Figures 16 and 17). This is the so-called "common bud" which is the initial form for the development of the zoarium in all groups of this order; its further development in various suborders proceeds in a different manner, but in all cases the terminal membrane of the adult zooids originates from the terminal membrane of the common bud.

In contrast to earlier authors who based all descriptions of the species of *Cyclostomata* and their division into systematic groups, on the basis of external zoarial characters, recent authors such as Waters (1887), Harmer (1891, 1896, 1898a, 1898b), and particularly Borg (1926, 1933b, 1944a, 1944c) have made a detailed analysis of this order (which is also followed by me in the description of major groups) on the basis of such anatomical characters of the zooid as the structure of the body wall and, particularly, the reproductive organs. Zoarial characters undergo significant change depending upon the ground and other external conditions, as well as age, and therefore are less reliable. Latest investigations have shown that the characteristics of the reproductive organs are more stable. In the majority of the modern species, gonozooids, or changed autozooids (the ovicells, or oecia of other authors), are the reproductive organs. Although gonozooids, either poorly or strongly widened in the middle section, are highly ramified, cover many zooids, and can change their form and size in one or the other case, nevertheless the form and location

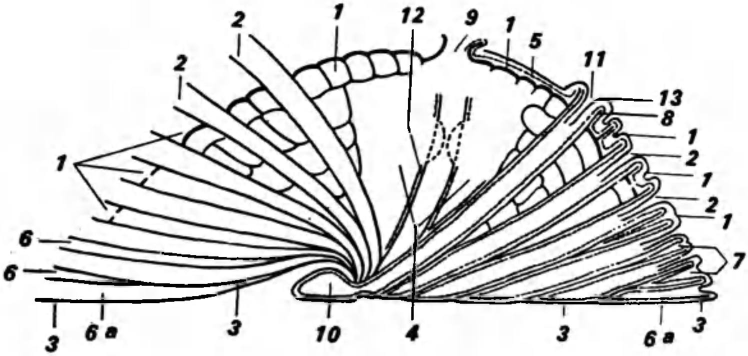


Figure 16. Diagram of a sagittal section from a sexually mature zoarium of *Lichenopora* (only the calcified parts have been drawn):

1—*alveoli* [*alveoli close to the budding zone* (6-a) *are either not covered or incompletely covered with the fornix; median-lateral alveoli are developed in the form of a few deposited layers so that the primary, secondary, and tertiary alveoli may be established here; in most of the central alveoli the walls have dissolved, and consequently their cavities have fused giving rise to one large cavity* (*brood chamber*), *while the other alveoli in the same region have only partly dissolved*]; 2—*zooids* (*autozooids, the kenozooids found in Calyptrostega*); 3—*basal plate;* 4—*brood chamber* (*a part of the zoarial coelomic cavity which, in this case, forms by the fusion of several alveoli*); 5—*Gymnocyst* (*only the cuticle; ectoderm and mesoderm are not included*); 6—*a part of the zoarial cavity around the budding margins of the zoarium, which has not yet divided into separate alveoli;* 6-a—*common bud* (*budding zone*); 7—*zoarial coelomic cavity;* 8—*cryptocyst* (*mesoderm not included*); 9—*opening of brood chamber* (*alveoli with changed form*); 10—*pro-ancestrula;* 11—*primary zooid;* 12—*mature zooid;* 13—*terminal membrane* (*from Borg,* 1926, 1944a).

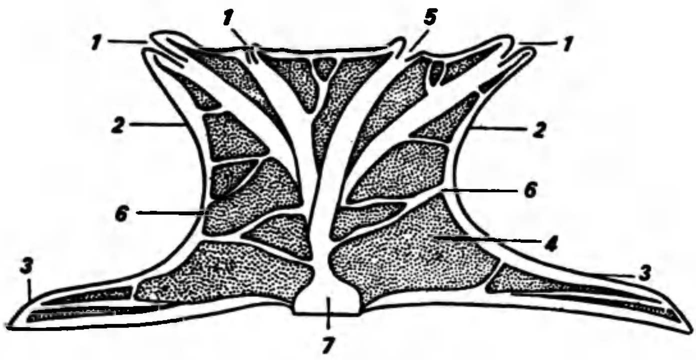


Figure 17. Diagram of the structure of a young *Pachystega*:
1—*autozooid;* 2—*gymnocyst;* 3—*kenozooid;* 4—*cryptocyst;* 5—*primary zooid;* 6—*pore channels;* 7—*pro-ancestrula* (*from Borg,* 1944a).

of their oviduct (oeciostome) and its orifice (oeciopore) are permanent and these can serve as dependable criteria. In a few of the now-living groups, like *Lichenoporidae* and *Heteroporidae,* the membranous sac in which the embryos develop, is not located in the extended gonozooid, as in most of the presently existing *Cyclostomata,* but originates from the unchanged fertile zooid in the zoarial cavity and, having overgrown it, surrounds the fertile as well as the neighboring zooids to form the zoarial brood chamber in which the oviduct and the orifice are also permanent characters. On the basis of the structure of the body wall of the zooid, Borg has differentiated *Cyclostomata* by a simple or double body wall. The simple body wall or gymnocyst consists of three layers: (1) the chitinous layer which, in turn, is double-layered consisting of a chitinous outer and an inner saturated with calcium; (2) the ectodermal layer; and (3) the mesodermal layer. Such a body wall is typical of presently existing *Cyclostomata.* They belong to two suborders: *Tubuliporina* Milne-Edwards and *Articulata* Busk. The other minor representatives of *Cyclostomata* have a double body wall (Figure 16) consisting of an outer gymnocyst and an inner cryptocyst. In this case the gymnocyst in most representatives is uncalcified, but in some, such as *Stegohornera,* it becomes calcified with the growth of the zoarium; this is reflected in the small sizes of their zoaria.

The cryptocyst, like the gymnocyst, consists of three layers: the middle, chitinous, calcified layer; the ectodermal secreting chitin and calcium; and the mesodermal. The chitinous layer in this case is in the middle with the inner ectodermal and the outer mesodermal layer located on either side of it. A slit-like space occurs between the cryptocyst and gymnocyst called the hypostegial cavity (Figure 17) which is a section of the whole body cavity. All the representatives with a double body wall belong to the suborders *Pachystega* Borg, *Calyptrostega* Borg, *Heteroporina* Borg, and *Isoporina* Kluge.

Key for Identification of the Suborders of the Order Cyclostomata

1 (2). Zoaria separated through definite intervals by chitinous articulations into joints or internodes. Gonozooids pyriform. ....II. *Articulata* Busk (see p. 156).

2 (1). Zoaria not divided by chitinous articulations.

3 (4). Zoarium consists of 2 types of zooids: the large autozooids, and the small kenozooids. Their orifices are arranged over the entire free surface of the zoarium...V. *Heteroporina* Borg (see p. 206).

4 (3). Zoarium consists of one type of zooids, the autozooids, but sometimes of autozooids and nanozooids. If there are kenozooids in the zoarium, these are devoid of orifices and found either near the base of the zoarium, or on the lateral or dorsal side of the zoarium.

5 (6). Zoaria prostrate, verrucose. Zooids arranged radially from the center, separated by alveoli, i.e., the calcified pit-like interstices in the zoarial cavity.........IV. *Calyptrostega* Borg (see p. 195).

6 (5). Zoaria not verrucose; zooids not arranged radially, nor separated by alveoli.

7 (8). Zoaria capitate or fungiform and free-growing. Zooids open at upper convex frontal surface of zoarium with one kind of large orifice, hexagonal in shape...VI. *Isoporina* Kluge subordo n. (see p. 211).

8 (7). Zoaria neither capitate nor fungiform, prostrate nor free-growing.

9 (10). Zoaria free-growing, ramified, thick-walled due to secondary calcification of cryptocyst on outer walls of zooids. Orifices of zooids located on one side of the zoarium. Gonozooid, expanded in the middle portion, is round or oval and situated on the dorsal or frontal sides, or in the juncture between the branches. ....III. *Pachystega* Borg (see p. 186).

10(9). Zoaria prostrate or free-growing, have different forms. Zoarial wall thin and simple. Orifices of zooids located on one or two sides of the zoarium or around the stem. In a few zoaria, nanozooids as well as autozooids are found. If kenozooids are present, these are devoid of orifices and located near the base of the zoarium or on the lateral or dorsal side. The reproductive organ is a poorly or strongly developed gonozooid and, in rare cases, a brood chamber...I. *Tubuliporina* Busk (see below).

I. Suborder **Tubuliporina** Milne-Edwards, 1838

Tubuliporina (part.) Milne-Edwards, 1838 : 233; *Parallelata* (part.) Waters, 1887 : 337; *Acamptostega* Borg, 1926 : 474; 1944a : 20.

The zoarium is prostrate or free-growing, simple or branched. The primary zooid is always prostrate over the substrate and is not separated from the primary disc by chitinous joints. The body wall is simple in the form of a gymnocyst. The zooids have no vestibular sphincter. Nanozooids as well as autozooids are present. If kenozooids are present, these are devoid of orifices and serve the purpose of attaching and affixing the zoarium to the substrate. Rhizooids are absent. The reproductive organ is a weakly or strongly developed gonozooid expanded in the middle part, but in rare cases, it is a brood chamber formed by the fusion of neighboring zooids around the fertile zooid.

Key for Identification of the Families of the Suborder Tubuliporina

1 (6). Zoarium prostrate or free-growing.

2 (3). Zoarium verrucose or free-growing, cup-shaped or cylindrical. Frontal side of zoarium consists of radially arranged conspicuous and complex rows of zooids, between which one or more gonozooids are stretched.......V. *Corymboporidae* Smitt (see p. 148).

3 (2). Zooids do not develop radially arranged, prominent, complex rows. Zoaria prostrate, single-layered, or free-growing in the form of single or double-layered lobes or stems with zooids arranged on one or both sides or around the stem.

4 (5). Zoaria prostrate or free-growing, consist of 1, 2, or many rows of zooids located on one side. The prominent ends of the zooids are free or arranged in rows or bundles. Gonozooid either small, flat, or saccate, and usually strongly outgrown between zooids ....I. *Tubuliporidae* Johnston (see p. 89).

5 (4). Zoarium prostrate and single-layered, or free-growing and double-layered. The prominent ends of the zooids are individually located or in rows, never connected bundles or joints. In addition to autozooids, nanozooids may be present. Gonozooids are saccate...........IV. *Diastoporidae* Busk (see p. 136).

6 (1). Zoarium free-growing, ramified.

7 (8). Zooids open on one side of the stem (trunk) or branch, are arranged in rows perpendicular to the stem. Rows divide in the middle into bivalves directed to different sides. Kenozooids located on basal side of stem. Gonozooid located on frontal side in the middle of the stem and between the rows of zooids along 1, 2, or more rows of zooids...II. *Idmoneidae* Busk (see p. 121).

8 (7). Zooids open around the stem of the zoarium, or on the top of bundles of zooids which are very closely connected with each other.

9 (10). Zooids open all around the stem of the zoarium. Gonozooids open by a semi-circular orifice located near the base of the prominent part of the zoid...III. *Entalophoridae* Lamouroux (see p. 132).

10 (9). Zooids open only at the top of the joints or bundles in which they closely fuse with each other along their entire length.............................VI. *Fascigeridae* d'Orbigny (see p. 154).

I. Family **Tubuliporidae** Johnston, 1838

Tubuliporidae (part.) Johnston, 1838 : 267; Hincks, 1880a : 424; Borg, 1944a : 21.

The zoaria are prostrate or initially prostrate, and later free-growing in the form of more or less long branches or stems. The proximal parts of the zooids are either flat or more or less completely separated; the distal parts of the zooid either protrude over the surface of the zoarium, or are somewhat long and free-growing, or are combined in rows or bundles. The gonozooids (especially their middle, wider parts) are either barely noticeable, small and flat, or slightly convex structures stretched between the zooids. The oeciostomes are either round or more or less flattened tubes opening through round or semi-circular orifices.

Key for Identification of the Genera of the Family Tubuliporidae

1 (6). Zoarium flattened and ramified along its length.

2 (3). Zoarium consists of one row of zooids..1. *Stomatopora* Bronn (see p. 90).

3 (2). Zoarium consists of a large number of zooid rows.

4 (5). Zoarium's comparatively narrow branches consist of 1 to 4 rows of oblong zooids. The free ends of the zooids are located either in perpendicular rows or collected together, a few giving rise to bundles. Gonozooid located near the distal end of the branches in the form of a small sac with a round and short oeciostome.........................2. *Proboscina* Audouin (see p. 91).

5 (4). Zoarium's wide lobulate branches consist of several rows of zooids. The free ends of the zooids are slightly raised above the surface of the zoarium. The growing margin of the lobes consists of 1 to 4 rows of developing zooids. Gonozooids are less noticeable, small, almost flat; the oeciostome is in the form of a short round tube or a round orifice..3. *Oncousoecia* Canu (see p. 95).

6 (1). Zoaria either prostrate or initially prostrate and later free-growing. Distal ends of the zooids are raised above the surface of the zoarium and more or less long; the growing margin of the lobes does not consist of continuous rows of developing zooids. Gonozooids in the form of tubes or semi-circular openings.............................4. *Tubulipora* Lamarck (see p. 99).

1. Genus **Stomatopora** Bronn, 1825

Alecto Lamouroux, 1821 : 84; Busk, 1875 : 23 (part.); *Stomatopora* Bronn, 1825 : 27; Hincks, 1880a : 424 (part.); Borg, 1926 : 358, 1944a : 24.

The zoarium is prostrate, dichotomously branched, and consists of one row of zooids. The zooids are cylindrical; their free distal ends more or less rise up steeply from the proximal prostrate part and open into a round orifice. In fertile zoaria, the gonozooid is surrounded by a few zooids acting as sources of food supply, and the zoarium becomes double-rowed at this point.

Genus type: *Stomatopora granulata* (Milne-Edwards).

Stomatopora granulata (Milne-Edwards, 1838) (Figure 18)

Alecto granulata Busk, 1875 : 24, pl. XXXII, f. 1; *Stomatopora granulata* Hincks, 1880a : 425, pl. 57, f. 1-2; Kluge, 1906 : 49, f. 6; Borg, 1926 : 358, f. 67-68.

The branches sometimes anastomose. The zooids are usually covered with barely noticeable pseudopores. The gonozooid is oblong, widening toward the distal end, and surrounded by a few irregularly arranged neighboring zooids. Sometimes the gonozooid is also found in a semi-erect condition.

The species lives on coralline, calcareous tubes of worms, Bryozoa,

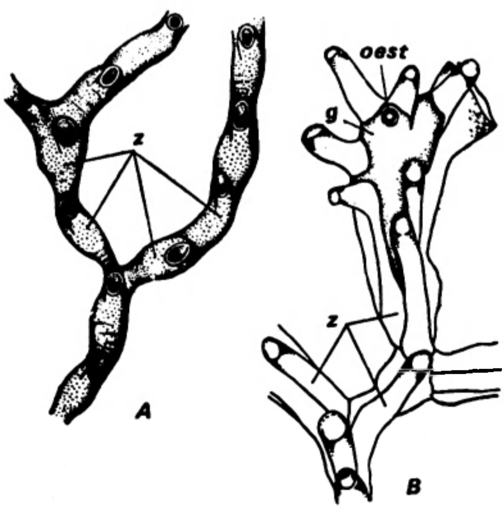


Figure 18. *Stomatopora granulata* (Milne-Edwards). *A*—part of the sterile zoarium (from Hincks, 1880a); *B*—distal part of the fertile zoarium (from Borg, 1926).

shells, and stones, at a depth from 9 to 385 m, on a bed of stone and silt, under a temperature ranging from 0.2 to 3°C.

Distribution. The species was found by me in the Barents and Kara seas. *Reports in literature:* Barents Sea (Kuznetsov, 1941), White Sea (Gostilovskaya, 1957), Bay of North Lavrentia (Whiteaves, 1901), Lofoten Islands (Nordgaard, 1918), Great Britain (Hincks, 1880a), northwest France (Joliet, 1877), and the western coast of North America, Vancouver Island (O'Donoghue, 1923).

This is an Arctic-boreal species.

2. Genus **Proboscina** Audouin, 1826

Proboscina Audouin, 1826 : 236; Osburn, 1953 : 620; *Tubulipora* subg. *Proboscina* (part.) Smitt, 1867 : 402, 458; *Stomatopora* (part.) Hincks, 1880a : 424.

The zoaria are prostrate and ramified. The branches, narrow or more or less widening toward the ends, consist of 1 to 4 rows of zooids. The zooids are in the form of long tubes whose free ends are slightly raised above the surface of the zoarium; sometimes several of them fuse in a row or bundle. The gonozooids are located near the distal end of the branches in the form of a sac with a short, round, or transversely oval oeciostome.

Genus type: *Proboscina boryi* Audouin, 1826.

1 (4). Zoarium not large in size. Branches consist of 1 to 2 rows of zooids. Gonozooid semi-erect, located at the end of the branch between the freely raised distal ends of the zooids..1. *P. gracilis* (Kluge).

2 (3). Zoarium in the form of 2 short branches. Gonozooid more or less long, situated in the middle of the branch between lateral rows of zooids. Oeciostome located near the distal end of the gonozooid in the form of a transversely oval tube tilted away from the end of the branch..........2. *P. fecunda* Kluge sp. n.

3 (2). Zoarium in the form of long, narrow, dichotomously bifurcated branches, consists of 2 to 3 rows of zooids whose free ends appear to be located in perpendicular rows. Gonozooids more or less short, situated either at the end of the branch, or under the terminal ramifications.................3. *P. major* (Johnston).

4 (1). Zoarium in the form of repeatedly and irregularly bifurcating branches which sometimes narrow, sometimes widen, consists of 2 to 4 rows of zooids whose free ends are either solitary or fused together in bundles of 2 to 4 ends each..4. *P. incrassata* (Smitt).

1. **Proboscina gracilis** (Kluge, 1915) (Figure 19)

Stomatopora gracilis Kluge sp. n. in Deryugin, 1915 : 389 (nomen nudum).

The zoaria are not large. The branches consist of 1 to 2 rows of zooids. The proximal half of the tubes of the zooids is prostrate, the distal half is free and rises up almost at an angle of 90°. At the end of the long branch between the 3 uprising parts of the zooidal tubes is located a vertically standing saccate gonozooid which ends with a facet in the top; in the center of this is located a small tubular oeciostome that tilts in the proximal direction and ends with an oval orifice whose diameter is smaller than the diameter of the tubes of the zooids.

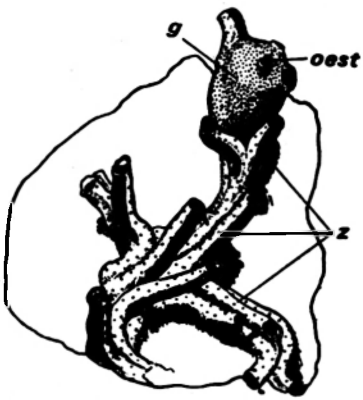


Figure 19. *Proboscina gracilis* (Kluge). Distal part with gonozooid and oeciostome. Barents Sea (Bay of Kola).

The species lives on the ascidia *Phallusia obliqua* Alder, at a depth of 100 to 150 m, on a bed of silty sand.

Distribution. That the species is endemic to the Kola Bay was confirmed by me.

2. **Proboscina fecunda** Kluge sp. n. (Figure 20)

The zoaria are not large (up to 6 mm), are two-branched, and mature early. The branches consist of 2 to 3 rows of zooids; the distal ends rise more or less sharply and freely above the surface. The long gonozooid is stretched in the middle of the branch between the lateral zooids. In its prominent part, the oeciostome is located independent of the zooid protruding from behind; the oeciostome is in the form of a short transversely oval tube, tilts opposite to the end of the twig, and opens in a perpendicularly oval orifice.

The species lives on laminaria, at a depth of 44 m, on a bed of solid silt.

Distribution. I found the species in the East Siberian Sea north of the Novo Sibirisk Islands.

This species is endemic to the East Siberian Sea.

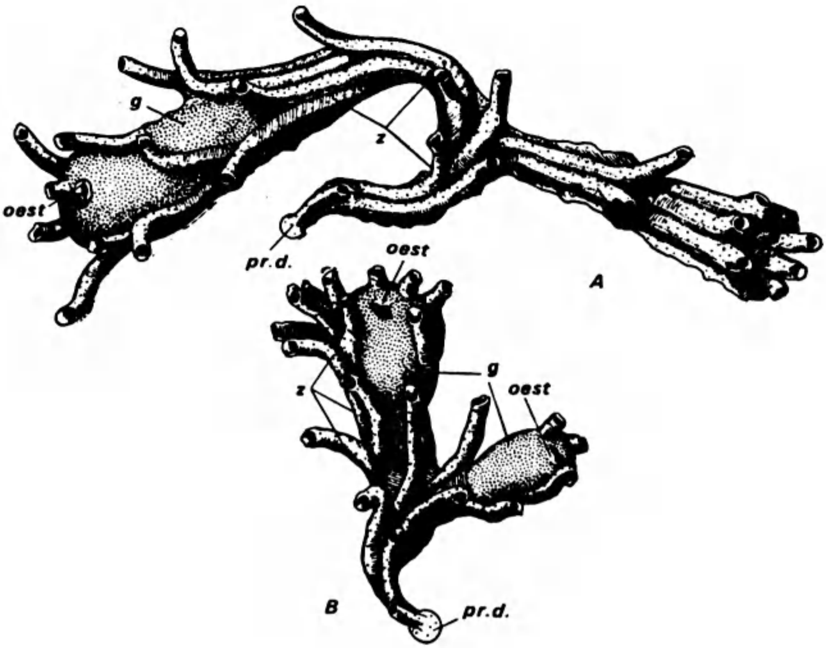


Figure 20. *Proboscina fecunda* Kluge. *A* and *B*—complete fertile zoaria, East Siberian Sea.

3. **Proboscina major** (Johnston, 1847) (Figure 21)

Stomatopora major Hincks, 1880a : 427, pl. 58, f. 1-4, pl. 61, f. 1; Kluge, 1906 : 50, f. 7; Marcus, 1940 : 50, f. 25.

The zoarium is prostrate and dichotomously branched. The branches are narrow and teniate, and consist of 2 to 3, sometimes 4, rows of zooids located in slanted or transverse rows. The procumbent part of the zooids is often covered with barely noticeable sparse pores, their distal ends rising above the surface in the form of more or less short and free tubes with round orifices at the ends. The gonozooid, in the form of a sac which widens in the distal part and constricts in the proximal, is located either at the end of the branch or under the terminal ramification. The oeciostome is a short round tube.

The species lives on shells and stones, at a depth from 20 to 324 m, on a bed of stone with a mixture of silt, under temperatures ranging from -1.23 to 2.3°C, in a salt concentration from 34.50 to 35.00‰.

Distribution. The species was located by me in the Barents Sea and near eastern Greenland. *Reports in literature:* western Norway (Nord-

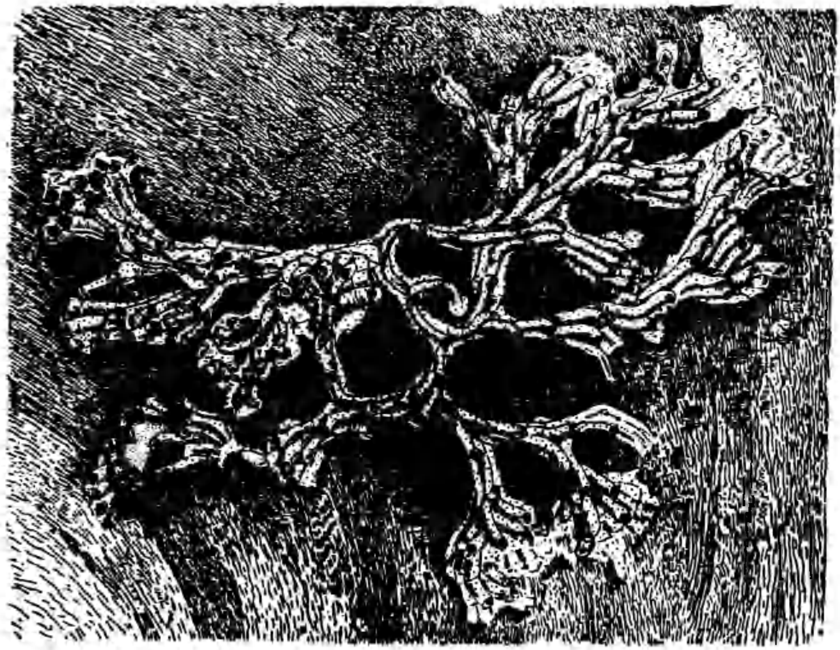


Figure 21. *Proboscina major* (Johnston). Complete fertile zoarium.

gaard, 1897), Great Britain (Hincks, 1880a), northern France (Joliet, 1877), Mediterranean Sea (Calvet, 1902), and Vancouver Island (O'Donoghue, 1923, 1926).

The species is Arctic-boreal.

4. **Proboscina incrassata** (Smitt, 1866) (Figure 22)

Tubulipora incrassata (subgen. *Proboscina*) (part.) Smitt, 1867 : 402, 458, 1872a : 1119, t. XX, f. 8; *?Stomatopora incrassata* Hincks, 1880a : 436; *S. incrassata* Kluge, 1906 : 51, f. 9; *S. granulata* (part.) Borg, 1933a : 517; Marcus, 1940 : 52, f. 26b; *Probiscina incrassata* Osburn, 1953 : 623, pl. 66, f. 1 and 2.

The zoarium is prostrate and ramified several times. The branches are short, sometimes narrow, sometimes wide, and consist of 1 to 3 rows of zooids; the slightly protruding free ends of the zooids are located singly, or in pairs in a row, or in bundles of 3 or 4, rarely more. The prostrate part of the tubes is more or less flat. The branches are frequently covered with transverse patterns. The gonozooid is simple in the form of a slightly convex expanded sac, located near the distal end of the branches, and surrounded by several zooids on each side. The oecios-

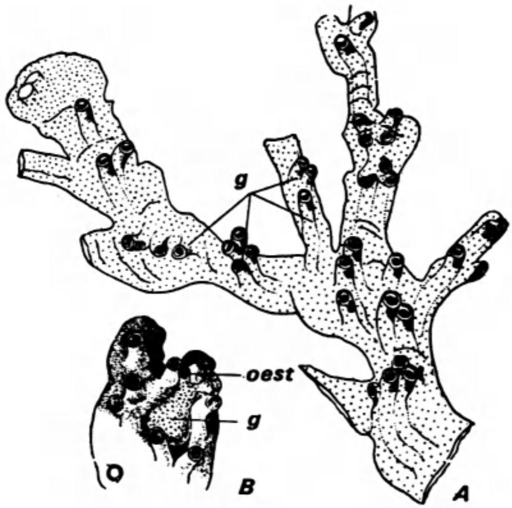


Figure 22. *Proboscina incrassata* Smitt. *A*—part of the sterile zoarium; *B*—part of the branch with gonozooid and oeciostome (from Osburn, 1953).

tome is in the form of a small short tube with a round orifice.

The species is found at a depth of 30 to 50 m on stony ground.

Distribution. This species was found by me in the Barents Sea (in the waters of northwest Spitsbergen) and in the Laptev Sea. *Reports in literature:* Barents Sea (Smitt, 1872a; ?Waters, 1904), Kara Sea (Smitt, 1879a), Chukotsk Sea near the Cape of Barrow (Osburn, 1953), ?British Islands (Hincks, 1880a), and the Queen Charlotte Islands near the western coast of North America (Hincks, 1884).

The species is Arctic.

3. Genus **Oncousoecia** Canu, 1918

Alecto (part.) Norman, 1869 : 310; *Diastopora* (part.) Smitt, 1867 : 395; *Stomatopora* (part.) Hincks, 1880a : 424; *Oncousoecia* Canu, 1918 : 325; Osburn, 1933 : 9; 1953 : 624.

The zoaria, fully prostrate, roundish, branched, and lobate, consist of several rows of zooids. The proximal parts of the zooids form a flat, smooth, even, or uneven surface, above which the distal ends of the zooids are slightly raised. The developing margin of the lobes consists of 1 to 4 continuous rows of developing zooids. The gonozooids, barely noticeable, are in the form of small, flat, or slightly convex sacs opening on the distal margin by an oeciostome in the form of a very small round tube with a round oecipore, or simply a round oecipore.

Genus type: *Alecto diastoporides* Norman, 1869.

1 (4). Zoaria thin, ramified, and lobate; growing margin consists of 1 to 2 rows of developing zooids.

2 (3). Zoaria thin-walled, translucent; growing margin consists of 1 row of developing zooids. The short, sharply uprising distal ends of the zooids are thin and round. Gonozooid cordate or bilobate with a short tubular oeciostome...2. *O. canadensis* Osburn.

3 (2). Zoaria denser with thicker tube walls; growing margin usually consists of 2 rows of developing zooids. Free ends of zooids are not sharply raised above the surface. Gonozooid oblong and flat, with a round orifice in the distal half...1. *O. diastoporides* Norman.

4 (1). Zoaria thick with uneven surface; growing margin consists of 3 to 4 rows of developing zooids. Zooids thick-walled; orifices restricted by multiangular boundaries. Gonozooids barely noticeable, have a concave surface; oeciostome in the form of a short round tube....................3. *O. polygonalis* (Kluge).

1. **Oncousoecia diastoporides** (Norman, 1869) (Figure 23)

Stomatopora diastoporides Hincks, 1880a : 434, pl. 63, f. 3 and 4; *Diastopora simplex* Smitt, 1872a : 1116, t. XX, f. 4; *Oncousoecia diastoporides* Osburn, 1933 : 9, pl. 2, f. 5-8.

The zoaria are prostrate, of medium thickness, and flabellate or lobate

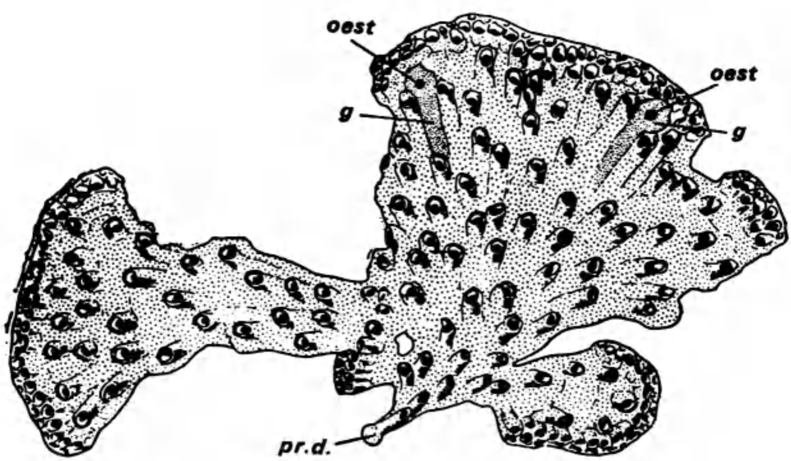


Figure 23. *Oncousoecia diastoporides* (Norman). Complete fertile zoarium.

in form. The surface of the zoarium has a light pattern parallel to the margins of the zoarium. The growing margin of the lobes frequently consists of 2 rows of developing zooids. The frontal walls of the zooids are, for the most part, completely flat except near the distal end where they become slightly convex; they are slightly raised above the zoarial surface at the ends of the zooids in the form of short and slanted, uprising, thick tubes which open into round orifices. The walls of the zooids are covered with close pseudopores, but in the more calcified zoaria they are hidden under the layer of calcium.

Gonozooids are located near the margin of the zoarium, either singly or in multiple numbers; in form, they are similar to the autozooids differing only by a little more width and a covering of denser and smaller pseudopores. The oeciostome is located near the distal end of the gonozooid in the form of a round orifice, often with a thickened margin, giving the impression of a very short tube with a round orifice whose diameter is approximately equal to half that of the orifice of the zooid.

The species lives on stones and shells, at a depth of 11 to 165 m, on a bed of shells (mussels), stone, and sand.

Distribution. This species was found by me in the Barents, Kara and Chukotsk seas. *Reports in literature:* Barents Sea (Smitt, 1867; Bidenkap, 1900a), White Sea (Gostilovskaya, 1957), waters of Baffin Bay near Coburg Island (Osburn, 1936), Labrador (Packard, 1866-69), Bay of St. Lawrence (Whiteaves, 1901), western Norway (Nordgaard, 1918), Shetland Islands (Norman, 1869), North Channel (Hincks, (1880a), Iceland (Nordgaard, 1924), the region of Woods Hole and the Bay of Man (Osburn, 1912, 1933).

This is an Arctic-boreal, circumpolar species.

2. **Oncousoecia canadensis** (Osburn, 1933) (Figure 24)

Diastopora simplex Smitt, 1867 : 396 (part.), pl. VIII, f. 7-8; *Stomatopora diastoporides* Kluge, 1906 : 51, f. 10; *Oncousoecia canadensis* Osburn, 1933 : 12, pl. 2, f. 1-4.

The zoaria, prostrate, thin, and round, are irregularly lobate in form. The surface of the zoarium has a light pattern parallel to the margins of the zoarium. The growing margin of the lobes consists of 1 row of developing zooids. The zooids are flat over the longer part, but near their distal end change into narrower and abruptly uprising short, free ends of tubes opening into a round orifice. The tubes are thin-walled, transparent, and covered with dense, minute pseudopores. The gonozooids are located near the margin of the zoarium and give the appearance of wide, thin-walled sacs of cordate form, covered with dense pseudopores. Frequently the lateral parts of the distal margin

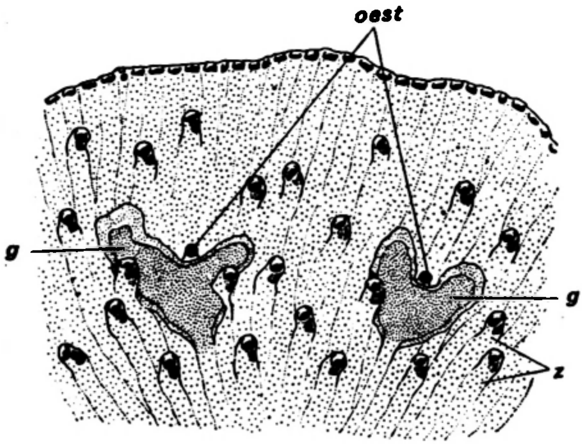


Figure 24. *Oncousoecia canadensis* Osburn. Marginal part of the zoarium with two gonozooids.

of the gonozooid develop into 2 more or less symmetrical lobes, between which the oeciostome opens either in the form of a short cylindrical tube, or a simple round orifice with a diameter that is much narrower than that of the autozooid.

The species lives on stones and shells at a depth of 14 to 324 m, more frequently at 50 to 150 m, under temperatures ranging from —1.7 to 5°C, in a salt concentration of 35.00 to 39.18‰.

Distribution. This species was found by me in the Barents, Laptev, and Chukotsk seas, and in the waters off western Greenland, Baffin Bay, and the Devisov Strait. *Reports in literature:* Barents Sea (M. Sars, 1851; Smitt, 1867, 1879b; Nordgaard, 1897; Bidenkap, 1900a; Andersson, 1902; Kuznetsov, 1941), White Sea (Kluge, 1908a; Gostilovskaya, 1957), western Greenland (Norman, 1876, 1906; Hennig, 1896; Kluge, 1908c; Levinsen, 1914), eastern Greenland (Levinsen, 1916), Gulf of St. Lawrence (Whiteaves, 1901), west of Finmark (Smitt, 1867; Nordgaard, 1918), along the coast of New Scotland and the Gulf of Man (Osburn, 1933).

3. **Oncousoecia polygonalis** (Kluge, 1915) (Figure 25)

Stomatopora polygonalis Kluge sp. n. in Deryugin, 1915 : 389 (nomen nudum); *Tubulipora lobulata* Osburn, 1933 : 16, pl. 1, f. 9; pl. 3, f. 1-5.

The zoaria, prostrate in the form of a thick cork layer, tightly enclose the substrate and have a round, flabellate, or roundish lobate form.

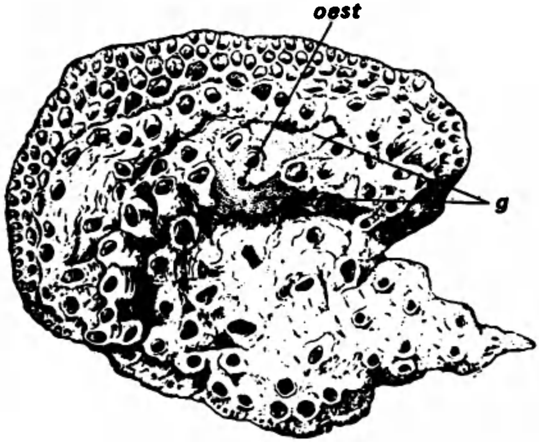


Figure 25. *Oncousoecia polygonalis* (Kluge).

The surface of the zoarium seems to consist of polyhedrons whose sides form the sharply expressed boundaries of constituent zooids which are thick-walled, highly calcified, and shaped more or less like a short tube. In the middle of these polyhedrons are located the round or oval orifices of the zooids. The walls of the zooids of the adult zoaria are devoid of pores. The surface of the zoarium is uneven and wavy. The growing margin of the zoarium consists of 3 to 4 rows of zooids which follow one after the other, and develop toward the margin of the zoarium. The gonozooid usually has an irregular form, but is sometimes bilobate with a slightly concave surface covered with minute pseudopores. The oeciostome, located on the distal margin of the gonozooid in the form of a slightly uprising thick-walled tube, is often located near the wall of the autozooid with a round orifice at the end whose diameter is almost half that of the autozooid.

The species lives on stones and shells, at a depth from 15 to 324 m, on a bed of shells and stones on silt, under temperatures ranging from -0.06 to 2.56°C, in a salt concentration of 32.84‰.

Distribution. The species was found by me in the Barents and Chukotsk seas. *Reports in literature:* Gulf of St. Lawrence (Whiteaves, 1874, 1901; ?Osburn, 1933).

The species is Arctic.

4. Genus **Tubulipora** Lamarck, 1816

Tubulipora Lamarck, 1816 : 161; Hincks, 1880a : 442; Harmer, 1898a : 86.

The zoaria are prostrate, or initially prostrate, and later free-growing.

The zoaria consist of 2 to 3 and more rows of zooids. The proximal parts of the zooids are more or less individuated; the uprising distal parts are comparatively longer. The growing margin of the branches or lobes does not consist of a continuous row of growing zooids. The gonozooids give the appearance of being more or less wide, prominent, saccate structures opening into the oeciostome in the form of round or flattened semi-circular orifices.

Genus type: *Tubulipora transversa* Lamarck, 1816: 182.

1 (16). Zoarium prostrate throughout.

2 (7). The distal ends of the zooids, rising over the surface of the zoarium, usually fuse in rows or groups.

3 (4). Uprising flabellate ends of the zooids form rows or groups which consist of 2 to 7 ends. Oeciostome in the form of a tube pressed on the sides, adheres to 2 neighboring zooids or freely deviates from the base of the neighboring zooid and opens into a slit-like orifice............................1. *T. flabellaris* (Fabricius).

4 (3). Raised ends of the zooids, not arranged flabellately, form rows or groups which consist of 2 to 3, rarely 4, raised ends. Oeciostome in the form of a cylindrical tube is not pressed from the sides, but opens into a round or oval orifice turned upward.

5 (6). Oeciostome in the form of a short tube with a roundish orifice at the end, belongs to the neighboring zooid or is located between 2 zooids........................2. *T. maris-albi* Gostilovskaya.

6 (5). Oeciostome in the form of a long, upward bent, and slightly widened tube toward the end, has an oval orifice located in the middle of the concave margin of the gonozooid...........
....................................3. *T. eminens* Kluge.

7 (2). Zoarium has free distal ends of the zooids raised above their surface; zooids not fused in rows or groups.

8 (13). Zoaria oblong with branches vary in form. Zoaria frequently biramous, with long branches which gradually widen toward their distal ends.

9 (10). Zooids in the proximal part of the zoarium are located close to each other at some places, thereby forming transverse rows. But normally, particularly in the distal part, they are free with short uprising ends. Gonozooid short or only slightly oblong. Oeciostome, in form of a round tube, is located in the middle of the distal margin of the gonozooid....................
..................................4. *T. dilatans* (Johnston).

10 (9). Zooids do not form rows; their free ends are long and bent upward. Gonozooid oblong and convex. Oeciostome in the form of a semi-circular orifice, encloses the base of the zooid

and is located in the corner formed by the gonozooid and the base of the zooid.................6. *T. smitti* Kluge sp. n.

11 (12). Zoarium biramous. Branches long. Zooids in the prostrate part are flat and slightly spearated. Gonozooids, wide, swollen, and located on the distal ends of the branches as well as in the middle portion, cover the entire width of the branches. Oeciostome, a relatively long and cylindrical tube, lies along its entire length toward the zooid....................... ....5. *T. fructuosa* Gostilovskaya.

12 (11). Zoarium not large, narrow. Branches, when present, very short. Zooids in the prostrate part maintain their distinct tubular form and are well individuated. Gonozooid oblong and wide at the distal end. Oeciostome a very low cylindrical tube located singly at the distal end of the gonozooid........ ....7. *T. uniformis* Gostilovskaya.

13 (8). Zoaria wide, usually flabellate, sometimes lobate or pyriform.

14 (15). Free ends of the zooids give the appearance of more or less long tubes of the same length throughout the zoarium. Gonozooid highly widened in the distal part. Oeciostome a short tube, wide at the end in the form of a funnel, and located on the distal end of the gonozooid either singly or attached to the zooid.................8. *T. aperta* Harmer.

15 (14). Free parts of the zooids, mildly tapering toward the ends, are longer in the initial phase of the zoarium. Gonozooid wide, usually bilobate. Oeciostome a short tube located in the middle of the gonozooid near its inner distal margin....... ....9. *T. minuta* (Kluge).

16 (1). Zoaria prostrate only in the proximal part of the zoarium.

17 (26). Free-growing branch-like parts of the zoarium widen toward the ends or lobes and are usually covered with gonozooids.

18 (23). Branches consist of transverse rows of zooids, connected along their length.

19 (20). Oeciostome in the form of a slightly flattened tube, bent at the end at a right angle and opening through an oval orifice, adjoins the wall of the zooid........10. *T. liliacea* (Pallas).

20 (19). Oeciostome not flattened and not adjoining the wall of the zooid, but located in the middle of the gonozooid between 2 transverse rows of zooids.

21 (22). Oeciostome in the form of a short, cylindrical tube which slightly narrows toward the end and opens into a round orifice...............................11. *T. borgi* Kluge.

22 (21). Oeciostome in the form of a short and wide, cylindrical protuberance from the gonozooid, is covered by dense pseudopores

on which, similar to the pedestal, is located a narrower conical tube that tapers toward the upper end and opens into a circular orifice......................12. *T. murmanica* Kluge.

23 (18). Zooids do not form transverse rows on the branches.

24 (25). Tubes of the zooids thick; in the wider lobe their free ends are turned toward the frontal side. Oeciostome usually diverges from the base of the zooid in the form of a long and independent tube; sometimes it fuses with a zooid that has a free distal end......................13. *T. ventricosa* Busk.

25 (24). Tubes of the zooids thinner than in *T. ventricosa,* their free ends directed toward the frontal as well as the basal side of the lobe. Oeciostome usually adjoins the zooids over a long distance, remaining free only at the very end; sometimes it rises singly and independently in the form of a short tube. ....14. *T. soluta* Kluge.

26 (17). Free-growing parts of the zoarium in the form of branched or long stems.

27 (28). Stems short and roundish, widen at the distal ends into a discoid head (capitulum), from the margin of which sprout branches with similar ends. Free ends of the zooids originate usually in bundles from all sides of the stem, as well as from the upper surface of the disc which may be covered with gonozooids. ....15. *T. penicillata* (Fabricius).

28 (27). Stems long, without discoid extensions at the ends.

29 (30). Free ends of the zooids diverge from all sides of the stem. Gonozooid located near the fork of 2 branches. Oeciostome a long tube that narrows toward the upper end............ ....16. *T. nordgaardi* Kluge.

30 (29). Free ends of the zooids diverge only from the frontal side of the bent stem. Gonozooid located in the less wide, distal part. Oeciostome a long tube that widens toward the upper end.... ....17. *T. fruticosa* Kluge.

1. **Tubulipora flabellaris** (Fabricius, 1780) (Figure 26)

Tubulipora flabellaris Smitt, 1867 : 401, 455, t. IX, f. 6-8; Harmer, 1898a : 99, pl. 8, f. 4; Osburn, 1912 : 218, pl. XX, f. 11.

The zoaria attached to the substrate by their whole base are pyriform, kidney-shaped, and fusiform, or rarely, lobate. The uprising sections of the zooids, partly free of each other, and partly fused into rows or groups, contain 2 to 3 or, sometimes, more raised parts. In the completely developed fertile zoaria, the rows in the distal part are frequently arranged

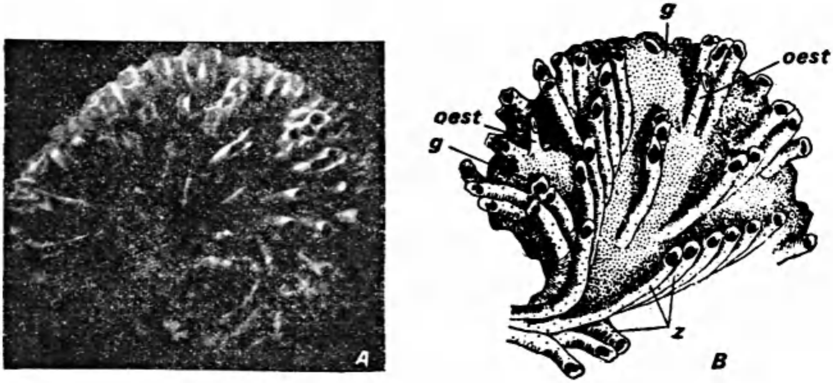


Figure 26. *Tubulipora flabellaris* (Fabricius). *A*—general view of the zoarium from the frontal side; *B*—fertile part of the zoarium with two gonozooids.

radially, and the zoarium acquires a well-expressed flabellate form. The zooids have sparse pores and are more or less long and round, and slightly bent inward. The gonozooids are usually found in the distal parts of the zoarium and have the appearance of oblong sacs or lobate structures; often the lobes fuse to form a wide surface which passes through the individual zooids or groups of zooids. The oeciostome is either in the form of a straight tube pressed from the sides which freely rises from the base of the adjoining individual, or is in the form of a slightly bent tube which is pressed from the sides and situated by its base between 2 neighboring individuals which rise freely from their distal part. The oeciopore, in the form of a slit-like orifice, is typical of the species.

The species lives on laminaria and other algae, or hydroids, shells, and stones, at a depth of 0 to 280 m, but frequently from 0 to 30 m, under temperatures ranging from −2.1 to −0.6°C, in a salt concentration of 33.39 to 34.58‰.

Distribution. The species was found by me in the Barents, White, Kara, Laptev, East Siberian and Chukotsk seas. *Reports in literature:* Barents Sea (Smitt, 1867; Nordgaard, 1897, 1923; Bidenkap, 1897; Kuznetsov, 1941), White Sea (Kluge, 1907, 1908a; Gostilovskaya, 1957), Kara Sea (Nordgaard, 1921), Chukotsk Sea (Osburn, 1923), northern coast of North America (Nordgaard, 1906a; Osburn, 1932), western Greenland (Fabricius, 1780; Smitt, 1868c; Hincks, 1877a; Vanhöffen, 1897; Kluge, 1908b; Levinsen, 1914; Osburn, 1919, 1936), Labrador (Hincks, 1877a), Gulf of St. Lawrence (Dawson, 1859), eastern Greenland (Levinsen, 1914, 1916), northern coast of Norway (Nordgaard, 1897, 1918), Skagerrack and Kattegat (Smitt, 1867; Marcus, 1940), North Sea (Borg, 1930a), from New Scotland to Cape Cod (Osburn, 1912, 1933), and along the western coast of North America up to California

(Robertson, 1910; O'Donoghue, 1923, 1926).

This is an Arctic-boreal, circumpolar species.

2. **Tubulipora maris-albi** Gostilovskaya, 1955 (Figure 27)

Tubulipora maris-albi Gostilovskaya, 1955 : 102, fig. 5-6.

The not very large zoaria are oblong and sometimes ramified, widening toward the distal margin. The zooids are arranged in groups of 2 to 3, sometimes 4, and their tubes adjoin each other almost throughout their length. The walls of the tubes are covered with sparse pores. The wider part of the zoarium is usually covered by a wide bilobate gonozooid densely covered with pseudopores. The oeciostome is situated in the middle of the concave distal margin of the gonozooid in the form of a somewhat flattened tube, or adjoins the nearest zooid, or is located between 2 zooids and opens into a circular or nearly circular orifice at the top.

The zoaria live on laminaria, at a depth of 1.8 to 18 m, on a bed of sand and stone.

Distribution. Reports in literature: White Sea, along the Karelian border and the Solovetsk Islands (Gostilovskaya, 1955, 1957).

The species is endemic to the White Sea.

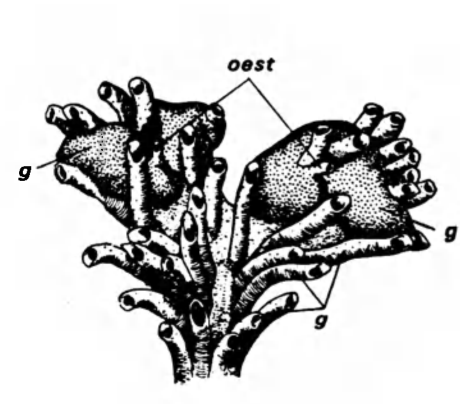


Figure 27. *Tubulipora maris-albi* Gostilovskaya. Distal part of the biramous fertile zoarium. White Sea.

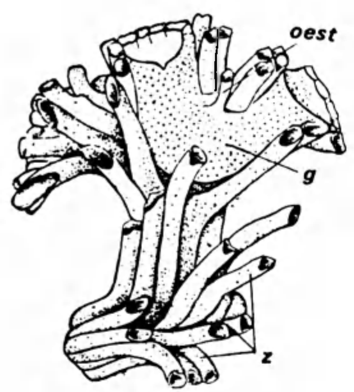


Figure 28. *Tubulipora eminens* Kluge. Distal part of the fertile zoarium. East Siberian Sea.

3. **Tubulipora eminens** Kluge, 1955 (Figure 28)

Tubulipora eminens Kluge, 1955a : 66, fig. 5.

The not large zoarium is prostrate and widens toward the distal end.

The branch consists of a few rows of tubes of zooids; the tubes are arranged in series of 2 to 3 and connected over a long distance, either separating at the ends, or sometimes fusing up to the ends. A wide bilobate gonozooid covered with dense pseudopores, is situated near the margins of the zoarium. In the middle of the concave distal margin it opens into a strongly developed oeciostome in the form of a long cylindrical tube with an oval orifice at the end turned upward, which is initially prostrate and slightly narrowed, but mildly widens from the middle and uprises independently.

The species lives on stones, at a depth of 35 m, on a bed of slit, sand, and stone.

Distribution. The species was found by me in the East Siberian Sea, near the North Cape of Bunge Land.

This species is endemic to the East Siberian Sea.

4. **Tubulipora dilatans** (Johnston, 1847) (Figure 29)

Stomatopora dilatans Hincks, 1880a : 429, pl. 57, f. 3; Kluge, 1906 : 50, f. 8; *Tubulipora lobulata* Hincks, 1880a : 444, pl. 61, f. 5; *T. dilatans* Borg, 1930a : 42, f. 17, 18; Osburn, 1933 : 11, pl. II, f. 9; *Diastopora repens* Smitt, 1867 : 395 (part.), t. VIII, f. 3.

The zoarium is prostrate, oblong, frequently ramified, and usually widens toward the distal end in the fertile lobes. Often zoaria are found in the form of 2 lobes, divergent near the beginning of the zoarium, but in general, the development of the lobes varies significantly. The zooids in the proximal region of the zoarium adjoin each other, sometimes forming transverse rows; only in the distal part of the zoarium are they free over a small length, opening into a round orifice at the end. The gonozooids are situated in the distal parts of the fertile lobes, appearing either as wide saccate structures stretched between individual zooids, or as a row of decumbent oval sacs numbering 1, 2 or even 3. The oeciostome is short and cylindrical, usually located in the middle of the distal margin of the gonozooid, and opens through a round orifice.

The species lives on stones and shells, at a depth of 18 to 1,267 m, on a bed of sand and pebbles.

Distribution. This species was found by me in the Barents and Kara seas. *Reports in literature:* Barents Sea (Kluge, 1906), White Sea (Gostilovskaya, 1957), Newfoundland (Jullien and Calvet, 1903), Yan-Maien Island (Lorenz, 1886), Skagerrack and Kattegat (Smitt, 1867; Levinsen, 1894; Silen, 1936; Marcus, 1940), Great Britain (Hincks, 1880a), northwestern coast of France (Joliet, 1877), and the Mediterranean Sea (Calvet, 1902).

This is an Arctic-boreal, Atlantic species.

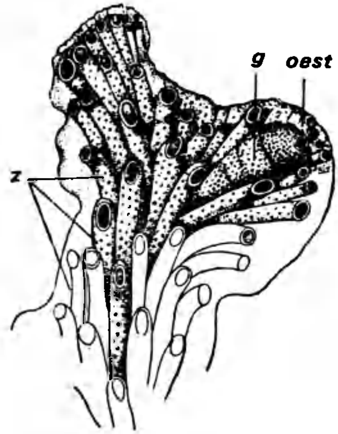


Figure 29. *Tubulipora dilatans* (Johnston). Distal part of the zoarium with the gonozooid (from Hincks, 1880a).

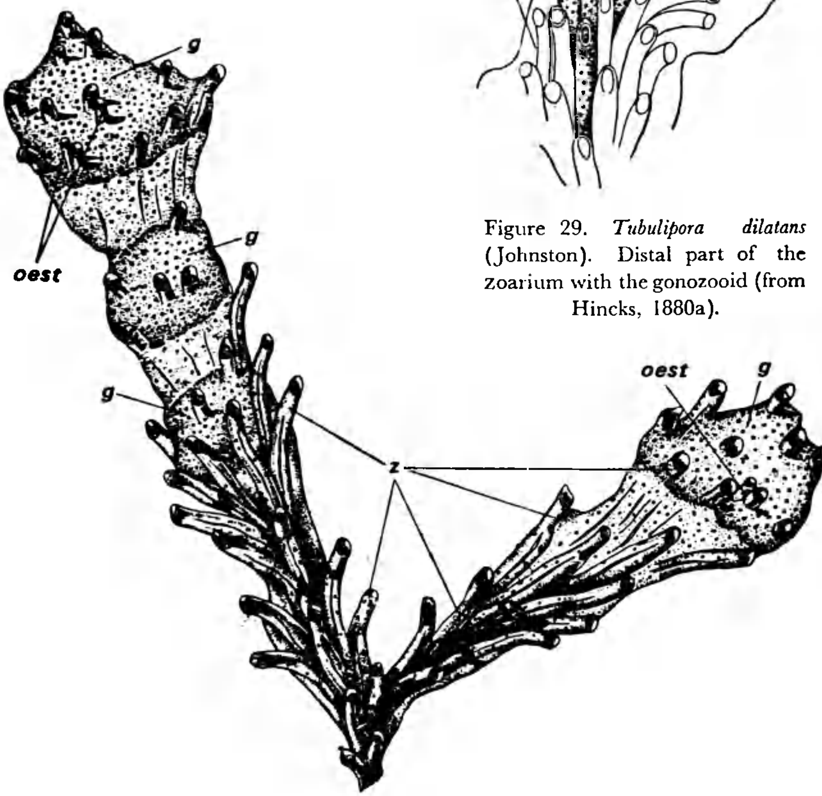


Figure 30. *Tubulipora fructuosa* Gostilovskaya. Fertile zoarium. White Sea.

5. **Tubulipora fructuosa** Gostilovskaya, 1955 (Figure 30)

Tubulipora fructuosa Gostilovskaya, 1955 : 104, fig. 9.

The zoarium is prostrate and biramous. Each branch ends in a gonozooid with one oeciostome on the right branch, and 2 on the left. The left branch, in addition to the developed distal gonozooid, also has 2 under-developed gonozooids arranged one after the other. The zooids are long and adjoin each other over a major part of their procumbent portion. Their distal ends diverge, uprising singly in the form of round tubes with a round orifice at the end. The procumbent parts of the zooids are flat and hence their boundaries have thin contours. The tube walls are thin and thus the polypides are visible through them. The surface of the tubes is covered with sparse minute pseudopores. The gonozooids are somewhat swollen, wider in the middle portion, and have dense pseudopores. The oeciostome, formed like a relatively long, straight, round tube with a round orifice at the end, has a diameter half that of the zooid; it either adjoins the zooid along its entire length, or is located between 2 zooids. The oeciostome, like the free ends of the zooids, is devoid of pseudopores.

Distribution. Reports in literature: White Sea in the Anzersk Strait (Gostilovskaya, 1955, 1957).

6. **Tubulipora smitti** Kluge sp. n. (Figure 31)

Tubulipora fimbria Smitt, 1867 : 401 (part.), t. IX, f. 5; non *T. aperta* Harmer, 1898a : 101, pl. 8, f. 2-3.

The zoaria are prostrate and bi- or tri-lobate. The lobes often widen toward the distal end. The zooids have a long freely uprising and slightly bent cylindrical part. They are not joined in a series, but arranged flabellately. The gonozooid is fairly convex, sometimes longer, sometimes wider, and located between individual zooids. It opens into one or several oeciostomes, each of which is situated near the tube of the zooid; the oeciostome is in the form of a semicircular opening at the level of the gonozooid, and either covers a portion of the zooidal wall or, sometimes, is embedded in its wall.

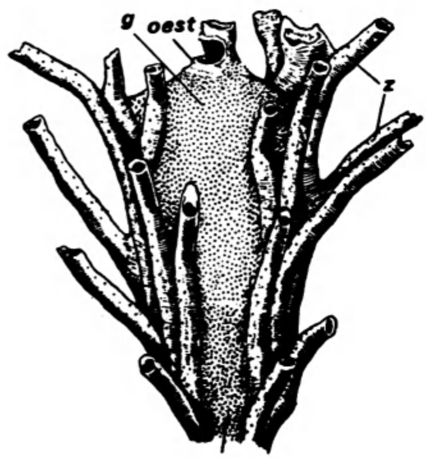


Figure 31. *Tubulipora smitti* Kluge. Gonozooid with oeciostome. Barents Sea.

The species lives on algae, at a depth of 10.8 to 36 m, on a bed of stone.

Distribution. The species was found by me in the Barents Sea in the Sor'e Gulf (Spitsbergen).

Thus far, this species is endemic to the Barents Sea.

7. **Tubulipora uniformis** Gostilovskaya, 1955 (Figure 32)

Tubulipora uniformis Gostilovskaya, 1955 : 103, fig. 7-8.

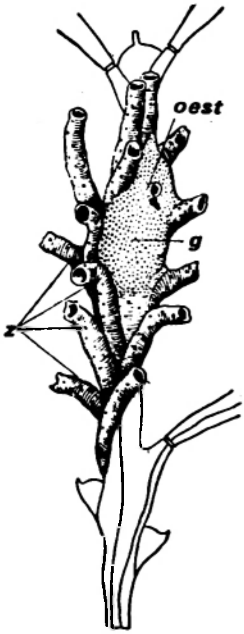


Figure 32. *Tubulipora uniformis* Gostilovskaya. Fertile zoarium. White Sea.

The not large zoaria are narrow and sometimes biramous. The few zooids are long in the form of round tubes with circular orifices at the ends; they adjoin each other over most of their length; their distal ends are free. The walls of the zooids are thin and covered with minute pseudopores. The gonozooid is oblong and wider at the distal end; its dorsal side adjoins the uprising free ends of the zooids. The wall of the gonozooid is covered with very dense pseudopores. The oeciostome, in the form of a free and very low tube with a roundish orifice, is located at the surface (facet) of the widened distal end of the gonozooid.

The species lives on laminaria at a depth of 1.8 to 20 m.

Distribution. Reports in literature: Barents Sea in the Kovdenski and Solovetski Gulfs (Gostilovskaya, 1955, 1957).

The species is Arctic.

8. **Tubulipora aperta** Harmer, 1898 (Figure 33)

Tubulipora aperta Harmer, 1898a : 101, pl. 8, f. 2, 3; Gostilovskaya, 1957 : 436.

The zoarium is prostrate, pyriform, flabellate or lobate. The zooids, in the form of more or less long, solitary, free tubes, lean sometimes in one direction, sometimes in another. The surface of the tubes is covered with sparse pseudopores. A broad, saccate gonozooid, frequently stretched between individual zooids and densely covered with pseudopores, is located in the distal half of the zoarium. The gonozooid opens into one or more oeciostomes. The latter form a short, cylindrical tube, sometimes free, sometimes adjoining the neighboring zooid, that widens on the upper side in the form of a funnel, and opens into a terminal round or oval oeciopore.

The species lives on laminaria, at a depth of 8 m, on a bed of stone.

Distribution. Reports in literature: White Sea in the Kovdenski Gulf (Gostilovskaya, 1957).

Harmer wrongly called this form *T. fimbria,* a name which was used by Smitt for the waters of Spitsbergen. The latter was described by me as a new species with the name *T. smitti.* Therefore the species described by us here, is a boreal species.

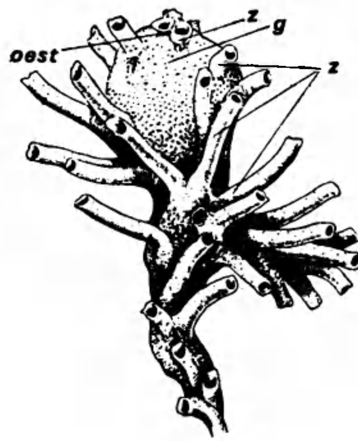


Figure 33. *Tubulipora aperta* Harmer. A part of the zoarium with the gonozooid. White Sea.

9. **Tubulipora minuta** (Kluge, 1915) (Figure 34)

Stomatopora minuta Kluge sp. n. in Deryugin, 1915 : 389 (nomen nudum); Kluge, 1946 : 211, t. III, f. 2.

The zoaria are prostrate. They have several forms: round, resembling a fully opened fan, ramified, or widely lobate with the lobes widening toward the margins. In the middle of the proximal margin of the zoarium is located a round primary disc from which the tube of the first zooid starts.

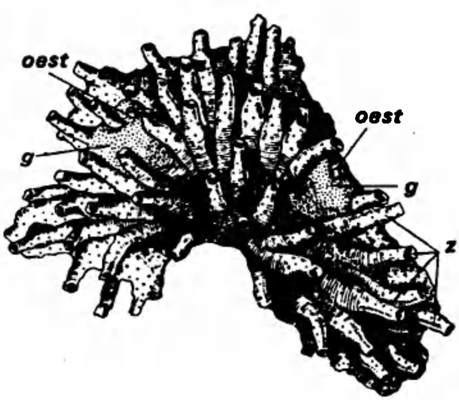


Figure 34. *Tubulipora minuta* (Kluge). Zoarium with 2 gonozooids and oeciostomes.

Two or 3 zooids start from it to expand in different directions. The latter in their turn give rise to 3 to 4 zooids, resulting in the formation of a relatively regular flabellate zoarium. Sometimes, after the 3rd or 4th generation of zooids, the zoarium begins to ramify toward more or less wide lobes. The prostrate part of the tubes is slightly convex, while the free raised terminal portions are round and slightly taper toward the ends. The raised free ends of the tubes are initially rather long, but gradually shorten toward the margins of the zoarium. Near the margin of the latter in 1, 2, or more places, are located the saccate gonozooids which are often broad, bilobate, and covered with very dense pseudopores. We frequently observed that the gonozooid, starting in the proximal part as an ordinary zooid covered with sparse pseudopores, in the middle portion abruptly became wider and covered with a multiplicity of pseudopores. The oeciostome is located in the middle of the concave distal margin of the gonozooid and has the form of a short, thin, cylindrical tube with its terminal, circular orifice turned upward.

The species lives on laminaria, at a depth of 9 to 72 m, on a bed of silt and stone.

Distribution. The species was found by me in the Barents and East Siberian seas. *Reports in literature:* White Sea (Gostilovskaya, 1957).

The species is Arctic.

10. **Tubulipora liliacea** (Pallas, 1766) (Figure 35)

Tubulipora liliacea Harmer, 1898a : 90, pl. 8, f. 7-9; Osburn, 1912 : 217, pl. XX, f. 10, 10a; 1933 : 15, pl. 2, f. 11; *T. serpens* Smitt, 1867 : 399, t. III, f. 1-5; t. IX, f. 1, 2.

Partly adhering to the substrate, the zoaria are partly dichotomously branched, but sometimes acquire a different form depending upon the substrate. The zooids are closely located to each other and their uprising distal parts form continuous rows transverse to the length of the branch, starting from its middle alternately on one side or the other; the zooids shorten as the distance increases from the median line of the branch and approaches the margin. The rows of zooids are frequently radially arranged in the distal parts of the branches.

Often the gonozooids are oblong and, located in the middle part of the fertile branch, give rise to lobes on one or the other side between the transverse rows of zooids, or they develop in a less regular form depending upon the substrate. The fertile branches of the gonozooid consist of uneven lobes stretching between the rows of zooids. The oeciostome is well-developed and, in some cases, is like a flattened broad tube joined by its wider side to one of the zooids on the hind side of the row, almost up to the distal margin of the latter where it bends and gives rise to a horizontally procumbent, short, and round tube which opens into a round orifice; in other cases, it is a short and oval tube freely sessile on the oecia between the rows of zooids; the tube is bent on the distal end into a horizontal tube opening by an oval orifice. The living zoarium is pale purple in color.

The species lives on red and other algae, hydroids, Bryozoa, shells, etc., at a depth of 25 to 1,000 m and more, mostly from 100 to 200 m, on a bed of silty sand and stone, under temperatures ranging from 0.08 to 1.51°C.

Distribution. The species was found by me in the Barents Sea. *Reports in literature:* Barents Sea (Danielssen, 1861; Smitt, 1867, 1879b; Nordgaard, 1918), waters off western Greenland (Norman, 1906; Levinsen,

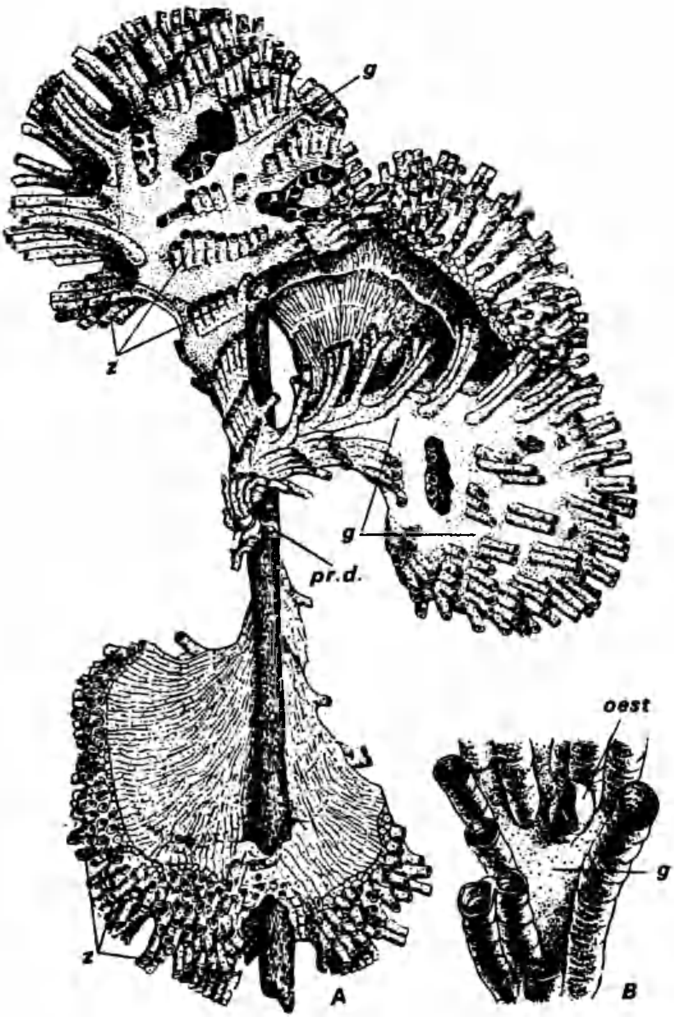


Figure 35. *Tubulipora liliacea* (Pallas). *A*—complete fertile zoarium; *B*—gonozooid with oeciostome (from Osburn, 1912).

1914), Labrador (Packard, 1866-69), Gulf of St. Lawrence (Whiteaves, 1901), along the entire coast of Norway (Nordgaard, 1905, 1906b, 1912a, 1918), western coast of Sweden (Smitt, 1867), North Sea (Nordgaard, 1907b), Great Britain (Hincks, 1880a), northwest France (Joliet, 1877), Mediterranean Sea (Calvet, 1902), from New Scotland to the region of Woods Hole (Osburn, 1912, 1933), region of Vancouver Island on the western coast of North America (O'Donoghue, 1926).

The species is Arctic-boreal.

11. **Tubulipora borgi** Kluge, 1946 (Figure 36)

Tubulipora borgi Kluge, 1946 : 208, fig. 9.

The zoarium is free-growing, ramose, convex on the frontal side, and flat on the base; at the place of transition of one side into the other, a sharp margin is formed. The branches are broad and consist of transverse rows of zooids, one following the other. The rows are made of 2 halves, each located at an angle to the other; initially, each half consists of 2 zooids, but later 4 to 6 zooids fuse in the row. The zooids of each half diverge in opposite directions: the right half to the right side, the left toward the left. The fusion of the zooids is observed almost to their uppermost distal end; furthermore, the marginal outer zooids numbering

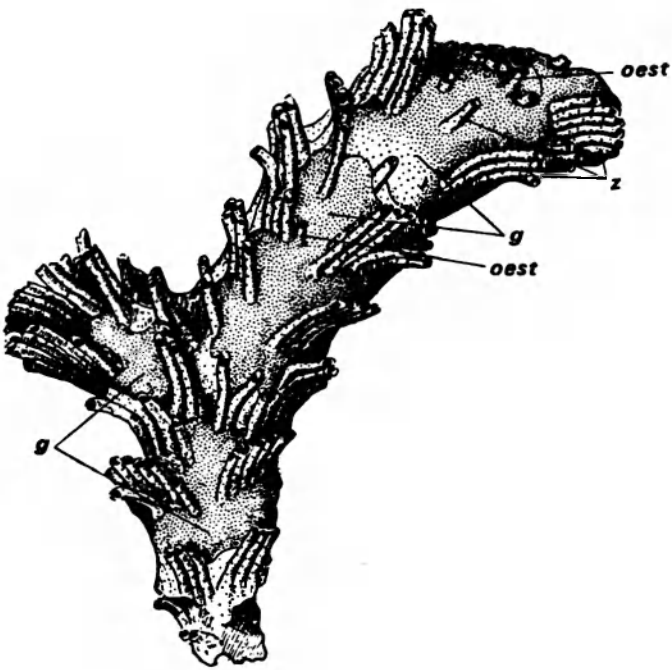


Figure 36. *Tubulipora borgi* Kluge. Distal end of the biramous fertile zoarium from the frontal side.

1 to 2, frequently separate from the others near the end and diverge at a small angle. This regularity of transverse rows is sometimes disturbed by the fact that in some rows, from the 3rd and 4th zooids in the middle row, new zooids branch out from the front, thereby forming a twin-like

row in these places. In an adult, a sexually mature zoarium gonozooid[1] is situated in the middle of the branch between the transverse rows of zooids, opening into the oeciostome and forming a comparatively short, cylindrical tube, slightly tapering toward the distal end. The oeciostome is located in the middle of the gonozooid between the 2 halves of the transverse rows.

The species probably lives on stones, at a depth of 73 m, on a bed of silt and stone.

Distribution. The species was found by me in the East Siberian Sea, and northeast of Novo Sibirisk Island.

The species is endemic to the East Siberian Sea.

12. **Tubulipora murmanica** Kluge, 1915 (Figure 37)

Tubulipora murmanica Kluge sp. n. in Deryugin, 1915 : 388 (nomen nudum); Kluge, 1955a : 66, fig. 6.

The zoarium is free-growing, broad, bilobate, slightly convex on the frontal side and concave on the dorsal side. The frontal side consists of tubes of zooids arranged in transverse rows, one following the other. The eastern transverse row consists of 2 halves located at a more or less acute angle in relation to each other. Initially each half consists of 5 to 6 zooids, but soon after 8 to 9, or even 10, zooids fuse in a row. The zooids of each half are slightly diverted in opposite directions. The zooids are more or less long and fusion continues to their ends. A more or less swollen gonozooid, densely covered with minute pseudopores, stretches from the secondary transverse row in the middle of the entire surface of the zoarium in both directions between the transverse rows of tubes of zooids up to the very distal end of the zoarium. In the middle of the gonozooid, between 2 transverse rows, the oeciostome is located close to the distal end in the form of a short cylindrical protuberance of the gonozooid; it is covered with pseudopores and, like the pedestal, has a narrow conical tube that tapers toward the outer end and opens through a roundish orifice.

The species lives on ascidia and stones, at a depth of 45 to 180 m,

[1] In my paper of 1946, I described the gonozooid as a continuous structure stretching the entire length of the branch and opening into 2 oeciostomes. While writing this volume I examined the slide again and discovered that the longer branch has not 1 but 2 gonozooids divided by a narrow sterile strip, with each gonozooid having its own oeciostome. The sketch of this species given here corresponds to this finding.

The present species is quite close in structure to the *T. murmanica* species described by me from the Kola Bay and the *T. anderssoni* species described by Borg (1926, 1944a) from the Antarctica.

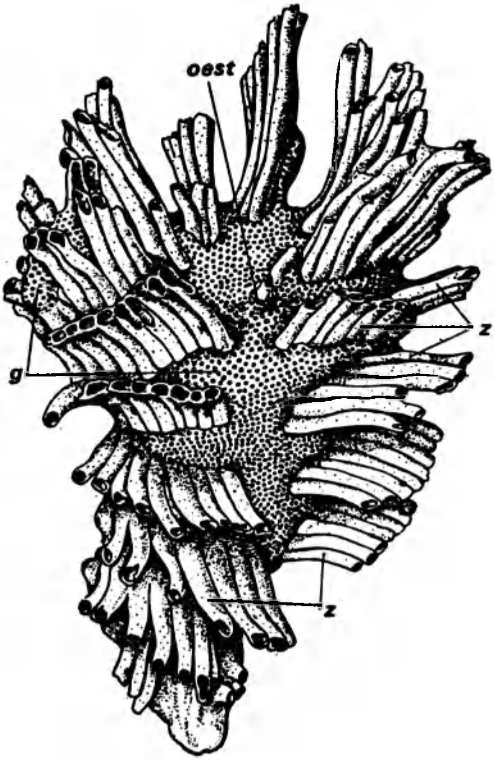


Figure 37. *Tubulipora murmanica* Kluge. Fertile zoarium from the frontal side. Barents Sea.

on a bed of stone and silt.

Distribution. The species was found by me in the Barents Sea in the Kola Bay.

To date, the species seems endemic to the Barents Sea.

13. **Tubulipora ventricosa** Busk, 1855 (Figure 38)

Tubulipora ventricosa Busk, 1875 : 26, pl. XXXII, f. 4; Nordgaard, 1918 : 18, f. 2-3; *T. incrassata* forma *erecta* Smitt, 1867 : 402 (part.); *Stomatopora incrassata* Kluge in Deryugin, 1915 : 389.

The zoarium is initially prostrate in the form of narrow ramose stems consisting of 2 to 3 rows of zooids, but frequently one or more branches are raised and widen above the substrate. These widenings grow out further towards the distal end, forming more or less convex lobes. The gonozooid develops at the frontal side of the lobe with a noticeably swollen

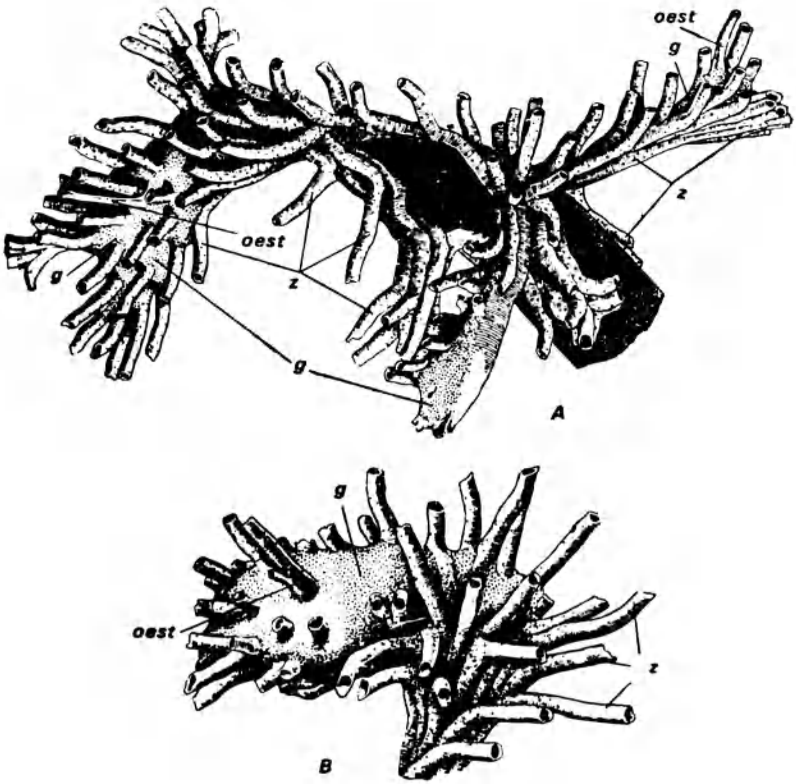


Figure 38. *Tubulipora ventricosa* Busk. *A*—complete, fertile zoarium; *B*—distal part of the branch with the gonozooid and oeciostome.

form and stretches between the individually raised zooids, which are densely covered with pseudopores. The zooids are thick and often slightly bent forward. Among the zooids, the oeciostome rises from the gonozooid in the form of a round tube that is either straight or bent, whose diameter is half that of the zooids, which opens at the distal end through a round orifice. This oeciostome usually diverges from the base of one of the zooids in the form of a free-growing tube, but sometimes it fuses over a small length by its proximal end with an adjoining zooid; thereafter it diverges from the latter, as a result of which its distal end becomes free. The basal side of the branches is usually more or less concave with a smooth surface.

The species lives on algae, tubes of annelids, Bryozoa, stones, etc., at a depth from 12.5 to 250 m, under temperatures ranging from -1.65 to 1.95°C, in a salt concentration of 27.22 to 34.83‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian seas, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1867), Kara Sea (Smitt, 1879a; Levinsen, 1887), Archipelago of the Canadian Islands (Busk, 1855, 1875, 1880; Nordgaard, 1918), and western Greenland (Smitt, 1868c; Hincks, 1877a; Kluge, 1908b).

The species is Arctic and circumpolar.

14. **Tubulipora soluta** Kluge, 1946 (Figure 39)

Tubulipora soluta Kluge, 1946 : 211, table IV, fig. 5.

Thin bundles of zooids start rising from the prostrate, ramose, basal part of the zoarium, which flabellately spread in the distal direction and divide into several lobes. The lobes of the zoaria, bent in different directions, do not lie in one plane. Although the tubes of the zooids fuse with each other into one complete unit over a large area, each zooid protrudes above the surrounding surface and maintains an isolated identity along the tubular length, as a result of which the surface of the lobes is not smooth. The distal ends of the zooids are free and gradually diverge from the surface of the zoarium at an acute angle. The tubes of the zooids are slightly bent on one or the other side. The orifices of the free ends of the tubes are round. The surface of the tubes is sparsely covered with minute pseudopores. The gonozooid develops in the expanded distal part of the lobe, the surface of which is densely covered with pseudopores. The oeciostome is usually located in the middle portion of the gonozooid in the form of a fairly long tube tapering toward the free end; its lower and slightly wider portion either adjoins the neighboring zooid over a certain length and then diverges from the latter, or rises independently from the neighboring zooids in the form of free tubes.

The species lives on the tubes of annelids, Bryozoa, pebbles, etc., at a depth of 22 to 422 m, on a bed of pebbles and silt, under temperatures ranging from −1.7 to 1.53°C, in a salt concentration of 27.22 to 35.00‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, and East Siberian seas.

This is a high-Arctic species.

15. **Tubulipora penicillata** (Fabricius, 1780) (Figure 40)

Tubulipora penicillata Smitt, 1867 : 403, 463, t. IX, f. 9-10, t. X, f. 1; Nordgaard, 1918 : 18, Text f. 1; *T. fungia* Couch, 1844 : 107, pl. XIX, f. 3; Smitt, 1867: 403, 462, t. X, f. 2-5; *Stomatopora fungia* Hincks, 1880a : 438, pl. LXII, f. 5-6.

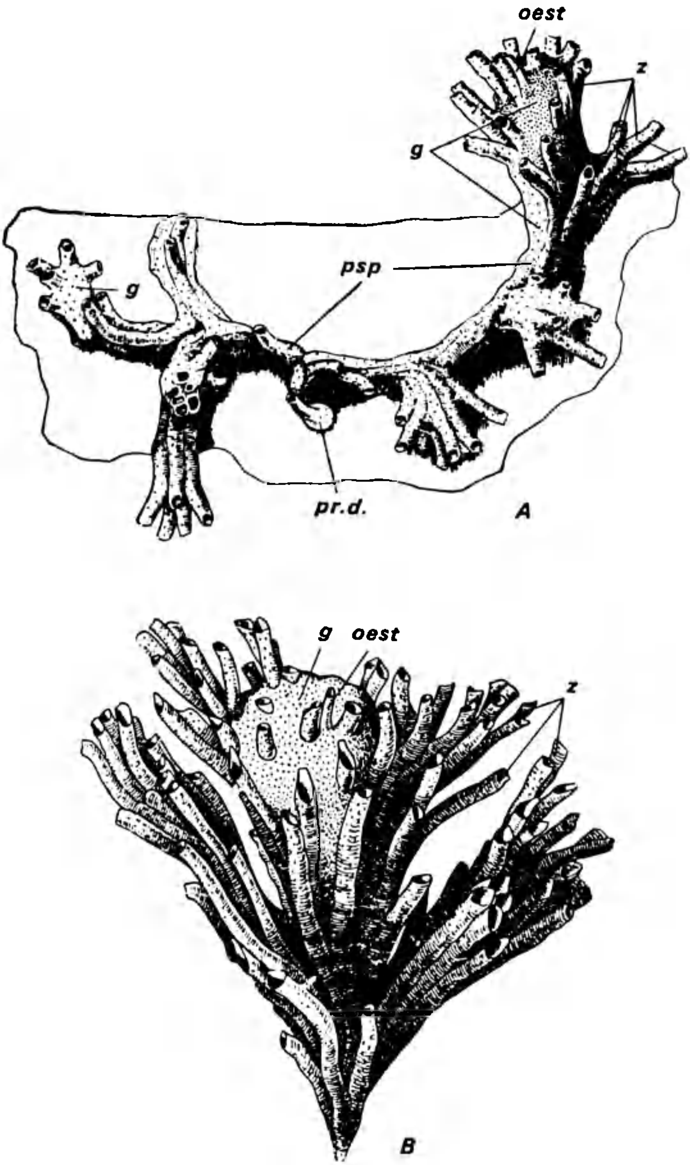


Figure 39. *Tubulipora soluta* Kluge. *A*—complete, fertile zoarium; *B*—distal part with the gonozooid.

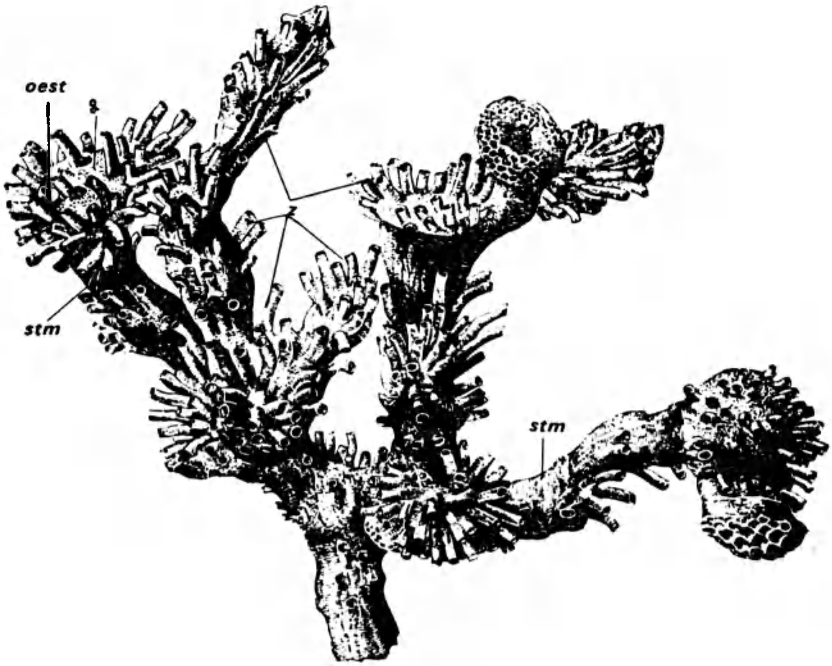


Figure 40. *Tubulipora penicillata* (Fabricius). Ramose distal part of the fertile zoarium. Barents Sea.

From the prostrate, more or less thick, irregularly ramose part of the zoarium, round stems rise and either widen on the distal end into a discoid head, or branch several times; these branches then terminate in a discoid head which, in turn, gives rise to a new branch at the margin. From the surface of the prostrate, as well as the free-growing stems, bundles of individual free-growing zooids rise, sometimes on one side, sometimes on the other, and open through a round orifice. In their broadened distal part, the stems have a smooth surface with a longitudinal and slightly transverse pattern. The margin of the upper disc is sometimes pointed. The head (capitum), a slightly thick, convex, round disc that sometimes has a depression in the center, is raised from all sides above the stem. The tubes of the zooids protrude through its upper surface in no particular order, mostly in groups at the margin of the disc and in small numbers singly in the center. The tubes along the margin of the disc are directed outward and upward; in the center they are more or less upwardly straight. In sexually mature heads, the entire upper side of the disc between the zooids is covered with gonozooids, the surface of which is densely covered with pseudopores. The oeciostome, located in the marginal tubes, looks like a tube bent toward the center, short in length, and slightly pressed on the sides; it opens through an irregular oval orifice.

The species lives on hydroids, Bryozoa, shells, and stones, at a depth of 25 to 280 m, on a bed of stone and silt with sand, under temperatures ranging from −1.38 to 1.53°C, in a salt concentration of 34.50 to 35.00‰.

Distribution. The species was found by me in the Barents Sea. *Reports in literature:* Barents Sea (Smitt, 1867; Nordgaard, 1897, 1905), ?northern coast of North America (Osburn, 1923), western Greenland (Fabricius, 1780; Levinsen, 1914), Northumberland Island (Hennig, 1896), Labrador (Busk, 1857) western coast of Norway (Nordgaard, 1918), Boguslen (Smitt, 1867), and Great Britain (Busk, 1875; Hincks, 1880a).

This is an Arctic-boreal, Atlantic species.

16. **Tubulipora nordgaardi** Kluge, 1946 (Figure 41)

Tubulipora nordgaardi Kluge, 1946 : 210, table III, fig. 1.

The zoaria are in the form of free-growing dichotomously branched stems. Each stem consists of 3 to 5 rows of zooidal tubes fused in a bundle, as a result of which the stem's thickness and outline in the cross section is not similar at different places along its length. The free ends of the tubes originate from the stem in different directions at different angles of about 45° or more, but never reach a right angle. The tubes of the zooids are relatively thick and sparsely covered with pseudopores. The length of their free ends is quite significant, rarely reaching up to twice the thickness of the stem. The orifices of the free ends are circular. The gonozooids occur extremely rarely. They are situated in the fork of the two branches and gradually widen to form saccate, broad structures densely covered with pseudopores. The oeciostome is located near the upper end of the widening in the form of a long tube which is broader near the base and tapers toward the upper half. The oeciostome opens by a round orifice, the diameter of which is almost one-half that of the zooidal tube.

Possibly the species lives on stones, at a depth of 73 m, on a bed of silt and stone.

Distribution. The species was found by me in the East Siberian Sea, northeast of Novo Sibirisk Island.

This species is endemic to the East Siberian Sea.

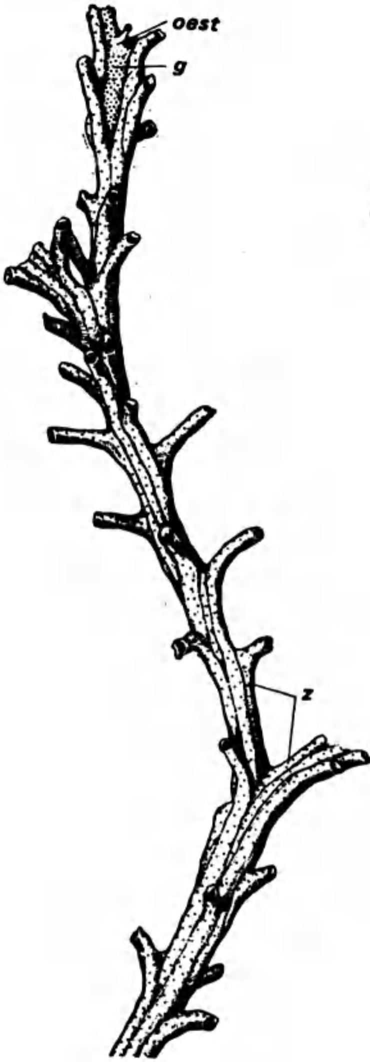


Figure 41. *Tubulipora nordgaardi* Kluge. A part of the zoarium with gonozooid. East Siberian Sea.

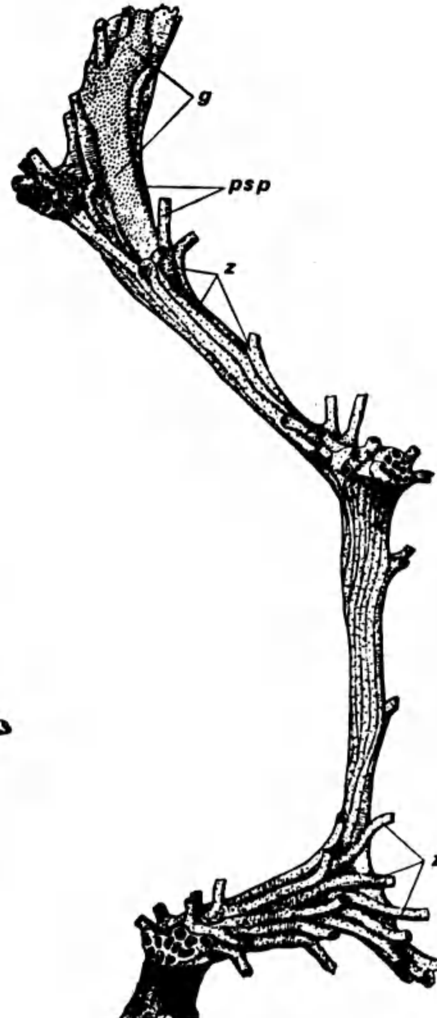


Figure 42. *Tubulipora fruticosa* Kluge. Part of a fertile zoarium from the basal and frontal side.

17. **Tubulipora fruticosa** Kluge, 1946 (Figures 42, 43)

Tubulipora fruticosa Kluge, 1946 : 210, fig. 11; *T. incrassata* Smitt, 1867 : 402 (part.), t. V, f. 5-7.

The prostrate, often ramose part of the zoarium, initially consists

Figure 43. *Tubulipora fruticosa* Kluge. Gonozooid.

of 2 to 3 rows of zooids which gradually thicken to form the stem separating from the substrate and rising in the form of a free-growing branched stem. The frontal surface of the latter usually consists of 3 to 4 rows of more or less long, distinctly isolated zooids rising upward, and on the sides, by their distal half. Depending upon the number of rows of zooids, the stem sometimes becomes thick, sometimes thin, and at the place of branching, the number of rows reaches up to 5 to 6 zooids. Usually the stem is not straight, but rather bends sometimes in one direction, sometimes in the other; frequently, its frontal side is more or less twisted toward the dorsal side. The dorsal side of the stem is roundish, but in the places of bifurcation, wider and thicker. The 2 branches do not always grow in a similar manner; often only 1 develops while the other lags behind. The tubes of the zooids are thick; their free ends are somewhat thin and open through a round orifice. Their surface is smooth, lustreless, milky-white, and entirely covered with sparsely distributed pseudopores. The tubes are frequently located on the frontal surface in pairs, sometimes on one side, sometimes on the other, as if alternating; the distal ends are never fused. The gonozooids develop in the broad distal parts of the branches, and are densely covered with pseudopores. Among the large number of zoaria with developed gonozooids examined by me, I found an almost undamaged oeciostome in only one zoarium. This oeciostome was a short, erect tube that widened toward the distal end, and had a roundish-oval orifice directed upward.

The species lives on Bryozoa, shells, and stones, at a depth of 1.5 to 1,000 m, mostly from 50 to 400 m, on a bed of stone and silt, under temperatures ranging from −1.8 to 3°C.

Distribution. The species was found by me in the Barents, Kara, and East Siberian seas. *Reports in literature:* Barents Sea (Smitt, 1867; Bidenkap, 1900a; Waters, 1904; Kuznetsov, 1941), and the Kara Sea (Smitt, 1879a).

The species is from the eastern sector of the Arctic.

II. Family **Idmoneidae** Busk, 1859

Idmoneidae Busk, 1859 : 94 (part.); Borg, 1944a : 76; *Tubuliporidae* Johnston, 1838 : 267 (part.); Smitt, 1867 : 398; Hincks, 1880a : 428; Harmer, 1915 : 118.

The zoaria are free-growing and dichotomously branched. The uprising distal ends of the autozooids are arranged in rows transverse to the longitudinal axis of the branch. The rows are divided along the middle line of the branch, alternating on both sides. The rows consist of 2 to 6 or 7 zooids opening on the frontal side of the branch. The rows are alternately bent, sometimes on one side, sometimes on the other. The zooids close to the middle line are the longest. Their basal part is partly or fully covered with one or more layers of kenozooids, forming the secondary thickening of the stems. Kenozooids occupy the space between the transverse rows of zooids along the middle line of the frontal side of the zoarium.

Key for Identification of the Genera of the Family Idmoneidae

1 (2). Branches frequently long, straight, and triangular or round in the cross section. Transverse rows of zooids arranged alternately on the sides of the branch. The sub-tentacular plate starts from each side, or from the basal side near the base of the rising stem (*Idmonea tumida*). Gonozooids arranged along the branch, or in the fork between the transverse rows of zooids, do not significantly broaden the branch...1. Genus *Idmonea* Lamouroux, 1821 (see below).

2 (1). Branches short, usually widen toward the end. Transverse rows of zooids stretch from the middle line of the branch along the sides almost at one level. The prostrate sub-tentacular plate, consisting of flat kenozooids, starts near the base of the uprising stem on the basal side. Gonozooids arranged at the end of the broadening branch between the transverse rows of zooids. ....2. Genus *Idmoneoides* Kluge, 1955 (Figure 114).

1. Genus **Idmonea** Lamouroux, 1821

Idmonea Hincks, 1880a : 450; *Tubulipora* (part.) Harmer, 1915 : 124.

The branches are often straight, long, and narrow, with a triangular or round cross section. The distal ends of the autozooids arranged in transverse rows, diverge along both sides of the branch, and strictly alternate on the side with each row consisting of 2 to 7 zooids. The sub-tentacular plate originates from each side of the base of the uprising stem in the form of flat kenozooids, and lies procumbent upon the substrate. (In *I. tumida* the sub-tentacular plate originates from the basal side.) The basal side of the branch is completely covered with one or several layers of kenozooids which make the stems thick. The gonozooids are located along the branch or in the fork between the transverse rows of zooids.

Genus type: *Idmonea atlantica* Johnston, 1847.

1 (6). Zoaria ramose.
2 (5). Transverse rows usually consist of 3, rarely 2 to 4, zooids.
3 (4). Basal side of the zoarium convex. Gonozooids, in the form of a long, narrow bulge, lie along the middle line of the branch and enclose many transverse rows of zooids. Oeciostome, in the form of a cylindrical tube, adjoins the distal side of the transverse row of zooids and opens upward and forward through a round orifice.................................1. *I. atlantica* Forbes.
4 (3). Basal side of the zoarium fairly flat. Gonozooids, in the form of a short, wide bulge located in different parts of the branches, usually cover 2 rows of zooids on each side. Oeciostome forms a tube which usually adjoins the zooid by its base; the remaining part, deviating from the zooid, is free and varies significantly in form...................1a. *I. atlantica* var. *gracillima* Busk.
5 (2). Broad transverse rows usually consist of 4 to 6, rarely 3, zooids. Basal side of the branches flat with a transverse pattern. Gonozooid oblong. Oeciostome, a more or less flattened tube, adjoins the distal side of the transverse row of zooids and, diverging from the latter, opens upward and forward into a wide rostrum with a round orifice....................2. *I. fenestrata* Busk.
6 (1). Zoaria either unbranched or biramous.
7 (8). Zoarium usually biramous. Basal side strongly convex and roundish. Distal ends of the zooids are slightly raised above the surface of the branch. Gonozooid not known to occur. ....3. *I. tumida* (Smitt).
8 (7). Zoarium usually not ramose. Basal part of the zoarium flat with sharp margins. Distal ends of the zooids significantly raised above the surface. Oblong gonozooid located in the distal part of the zoarium. Oeciostome, a short, frontally bent, and erect tube, opens through a transversely oval orifice, and is located in the distal end of the gonozooid between the lateral rows of zooids.........................4. *I. bidenkapi* Kluge.

1. **Idmonea atlantica** Forbes Mss (Figure 44)

Idmonea atlantica Forbes (manuscript) in Johnston, 1847 : 278; *Tubulipora* (*Idmonea*) *atlantica a:* forma *erecta* Smitt, 1867 : 399, 434, t. IV, f. 5-11.

The zoaria are free-growing and dichotomously branched. The branches, usually located on one plane, are somewhat triangular in the cross section with a slightly convex basal side and roundish corners. The uprising distal ends of the zooids, originating on both sides from the middle longitudinal line, are displaced by parallel transverse rows. The zooids, in rows of 2 to 4 each, are closely attached to each other, and their orifices are slightly diverted, sometimes in one direction, sometimes in another. The zooids located near the middle line of the branch are the longest; the ones following them in the row gradually shorten toward the margin. The middle frontal surface remaining along the branches between the rows of zooids, is full of developing gonozooids in the fertile branches, which represent fairly irregular shaped bulges. These bulges are densely covered with pseudopores and enclose a large number of zooidal rows along the branches. Near the distal end, the gonozooid opens into an oeciostome in the form of a tube similar to that of a common zooid, but located on the distal side of the row of zooids, it opens forward and upward through a round orifice.

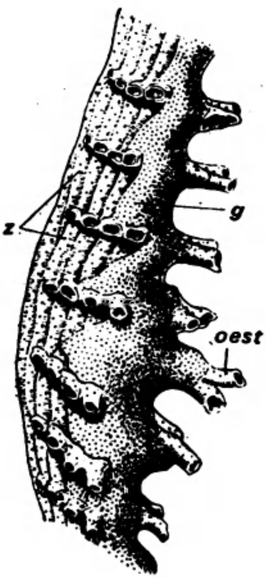


Figure 44. *Idmonea atlantica* Forbes. A part of the fertile branch of the zoarium with oeciostome.

The basal side of the zoarium is covered with one or a few layers of kenozooids that serve to fix the stems, and form a longitudinal pattern with pseudopores on the smooth surface; semi-circular transverse margins of overgrowths of layers of kenozooids are found in the young zoaria. The zoarium starts with a primary disc from which the first zooid originates giving rise to the daughter zooid. The latter, in turn, gives rise to a new daughter zooid which may do the same. All these zooids are directed by their free ends alternately to one or the other side. Kenozooids develop simultaneously along the sides of these zooids, which soon form a broad sub-tentacular disc around the base of the zoarium. After the formation of this disc, the discs grow upward, forming the free-growing part of the zoarium. Along with the upward growth of the zoarium, a layer of kenozooids develops on its basal side; these kenozooids are formed from a portion of those kenozooids which had separated from the "sub-tentacular disc".

The species lives on Bryozoa, tubes of worms, shells, and stones, at a depth of 5 to 593 m, more frequently from 100 to 150 m, on a bed of silt, stone, and shells, under temperatures ranging from −1.66 to 6.3°C, in a salt concentration of 33.73 to 35.00‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, and East Siberian seas, and in the waters off Labrador and western Greenland. *Reports in literature:* Barents Sea (Danielssen, 1861; Smitt, 1867, 1879b; Vigelius, 1881-82; Nordgaard, 1897, 1900, 1905, 1907b, 1912a, 1918, 1923; Bidenkap, 1897, 1900a; Norman, 1903a; Waters, 1904; Kuznetsov, 1941), Kara Sea (Smitt, 1879a; Levinsen, 1887; Nordgaard, 1912b, 1921), northern coastal waters of North America and the Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1923), western Greenland (Smitt, 1868c; Norman, 1876, 1906; Hincks, 1877a; Hennig, 1896; Vanhöffen, 1897; Kluge, 1908b; Levinsen, 1914; Osburn, 1919), Labrador (Packard, 1863, 1866-69), Gulf of St. Lawrence (Dawson, 1859; Whiteaves, 1901), eastern Greenland (Kirchenpauer, 1874; Andersson, 1902; Levinsen, 1916), Yan-Maien (Lorenz, 1886), western coastal waters of Norway (Smitt, 1867; Nordgaard, 1918), Skagerrack (Silen, 1936), Great Britain (Hincks, 1880a), and Iceland (Smitt, 1867).

The species is Arctic-boreal.

1a. **Idmonea atlantica** var. **gracillima** Busk, 1875 (Figure 45)

Idmonea gracillima Busk, 1875 : 14, pl. VII, f. 5-6; *I. watersi* Kluge, 1946 : 212, t. III, f. 3, fig. 12.

The zoaria are free-growing, ramose, sometimes with thick, short, and bent branches, sometimes studded with thin and straight branches. As a rule 3, or rarely 2 or 4, tubes of zooids stretch on the convex frontal side of the branches along both sides of the middle line. The fused distal ends of the tubes rise above the surface of the branches, alternately on one of the other side, and turn in opposite directions to form rows perpendicular to the longitudinal axis. The dorsal side is quite flat and covered with a single or several layers of kenozooids. Gonozooids are located on different parts of the branches—either near the point of ramification, or along the length of the unbranched part—and 2 gonozooids

Figure 45. *Idmonea atlantica* var. *gracillima* Busk. Part of the branch of a zoarium with two gonozooids.

may be found on one branch. The gonozooids are short, broad, and strongly convex bulges, densely covered with pseudopores and usually including 2 rows of individuals on each side. The occiostome varies considerably in form, but is usually located near the distal end of the gonozooid. Sometimes it is more or less long and cylindrical, and located on the distal side of the transverse row where it opens upward and forward through a round orifice; sometimes it originates as a roundish tube adjoining the nearest zooid, but later diverges from it and stretches in different directions in the form of a free, narrow tube pressed on the sides and opening out by a slit-like orifice.

The species lives on Bryozoa, shells, and stones, at a depth of 17 to 1,000 m, mostly from 100 to 300 m, on a bed of silt and stone, or silt and sand, under temperatures ranging from -1.68 to $1.5°C$, in a salt concentration of 33.12 to 34.50‰.

Distribution. This variety was found by me in the Barents, Kara, Laptev, and East Siberian seas. *Reports in literature:* Barents Sea (Waters, 1904), and the Atlantic Ocean (Busk, 1875).

This is a high-Arctic, deep-water species.

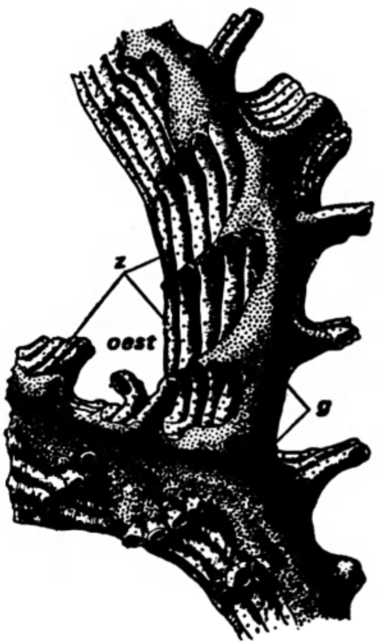


Figure 46. *Idmonea fenestrata* Busk. A part of the fertile zoarium.

2. **Idmonea fenestrata** Busk, 1859 (Figure 46)

Idmonea fenestrata Busk, 1859 : 105, pl. XV, f. 6.

The zoaria are not large, but free-growing and very dichotomously branched. The subsidiary branches have a triangular form in the cross section. The basal surface, covered with a longitudinal pattern and small pseudopores, is flat and broad, as a result of which its margins are somewhat pointed during the transition into the lateral sides of the frontal surface. The distal ends of the zooids, raised above the frontal surface collectively in numbers of 3 to 6, form broad, alternate transverse rows that bend sometimes to one side, sometimes to the other. The space remaining free between the rows of zooids is filled, in the fertile zoaria, with relatively early maturing, long gonozooids of irregular form, which enclose several rows of zooids. Usually the gonozooid opens near the point of ramification into an oeciostome in the form of a more or less flattened tube which adjoins the distal side of the transverse row of tubes of zooids; from one-half to two-thirds the length of the latter, it diverges from the zooids to open forward and upward through a broad, round rostrum with an orifice.

The species lives on hydroids, Bryozoa, and tubes of worms, at a depth of 9 to 360 m, more frequently at 50 to 100 m, on a bed of silt and shell, under temperatures ranging from −1.61 to 1.74°C, in a salt concentration of 34.29‰.

Distribution. The species was found by me in the Barents, Kara, and Laptev seas, and off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1867, 1879c; Bidenkap, 1900a; Waters, 1904).

The species is Arctic.

3. **Idmonea tumida** (Smitt, 1872) (Figure 47)

Tubulipora (*Idmonea*) *tumida* Smitt, 1872a : 1119, t. XX, f. 5-7; *Idmonea tumida* Kluge, 1946 : 212, t. III, f. 4-5, fig. 13.

The zoaria are not large, not exceeding 2 cm in length, and are often biramous. The branches are thick, almost round in a cross section, with zooids arranged on 2 sides of the convex frontal side. On each side of the branches, zooids are arranged in alternating rows perpendicular to the length of the axis; each row consists of 3 to 4 zooids. The zooids in the rows tightly adjoin each other. Their slightly tapering distal ends are a little raised almost at a right angle above

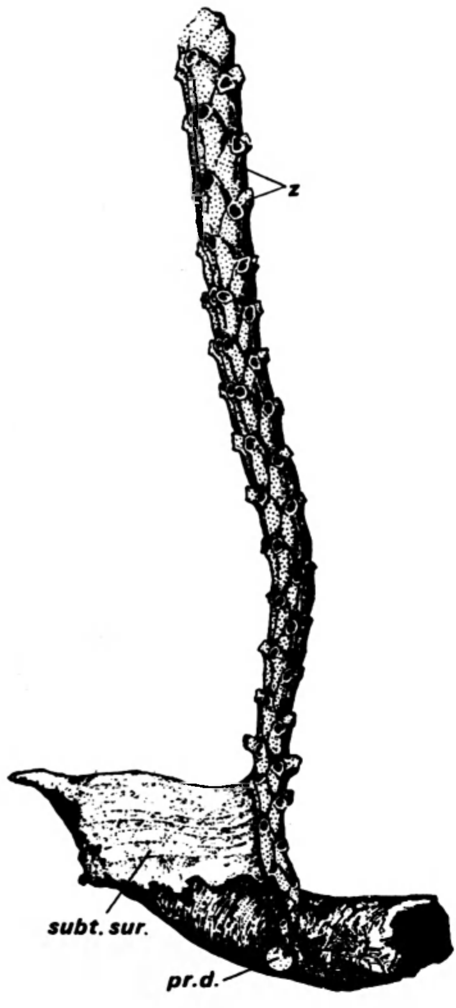


Figure 47. *Idmonea tumida* (Smitt). A simple zoarium with a primary disc.

the fertile surface of the branch. Their walls are thick, becoming slightly thinner toward the free ends, and their surface is covered with dense pseudopores. The orifices of the zooids are round. The basal side of the zoarium is prominently convex and roundish. The branches are frequently concave. Gonozooids have not been noticed.

The species lives on the calcareous tubes of worms, and on pebbles, at a depth of 80 to 414 m, on a bed of silt and stone, under temperatures ranging from −1.17 to −1.2°C, in a salt concentration of 34.63 to 34.65‰.

Distribution. The species was found by me in the Barents, Kara, and East Siberian seas. *Reports in literature:* Barents Sea (Smitt, 1872a; ?Waters, 1904; ?Nordgaard, 1912b).

4. **Idmonea bidenkapi** Kluge, 1955 (Figure 48)

Idmonea serpens Bidenkap, 1900a : 528 (non-Johnston); *I. bidenkapi* Kluge, 1955a : 68, fig. 8.

The free-growing zoarium is not large, attains a height of up to 5 mm, is unbranched, and slightly curves on the frontal side. The zooids are arranged in transverse rows of 2 to 5 each. In the rows the raised distal parts of the zooids closely adjoin each other; only in one sample was a zooid, standing close to the middle line of the stem, separated from the remaining zooids of the row—probably associated with the development of the gonozooid. The basal side of the zoarium is concave and flat with sharp margins as in *I. fenestrata* Busk. In the distal half of the zoarium, in the middle between transverse rows of zooids, is located a fairly long gonozooid which, by its distal end, opens through an oeciostome in the form of a tube with an oval orifice; the tube stands between the lateral rows of zooids and bends toward the frontal side. The orifice is directed toward the frontal side. Unfortunately the zoarium was broken near its base and therefore the structure of its beginning part still remains

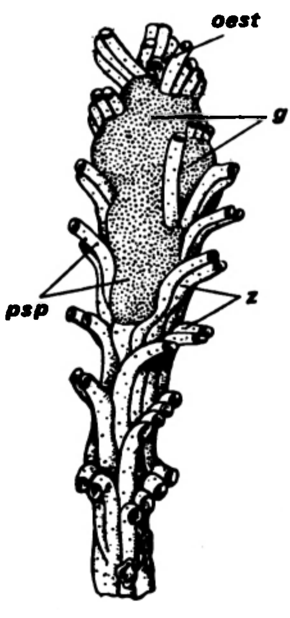


Figure 48. *Idmonea bidenkapi* Kluge. Distal part of the fertile zoarium. Barents Sea.

unexplained.

The species lives on clay or gravel, at a depth of 1,000 m.

Distribution. The species was found by me in the Barents Sea northward of Spitsbergen.

Thus far the species is endemic to the Barents Sea.

2. Genus **Idmoneoides** Kluge, 1955

Tubulipora (part.) Kluge, 1946 : 206; *Idmoneoides* Kluge, 1955a : 69.

The branches are short and usually broader toward the end. The raised distal ends of the autozooids are arranged in transverse rows which stretch away on both sides of the branch, often in one level, and consist of 2 to 3, rarely 1 to 4, zooids. Occasionally the ends (over a large part) are separated and free.

The sub-tentacular plates originate from the base of the basal side of the uprising stem in the form of a layer of flat kenozooids prostrate on the substrate. The basal side of the branch is partly covered with kenozooids. The gonozooids are usually located at the end of the branch between the transverse rows of zooids.

Genus type: *Idmoneoides arctoflabellaris* Kluge, 1946.

1 (2). Zoarium ramose. Rows of zooids symmetrically arranged on both sides of the middle line of the branch. Raised distal ends of the zooids usually closely adjoin each other in transverse rows, but frequently the ends are separate. Gonozooid situated in the middle between symmetrical transverse rows of zooids...1. *I. arctoflabellaris* (Kluge).

2 (1). Zoarium not ramified. Rows of zooids arranged asymmetrically on both sides of the middle line of the stem. Raised distal ends of the zooids in the rows are free throughout their length. Gonozooid located asymmetrically on the frontal surface of the stem. ....2. *I. simplex* Kluge.

1. **Idmoneoides arctoflabellaris** (Kluge, 1946) (Figure 49)

Tubulipora arctoflabellaris Kluge, 1946 : 206, fig. 8.

The zoaria, free-growing and small, attain up to 10 to 12 mm in height, and consist of a short prostrate part from which rises a more or less oblong, dichotomously branched, and free-growing part. The prostrate part of the zoarium starts with a primary disc that directly changes into the tube of the first zooid, which is raised by its distal end.

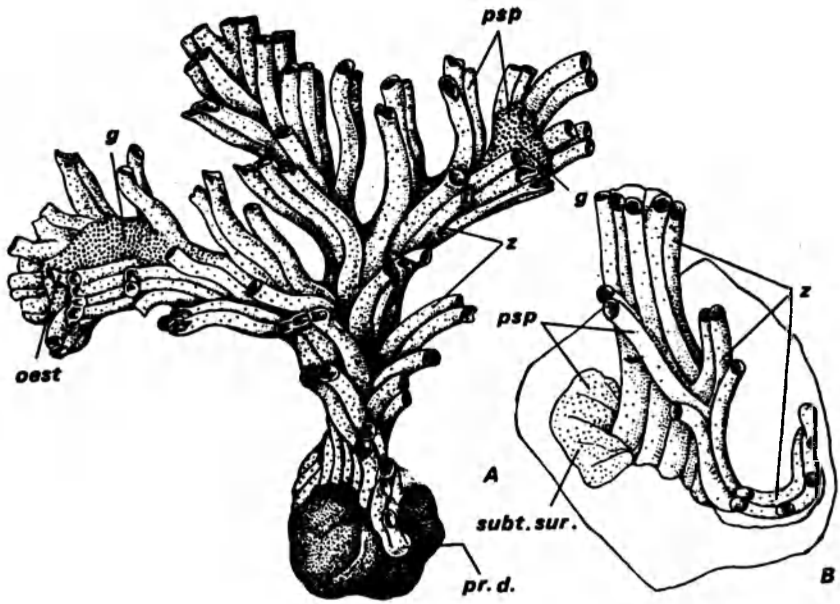


Figure 49. *Idmoneoides arctoflabellaris* (Kluge). *A*—complete, ramose, fertile zoarium; *B*—initial part of the zoarium. Polar Basin (south of Franz Josef Land).

From the basal part of the first zooid the daughter zooids starts which, in turn, gives rise to a new daughter zooid. This may be repeated 3 to 4 times, as a result of which a row of zooids of subsequent generations is formed, which stands in a semi-vertical position; their short, free, distal ends are often alternately directed to different sides. The tubes of the succeeding generations are oblong and grouped in rows of 2 or 3 and arranged either alternately on one or the other side of the frontal surface of the branch, or divert almost at one level from the middle line of the branch, or appear as if split into 2 rows following one another. The tubes usually deviate by their raised distal ends, sometimes in one direction, sometimes in the other, as happens in the genus *Idmonea.* In rare cases, the zooids are arranged singly or 4 to 5 in a row. Frequently, the distal ends of the zooids in the rows separate from each other and remain free. The surfaces of the tubes are covered with pseudopores that are denser in the prostrate part (particularly in the terminal section) than in the free-growing part. The kenozooids originate in the lower zooids from the almost vertical or obliquely uprising part of the zoarium (which serves as the pedestal for the free-growing part) on the side opposite to the beginning of the growth of the zoarium, i.e., from the basal side, and sometimes even from the sides. The kenozooids settle down on the substrate and overgrow the latter in the form of a continuous thin plate consisting of a complete row of flattened tubes fused together, which form the sub-tentacular plate for the free-growing part of the zoarium.

Usually at the end of the branches, at their broader frontal surface between the 2 rows of zooids, or in the middle of the radially located rows, a relatively short gonozooid develops which covers usually 2, and rarely 3, transverse rows of zooids. The surface of the gonozooid is densely covered with pseudopores. The gonozooid opens into an oeciostome, which is usually more or less tube-shaped and fused by its lower part to the wall of the zooid from the distal side of the transverse row, but more often the oeciostome deviates from the zooid and grows freely in the form of a straight tube pressed on the sides and opening through a slit-like orifice. But sometimes the oeciostome is a short tube with an oval orifice, which diverges from the zooid only near the end, or it grows completely independent of the nearest zooid. It is not rare to find a gonozooid on almost every branch of the zoarium, in which case the latter then has several (up to 5 were observed) gonozooids with an oeciostome.

The living colonies are stained a pink-violet color. The species lives on Bryozoa, tubes of worms, mollusks, shells, and stones, at a depth of 20 to 445 m, on a bed of silt and stone, under temperatures ranging from −1.33 to 1.53°C.

Distribution. The species was found by me in the Barents, Kara, Laptev, and East Siberian seas.

The species is from the eastern sector of the high Arctic.

2. **Idmoneoides simplex** Kluge, 1955 (Figure 50)

Idmoneoides simplex Kluge, 1955a : 70, fig. 11.

The zoarium is not large, reaching a height of up to 4.5 mm, grows freely, and is unbranched. Initially prostrate, it consists of 2 rows of zooids, and later of 3 and 4 zooids whose freely raised distal ends diverge from the middle line of the stem on different sides, usually 1 to 2 on one side and 2 to 3 on the other. The distal ends of the zooids, raised above the surface of the stem, grow freely and do not fuse. In the place of the transition from the prostrate part of the zoarium into the upright growing one, the kenozooids let down from the basal side of the rising stem to the substrate, forming the sub-tentacular plate supporting the free-growing part. The dorsal side of the zoarium is slightly concave, more or less flat, and partly, particularly in the distal section, covered with kenozooids in the form of close, flat tubes through whose transparent walls the margins of the autozooids from the next layer are visible.

The long, saccate gonozooid stretches on one side in the distal half

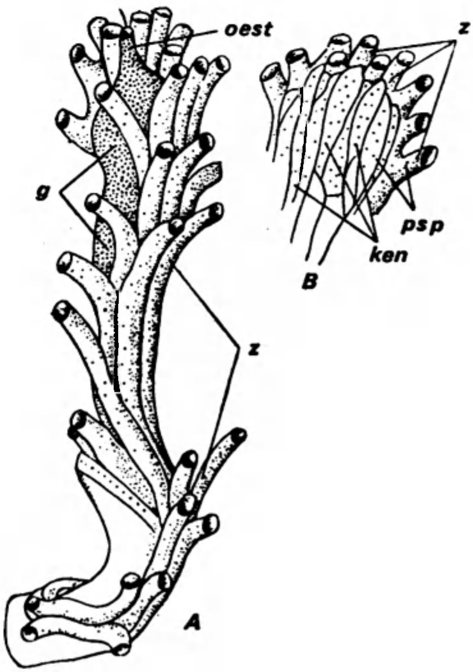


Figure 50. *Idmoneoides simplex* Kluge. Barents Sea. *A*—fertile zoarium from the frontal side; *B*—distal part of the zoarium from the basal side.

of the frontal side of the zoarium, and asymmetrically opens on the distal end with a long, almost straight tube located between 2 zooids; this tube opens through a round orifice directed forward. The species lives on calcified tubes of worms, at a depth of 280 m, on a bed of silt, at a temperature of −1.1°C.

Distribution. The species was found by me in the northeastern part of the Barents Sea.

The species is endemic to the Barents Sea.

III. Family **Entalophoridae** Reuss, 1869

Entalophoridae Borg, 1944a : 105 (part.); *Idmoneidae* Busk, 1875 : 10 (part.).

The zoarium consists of a prostrate ramose part from which uprises one, sometimes more, free-growing, roundish stem that is usually branched. The zooids form the stem over a large part of their length and their free ends open around the stem and branches. The gonozooid, located on the surface or on the distal end of the stem, either proliferated or nonproliferated by the tubes of the zooids, opens through the oeciostome in the form of an orifice near the base of the raised part of the zooid.

Genus **Entalophora** Lamouroux, 1821

Entalophora Lamouroux, 1821 : 81; Hincks, 1880a : 455; Borg, 1926: 184; 1944a: 106; *Pustulopora* Milne-Edwards, 1838 : 219; Busk, 1875 : 20.

The zoarium is free-growing and simple or branched; the stem is roundish or oval, and consists of zooids in the cross section; the free ends of the zooids are relatively long and directed to different sides. The gonozooid is oblong, mildly broadened in the middle part, and located either on the distal end of the stem, or on one of the branches near the stem's bifurcation. The oeciostome in our species was a semi-circular orifice near the base of one of the zooids which surrounded it.

Genus type: *Entalophora cellarioides* Lamouroux, 1821.

1 (2). Zoaria large, reaching a height of up to 15 to 20 mm, usually ramose in an irregular manner or dichotomous; gonozooid located near the bifurcation, usually on one of the branches.......... ....1. *E. clavata* Busk.

2 (1). Zoaria minute, height up to 4 to 6 mm, usually unbranched or, if branched, only near the base; gonozooid located on the distal end of the stem, and surrounded by a few zooid bundles..... ....2. *E. harmeri* Osburn.

1. **Entalophora clavata** (Busk, 1859) (Figure 51)

Entalophora clavata Hincks, 1880a : 456, pl. LXV, f. 5-8; Marcus, 1940 : 76, f. 41; *E. deflexa* Nordgaard, 1900 : 18, pl. I, f. 10-11.

The zoaria are large, attaining a height up to 1.5 to 2 cm. The procumbent portion is usually ramose but mostly dichotomous. The free-growing parts are usually raised in the form of 1 or 2 stems in the places of ramification of the prostrate part. These stems are roundish or oval and vary in form in the cross section: they may be straight or bent, branched or unbranched, or sometimes regularly dichotomous. The stem, toward the distal part, branches into 2 to 3, and sometimes a greater number of branches that are usually short, but sometimes longer, in which case the distal ends of the zoarium become more or less wider with a clavate form.

The zooids are arranged in 3 to 5 rows in the visible half of the stem. Their more or less free distal ends spread in all directions around the stem.

The stem, more or less long and simple or branched, is located near the bifurcation on one of the branches and is usually not perforated by zooids. In instances where the gonozooid is located between the branches, the stem is shorter and broader. The oeciostome, located near the base of one of the zooids, is in the form of an orifice at the level of the gonozooid which encloses the base of the zooid in a semi-circle, but sometimes the gonozooid forms a sort of projection, stretching along the zooid and opening at its distal end through the oeciostome. The lateral sides of the slightly thickened margin of the oeciostome often continue upward along the zooid facing each other up to their fusion; when this happens,

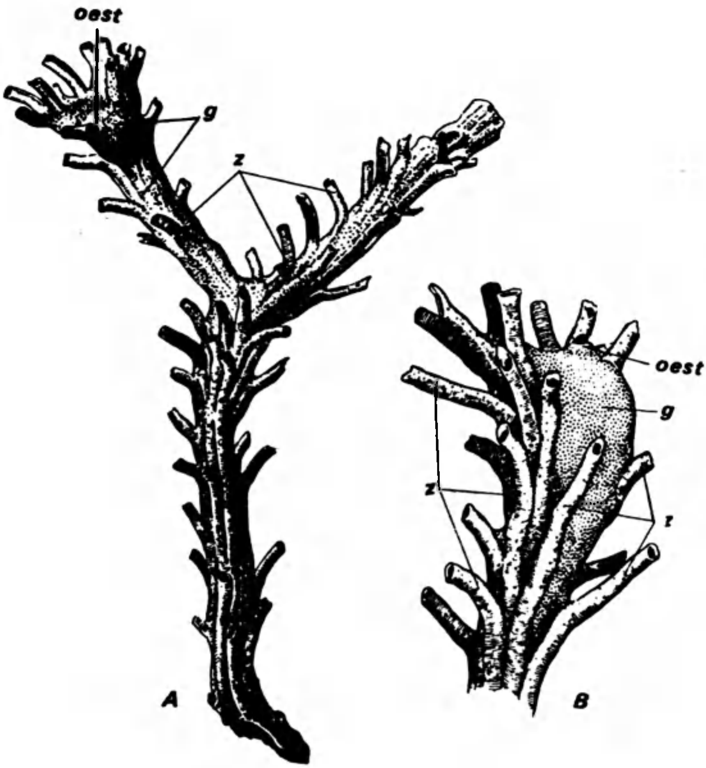


Figure 51. *Entalophora clavata* (Busk). *A*—biramous fertile part of a zoarium; *B*—gonozooid with oeciostome.

the wall of the zooid is somewhat depressed, narrowing the cavity of the tube of the zooid.

The species lives on algae, hydroids, Bryozoa, tubes of segmented worms, shells, and stones, at a depth of 2.5 to 475 m, more frequently at 50 to 150 m, on a bed of silt and stone, under temperatures ranging from −1.9 to 2.2°C, in a salt concentration from 31.5 to 35‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, and East Siberian seas. *Reports in literature:* Barents Sea (Nordgaard, 1900; Andersson, 1902), northern coast of North America (Osburn, 1923), Gulf of St. Lawrence (Whiteaves, 1901), eastern Greenland (Andersson, 1902; Levinsen, 1914), Yan-Maien Island (Lorenz, 1886), Great Britain (Hincks, 1880a) and the waters off Vanocouver Island (O'Donoghue, 1923).

This is an Arctic-boreal, circumpolar species.

2. **Entalophora harmeri** (Osburn, 1933) (Figure 52)

Diaperoecia harmeri Osburn, 1933 : 13 (part.), pl. 3, f. 6-8; 1936 : 340; *Entalophora clavata* Kluge, 1908b : 554; 1929 : 23; Osburn, 1919 : 606.

The zoaria are not large (up to 4 to 6 mm in height), and have a short prostrate part from which a roundish, often curved, and frequently unbranched stem extends. The free ends of the zooids vary in length, but the length is never greater than the width of the stem.

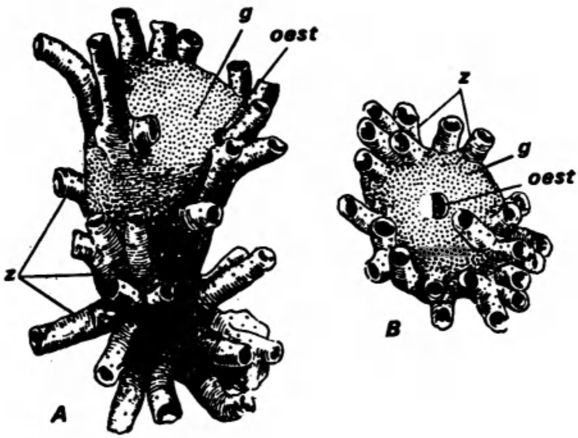


Figure 52. *Entalophora harmeri* (Osburn). *A* and *B*—stem with gonozooid surrounded by bundles of zooids.

On the distal end of the stem, widened because of the gonozooid, zooids are arranged on the periphery of the gonozooid, usually in several (from 2 to 4) bundles; when these zooidal bundles are oblong, they create the impression that the stem has begun branching out, whereas in reality these bundles do not develop further, nor does the formation of branches occur. The gonozooid is long. It starts its growth like a common zooid, sparsely covered with pseudopores, and then gradually becomes wider and covered with denser and larger pseudopores until, reaching the upper part of the stem, it is so widened that it forms a convex distal surface sometimes perforated by 1 to 2 zooids. The oeciostome, usually located near the base of the tube of one of the zooids in the form of a semi-lunar orifice at the level of the gonozooid, encloses a part of the wall of the zooid.

The species lives on algae, hydroids, and Bryozoa, at a depth varying from 21 to 175 m, on a hard bed.

Distribution. The species was found by me in the Barents and Kara seas, and in the waters off western Greenland. *Reports in literature:* northern coast of North America and the Canadian Islands (Osburn, 1936), western Greenland (Kluge, 1908b, Osburn, 1919), Gulf of St. Lawrence (Whiteaves, 1901), and New Shetland (Osburn, 1933).

This is an Arctic-boreal species.

IV. Family **Diastoporidae** Busk, 1859

Diastoporidae Busk, 1859 : 91; 1875 : 27; Smitt, 1867 : 395; Harmer, 1915 : 113; *Tubuliporidae* (part.) Hincks, 1880a : 424.

The zoaria are completely prostrate in the form of a crust, or partly free-growing in the form of two-layered lamellate structures. The zoaria are either in the form of a round or oval plate whose outgrowing lateral lobes sometimes fuse with each other near the primary disc, or they have an irregular form of lamellate structures which anastomose between themselves. The autozooids are tubular, sometimes cylindrical, sometimes slightly flattened; their relatively long or free distal ends, slightly raised above the surface, are located either singly or in rows which never fuse into ligaments or bundles. In some species, small heterozooids or nanozooids may be found. Gonozooids in the form of oval and often transversely broadened bulges which are densely covered with pseudopores, open with either very short or more or less longer, round tubes.

Key for Identification of the Family Diastoporidae

1 (2). Nanozooids located between the autozooids...1. Genus *Diplosolen* Canu (see below).
2 (1). Nanozooids absent....2. Genus *Berenicea* Lamouroux (see p. 142).

1. Genus **Diplosolen** Canu, 1918

Diastopora Lamouroux, 1821 : 42; Smitt, 1867 : 395; 1879a : 13; Hincks, 1880a : 475; Waters, 1904 : 173; *Reticulipora* Smitt, 1872a : 1117; *Diplosolen* Canu, 1918 : 329; Borg, 1926 : 291.

The zoaria are either thin, prostrate, overgrowing plates, or dichotomously branched vertical plates with a bilateral arrangement of zooids on them; the branches anastomose forming a reticular layer. The proximal prostrate parts of the zooids are flat; their distal ends rise above the surface in the form of short or long tubes arranged in a checkered pattern. Between the autozooids, nanozooids which open through minute round orifices, are arranged sometimes in shorter and narrower, sometimes longer and broader, flat cavities. The gonozooids, oval or round bulges at the surface of the zoarium, are densely covered with pseudopores, and usually fitted with many (more than 100) embryos. The oeciostomes are in the form of short, straight, or bent tubes.

Genus type: *Berenicea obelia* Johnston, 1838.

1 (4). Zoaria in the form of thin single-layered plates, are either prostrate throughout the substrate, or partly procumbent and partly free-growing.

2 (3). Distal ends of zooids and nanozooids usually slightly raised above the surface of the zoarium. Orifices of nanozooids located either between the orifices of the zooids, or in line with the latter. ....1. *D. obelia* (Johnston).

3 (2). Distal ends of zooids and nanozooids more or less markedly raised above the surface of the zoarium. Distal ends of nanozooids usually open near the orifices of the autozooids, either on a level with them, or a little above or below........................ ....1a. *D. obelia* var. *arctica* (Waters).

4 (1). Zoaria in the form of free-growing, dichotomously branched, vertical plates with a bilateral arrangement of zooids on them.. ....2. *D. intricarius* (Smitt).

1. **Diplosolen obelia** (Johnston, 1838) (Figure 53)

Diastopora obelia Hincks, 1880a : 462, pl. 66, f. 10, 10a; *Diplosolen Obelia* Osburn, 1933 : 14, pl. 1, f. 7; Marcus 1940 : 71, f. 38.

The zoarium is strongly overgrown and the lobes vary greatly in form. The growing margin of the zoarium consists of one row of undeveloped zooids surrounded by a narrow strip of the basal plate. The procumbent parts of the zooids are flat, and their raised distal ends are arranged in a slightly checkered pattern. Between the zooids are located the more minute heterozooids or nanozooids in the form of comparatively narrow flat tubes, sometimes shorter, sometimes longer, which open through very small orifices slightly raised above the surface in comparison to the orifice of the zooids: in the short tubes, these orifices are located near the distal end; in the longer ones, near their middle portion, similar to *D. intricarius*. The surface of the tubes is covered with sparser and more minute pseudopores. Sometimes the orifices of the zooids are closed by porous calcareous plates.

The gonozooids are sometimes oval, sometimes irregular and transversely broadened, convex, and densely covered with pseudopores; the orifices of the zooids and nanozooids open on their surface. The oecios-

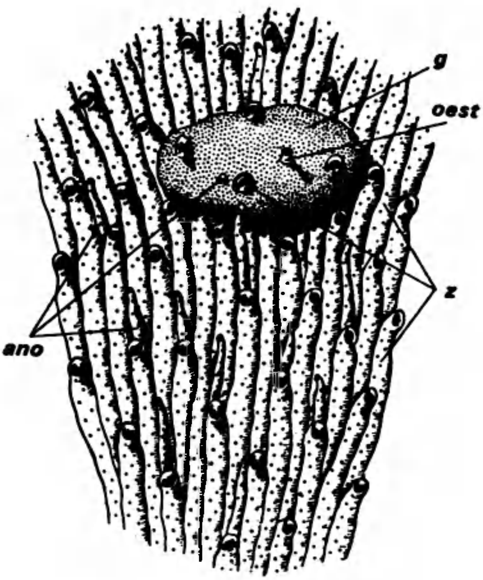


Figure 53. *Diplosolen obelia* (Johnston). Area of a zoarium with a gonozooid.

tome is a very short tube with a round orifice which is smaller in size than that of any zooid, and larger than that of any nanozooid in the zoarium.

The species lives on laminaria, Bryozoa, shells, and stones, at a depth of 10 to 500 m, on a bed of sand and silt.

Distribution. The species was found by me in the southwestern part of the Barents Sea, and near the eastern coast of Greenland. *Reports in literature:* Barents Sea (Nordgaard, 1918), along the western coast of Norway from Finmark toward the south (M. Sars, 1851; Smitt, 1867; Nordgaard, 1897, 1905, 1906b, 1907b, 1912a, 1918), Skagerrack and Kattegat (Smitt, 1867; Levinsen, 1894; Silen, 1936; Marcus, 1940), Great Britain (Norman, 1867, 1869; Hincks, 1880a), northern and southern France (Jullien and Calvet, 1903), Mediterranean Sea (Calvet, 1902), and from the Isle of Man to the Island of Cuba (Osburn, 1933; Canu and Bassler, 1928).

The species is boreal.

1a. **Diplosolen obelia** var. **arctica** (Waters, 1904) (Figure 54)

Diastopora obelia var. *arctica* Waters, 1904 : 171, pl. 21, f. 1; *D. hyalina a: obelia* (part.) Smitt, 1867 : 396; *D. obelium* O'Donoghue, 1926 : 24, pl. II, f. 17.

The zoaria, round or somewhat irregular in shape, overgrow partly or fully around the substrate in the form of a flat crust. The prostrate parts of the zooids are flat, and their quite markedly raised distal ends are usually arranged in a checkered pattern; the orifices of the zooids are round. The nanozooids located near the zooids, are mostly of the same length as the zooids, but are rather narrower and often slightly bent against their frontal wall by their own procumbent part. The distal ends of the nanozooids are raised above the surface, significantly

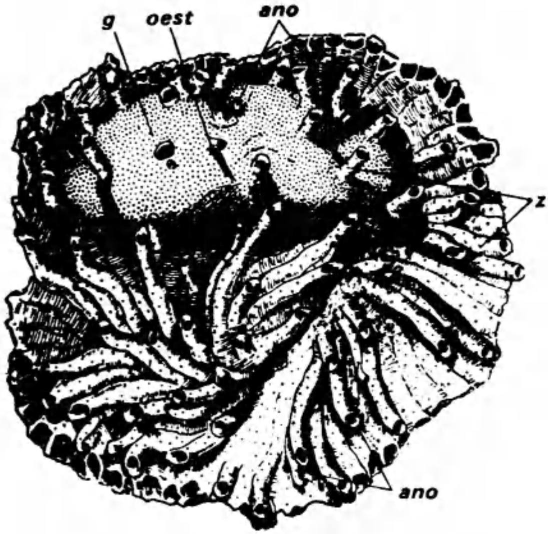


Figure 54. *Diplosolen obelia* var. *arctica* (Waters). Zoarium with gonozooid.

tapered, stretched in the form of thin tubes along the terminal part of the zooid, and more or less closely adjoin it. Rarely, the nanozooids are separated from the zooids, either in the middle or on the back side in line with the terminal part of the zooid. The prostrate parts of the zooids, as well as the nanozooids, are covered with small and sparse pseudopores. The gonozooids are fairly convex structures mostly of a transversely oval form, located parallel to the distal margin of the zoarium. Their surface has a dense cover of larger pseudopores and is perforated with the markedly raised ends of the zooids and nanozooids. There may be several gonozooids with oeciostomes in one zoarium. The oeciostome in the form of a very short tube that is broader near the base and slightly tapers toward the end, opens through a round orifice which is smaller than that of the zooid but larger than that of the nanozooid.

The species lives on Bryozoa, shells, and stones, at a depth of 1.5 to 312 m, often from 50 to 200 m, on a bed of stone and shells, under temperatures ranging from −1.8 to 4.78°C, in a salt concentration of 29.96 to 34.75‰.

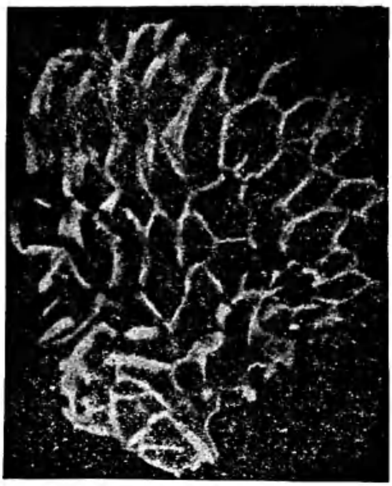
Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, and Okhotsk seas, and off Labrador and western Greenland. *Reports in literature:* Barents Sea (M. Sars, 1851; Smitt, 1867, 1879a, 1879b; Urban, 1880; Bidenkap, 1897, 1900a; Andersson, 1902; Norman, 1903; Waters, 1904; Nordgaard, 1923; Kunznetsov, 1941), White Sea (Smitt, 1897b; Kluge, 1907, 1908a; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Vigelius, 1881-82; Levinsen, 1887; Nordgaard, 1912b, 1921), northern coast of North America and the Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1923, 1936), western Greenland (Smitt, 1868c; Hincks, 1877a; Norman, 1906; Kluge, 1908b; Levinsen, 1914), Gulf of St. Lawrence (Dawson, 1859; Whiteaves, 1901), eastern Greenland (Kirchenpauer, 1874; Andersson, 1902; Levinsen, 1916), Yan-Maien Island (Lorenz, 1886); region of Vancouver Island (O'Donoghue, 1926).

This is an Arctic, circumpolar species.

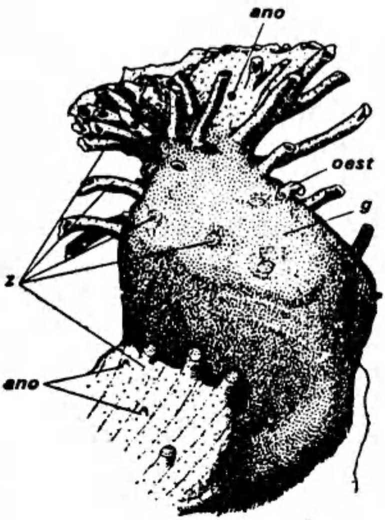
2. **Diplosolen intricarius** (Smitt, 1872) (Figure 55)

Reticulipora intricaria Smitt, 1872a : 1117, t. XX, f. 1-3; *Diastopora intricaria* Waters, 1904 : 173, pl. 19, f. 1-13; *Diplosolen intricarius* Borg, 1926 : 237, 293.

The zoarium, free-growing over a large part, consists of relatively low vertical plates, on both sides of which zooids are located in slightly wavy rows. The plates are branched, and the branches fuse together to form a layer of intertwined plates above which another similar layer is formed; this may be repeated a number of times, as a result of which the complex zoarium typical of the species develops. The zoarium is high and multilayered near the base; after that it becomes a thin layer at the distal margin consisting of lower plates. The lower or basal margin



A



B

Figure 55. *Diplosolen intricarius* (Smitt). *A*—general view of the zoarium; *B*—part of a plate of zoarium with gonozooids.

of the plate is somewhat thicker and rounded; in the layer of intertwined plates it forms a more or less even surface. The height of the plate varies throughout its length; the higher parts look like lobes that are sometimes low, sometimes high, and give a very uneven appearance to the margin of the plate. A thin plate stretches in the middle of the upper margin of the plate with zooids located on both sides. Sometimes this plate forms hoods which are not yet covered by zooids, and these give it a sharp margin. The zooids, more or less long and flat, stretch in slightly wavy rows that are either straight or slanted from the basal margin to the upper margin of the plate. The distal end of the majority of the zooids is often barely raised above the surface of the plate; it has an orifice with an oval outline, covered with a calcareous plate, and perforated by a multiplicity of pores. However in many places, particularly near the upper margin of the plate and near the gonozooid, these zooidal ends take the form of long open tubes which originate at a right angle to the surface of the plate. Nanozooids are located between the orifices of the zooids in the form of oblong, wide, flat cavities, which cover almost the entire frontal surface of the zooids, except for the extreme distal end and the orifice. These cavities open through very small tubes with round orifices located in different places on the frontal surface of the nanozooid. Like the zooids, the nanozooids are also covered with pseudopores, and when the orifices of the zooids are covered with a porous calcareous plate, they are likewise covered by it. The gonozooids are large and prominently convex with a roundish outline; their width is somewhat larger than their length; sometimes the tubes of the zooids perforate the wall and are significantly raised above the wall of the gonozooid, but usually they reach only to the level of the wall, similar to the nanozooids; both are covered with simple calcareous plates. The wall of the gonozooid is densely covered with pseudopores. The gonozooid opens in the distal half through the oeciostome in the form of a tube which is sometimes relatively short and straight, sometimes longer and bent on the proximal side; a round orifice appears at the end of this tube.

The species lives on Bryozoa, shells, and stones, at a depth ranging from 36 to 1,000 m, under temperatures varying from −1.9 to 3.1°C, in a salt concentration of 31.44 to 35‰.

Distribution. The species was found by me in the Barents, Kara, and Laptev seas, and in Devisov Bay. *Reports in literature:* Barents Sea (Smitt, 1872a, 1879b; Nordgaard, 1897, 1900; Bidenkap, 1897, 1900a; Waters, 1904), Kara Sea (Smitt, 1879a; Levinsen, 1887; Nordgaard, 1912b), Baffin Bay (Smitt, 1872a), waters off eastern Greenland (Andersson, 1902), and toward the east of Iceland (Nordgaard, 1900).

The species is Arctic.

2. Genus **Berenicea** Lamouroux, 1821

Diastopora (part.) Smitt, 1867 : 395; Busk, 1875 : 28; Hincks, 1800a : 457; Borg, 1944a : 61; *Berenicea* Harmer, 1915 : 114.

The zoaria are either thin, prostrate, one-layered plates, fully or partially growing around the substrate, or free-growing, ramose, anastomotic, thin and straight, or thick and sinuate plates with zooids arranged bilaterally on them. Nanozooids are absent. In many species the orifices at the end of the zooids are covered with a thin, calcareous, porous plate which, in some species, stretches in the middle into a thin tube opening through a round orifice. The gonozooid is oval or transversely broadened in its middle widest part. The oeciostome is in the form of an upward turned tube.

Genus type: *Diastopora foliacea* Lamouroux, 1821.

Of the species of this genus found in our waters, 2 have been reported in literature: *Berenicea patina* Lamarck and *B. suborbicularis* Hincks. Although the first of these is not found in our waters, in spite of its having been reported in the Kara Sea, I am giving its description here keeping in mind that it is closely related to the new species, *B. arctica* Kluge, reported by me, and that the possibility exists of its penetration into the Barents Sea via the warm current. I am not giving a description of the second species, because it is synonymous with that distributed widely in our waters, namely, *Oncousoecia canadensis* Osburn.

1 (6). Zoaria prostrate, overgrowing, one-layered.
2 (5). Free ends of the zooids more or less long and raised along the entire surface of the zoarium.
3 (4). Free ends of the zooids fuse into prominent rows. Transversely oval gonozooid opens in the middle of the distal margin through a short, round, bent tube .... 1. *B. arctica* Kluge.
4 (3). Leading ends of zooids are not interconnected and present a checkered pattern. Transversely oval gonozooid opens with a longer, bent round tube in the middle of the distal edge...... .... 2. *B. oblonga* Kluge.
5 (2). Free (leading) ends of zooids in the middle part of the zoarium low, not raised, and prominent only near the margins. Zooids, if formed in rows, not raised. Zoarium usually surrounded by a wide basal plate .... 3. *B. patina* Lamarck.
6 (1). Free-growing, thick, and sinuate plates with a bilateral arrangement of zooids on them, arise from the prostrate base........ .... 4. *B. meandrina* (S. Wood).

1. **Berenicea arctica** Kluge, 1946 (Figure 56)

Berenicea arctica Kluge, 1946 : 213, t. V, f. 5;? *B. patina* Levinsen, 1887 : 326.

The zoaria, prostrate, flabellate, or round in form, fix to the substrate either by their entire surface, or only by their middle part, remaining free toward the margins. The first zooid originates from the round primary disc which, by sequential budding of daughter zooids in a radial direction, gives rise to a bilaterally symmetrical zoarium, the lateral lobes of which

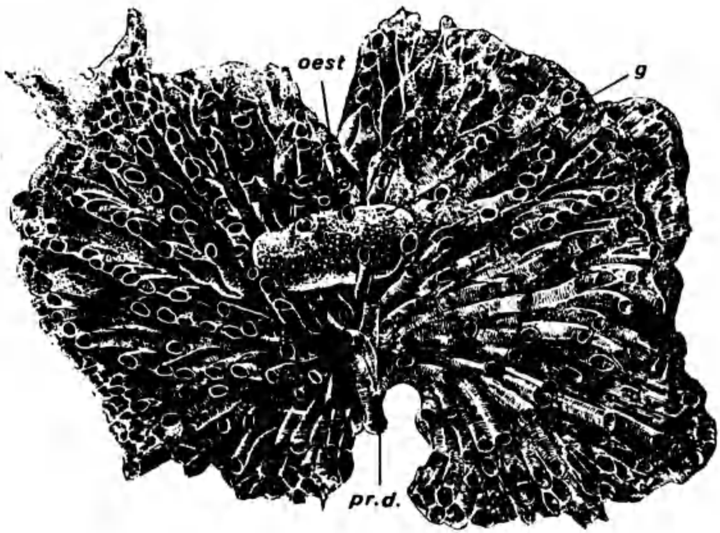


Figure 56. *Berenicea arctica* Kluge. Complete zoarium with gonozooid.

grow out more and more behind the primary, and face each other up to a complete or partial overgrowing around the latter. This outgrowth of the lateral lobes takes place because of the ramification of the radial rows of the tubes. After the lateral lobes fuse, the zoarium becomes round in shape, and the zooids are quite prominently arranged in a radial direction. As the outgrowth occurs, these radial rows of zooids deviate more and more from the middle line in opposite directions. In the middle of the colony, the tubes of the zooids rise slightly above the surface of the zoarium, and the closer they come to the margins, the steeper they rise; the zooids fuse along their entire length and form prominent, costate, radial rows. Because of branching, these rows are not continuous but fragmented. Many of the zooids are closed at the end with porous, calcareous plates. The lateral walls of the tubes are covered with pseudopores. Along the fusion of the lateral lobes of the zoarium, and behind its center, 2 or 3 gonozooids develop. The gonozooid has the form of a transversely oval, bulging, saccate structure with outgrown lateral lobes; it is densely covered with pseudopores. In the middle of its distal margin, the oeciostome is located in the form of a short tube bent upward which opens into a slightly broader transversely oval orifice.

The species lives on ascidia and stones, at a depth of 42 to 360 m, on a bed of silt, stone, and shells, under temperatures ranging from −1.12 to −1.20°C, in a salt concentration of 34.27 to 34.90‰.

Distribution. The species was found by me in the Barents and Kara seas.

The species is Arctic.

2. **Berenicea oblonga** Kluge, 1946 (Figure 57)

Berenicea oblonga Kluge, 1946 : 214, t. V, f. 6; *Diastopora simplex* Smitt, 1879a : 13 (part.).

The prostrate zoaria vary in form; sometimes they are tightly fixed

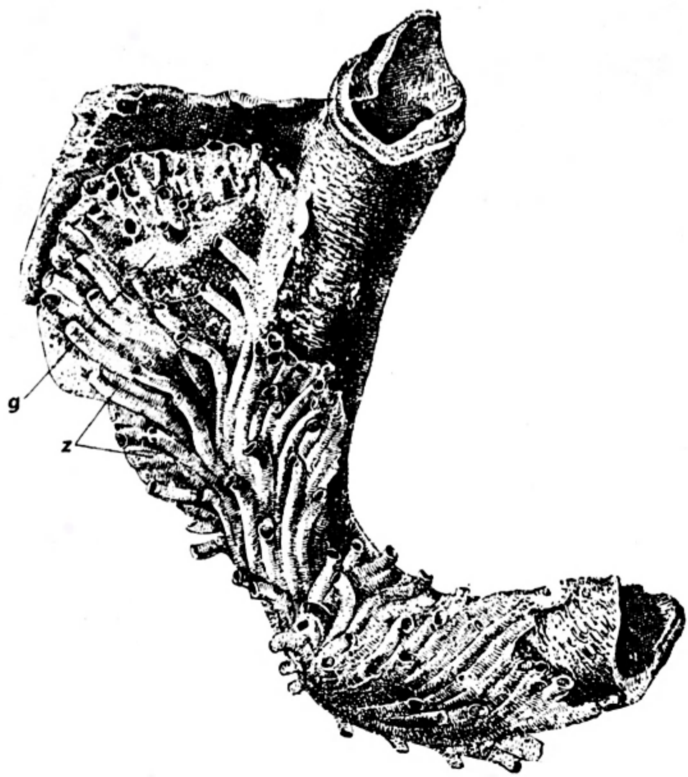


Figure 57. *Berenicea oblonga* Kluge. Complete zoarium with gonozooid.

and grow around the substrate, sometimes they are partly free-growing with a slightly bilateral symmetrical growth. They consist of long tubes of zooids, the proximal half of which is flat, and the distal half more or less sharply raised from the surface; they grow freely in the form of a round tube which is slightly narrower than the procumbent part. The free ends of the tubes are arranged in a checkered pattern; in the initial growth of the zoarium, they are short, but longer near the margin, and either more or less straight, or slightly bent. The surface of the tube is covered with minute pseudopores. The gonozooid develops on the surface of the zoarium, close to the periphery, in the form of a bulging, oval sac whose witdth is significantly greater than its length. Its surface is covered with dense pseudopores. Almost in the middle of its distal margin, it opens with an oeciostome in the form of a long, upward-bent tube with a round orifice at the end. The tube of the oeciostome is a little thinner than the tube of the zooid. The basal plate on the margin of the zoarium is absent.

The species lives on calcareous Bryozoa, tubes of worms, and stones, at a depth of 65 to 360 m, on a bed of silt, sand, and stones, under a temperature of $-1.20°C$, in a salt concentration of 34.90‰.

Distribution. The species was found by me in the Barents Sea, north of Franz Josef Land, in the Kara Sea in the Trough of St. Anna, and on the Central Plateau. *Reports in literature:* Kara Sea (Smitt, 1879a).

The species is Arctic.

*3. **Berenicea patina** (Lamarck, 1816) (Figure 58)[a]

Diastopora patina Smitt, 1867 : 397, t. VIII, f. 13-15; Hincks, 1880a : 458, pl. LXVI, f. 1-6; *Berenicea patina* Borg, 1930a : 48, f. 27; ?*Diastopora patina* var. *radiata* Levinsen, 1887 : 326.

The zoaria are prostrate and either fully overgrow the substrate, or adhere to the substrate in the central part and grow freely on the margins; in the latter case, they assume a cup-like shape. They are round or oval in form and attain a diameter of up to 12 mm. Usually the thin basal plate stretching along the margin in a circular manner, is covered with radial costate lines, i.e., the zone of newly forming zooids. The zooids in the middle of the zoarium are usually shorter than the marginal ones, since all of them slant from the center toward the margins; their orifices are not round but oval (diameter of the tubes, 0.13 mm) and very often are covered with a porous, calcareous plate. Sometimes the

[a] Species from neighboring and slightly separated waters, which have not yet been found in our northern seas, have been marked with an asterisk.

zooids are arranged as if in radial rows which are short and straight, or longer and sinuate, and the zooids do not come close to each other. The gonozooid is in the form of a transversely oval or semi-lunar bulge densely covered with pseudopores, and it encloses many zooids situated near the margin of the zoarium. The oeciostome has the form of a long cylindrical tube with a round orifice. It is not rare to come across instances in which one zoarium rests on the other, as if covering it, and sometimes under the lower one, another zoarium may be seen. Furthermore, zoaria are sometimes found with daughter zoaria settled along their margins, the number reaching up to 10 or more. This suggests that in the given species, not only horizontal or lateral, but also vertical budding takes place.

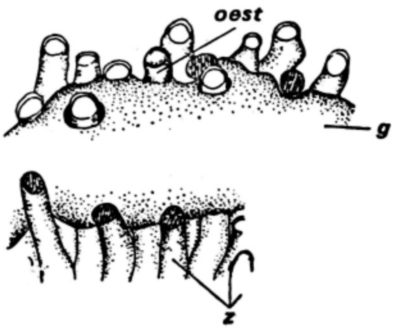


Figure 58. *Berenicea patina* (Lamarck). A part of the gonozooid (from Borg, 1930b).

The species lives on algae, Bryozoa, shells, and stones, at a depth from 5 to 280 m.

Distribution. Although there are reports in literature about the occurrence of this species in the Kara Sea (Levinsen, 1887), I never came across this form in our waters; I think Levinsen had in mind the form described by me from 4 stations of the Kara Sea under the name of *Berenicea arctica*. This seems even more probable since he listed it as *Diastopora patina* var. *radiata* which is particularly characteristic of the form I described. *Reports in literature:* coastal waters of western and southern Norway (M. Sars, 1851; Nordgaard, 1897, 1906b, 1912a, 1918), Skagerrack and Kattegat (Smitt, 1867; Levinsen, 1894; Marcus, 1940), North Sea (Ortmann, 1894), Great Britain (Hincks, 1880a), France (Fischer, 1870; Joliet, 1877), Bay of Biscay (Jullien and Calvet, 1903), Mediterranean Sea (Calvet, 1902), Newfoundland (Jullien and Calvet, 1903), southern Labrador (Packard, 1863), Gulf of St. Lawrence (Verrill, 1873; Whiteaves, 1901), Bay of Fundy (Verrill, 1873), Queen Charlotte Islands (Hincks, 1884), and the region of Vancouver Island (O'Donoghue, 1923).

The species is boreal and widely distributed, but reports by earlier authors of its distribution along the American coast require verification, as no later author has reported this species in that region.

4. **Berenicea meandrina** (S. Wood, 1844) (Figure 59)

Mesenteripora meandrina Busk, 1859 : 109, pl. XVII, f. 2, pl. XVIII, f. 4, pl. XX, f. 2;

1875 : 29; 1880 : 239; Smitt, 1867 : 398, 432; Robertson, 1910 : 251, pl. 23, f. 36-38; *Berenicea meandrina* Borg, 1933a : 519; *Plagioecia meandrina* Osburn, 1936 : 540.

The zoaria, partly prostrate, partly free-growing, are semi-circular or circular and cavernous, and consist of anastomotic, calcareous plates. The tubes of the zooid, originating from the primary disc, move out flabellately in opposite directions, and make the prostrate part gradually thicker while giving rise to the thick drooping margin due to the faster reproduction of the zooids; the margin consists of 3 to 5 rows of undeveloped zooids. The zoarium, along the margin, is surrounded by a fairly wide, edging, basal plate. The folds in the basal plate, formed at several places on the margin of the prostrate part, give rise to vertically uprising plates; zooids are arranged in several layers on these middle, basal plates, and gently rise up from the basal side to the surface of the plates. These plates, after overgrowing, form folds and become sinuate, and on meeting other similar plates, fuse together at the end of the zooids into a complex of intertwining, sinuate plates. Due to the round or oval shape of the

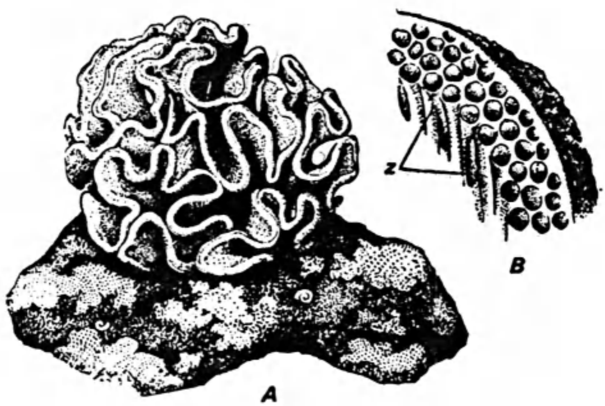


Figure 59. *Berenicea meandrina* (S. Wood). *A*—general view of the zoarium; *B*—part of the zoarium, showing the form and arrangement of zooids.

prostrate part, the vertical plates, formed at different stages of development of the latter, vary in size, being larger in the earlier stage rather than at the later. As a result of this, the zoarium first looks like a segment, but later, as the plates at the margins develop, it becomes semi-circular in shape, and ultimately circular. The tubes of the zooids are thick-skinned, but as they reach toward the surface of the zoarium, their walls become thinner and the tubes rise diagonally above the surface to become walled, round tubes eventually, which gradually taper toward the distal end. In the process of plate overgrowth, these raised tubes, remaining near the margin of the zoarium, gradually fall away to leave behind large orifices at the surface of the plate near their base; these openings are sometimes covered with a thin calcareous layer. In some cases, the calcareous layer closing the lower remaining parts of the tubes, stretches out into a very thin tube in the middle, which opens through a round orifice at the end.

The gonozooid, in the form of a bulge at the surface of the free-growing plate, is usually located in the depressions of its folds near the growing margin. An oeciostome is not known to exist.

The species lives on stones and algae, at a depth of 18.5 to 155 m, on a bed of sand and stone, under a temperature of 2.13°C, in a salt concentration of 32.18‰.

Distribution. The species was found by me in the Chukotsk and Barents seas, and in the waters off western Greenland. *Reports in literature:* Baffin Bay, near Koburg Island (Osburn, 1936), waters off western Greenland (Smitt, 1867; Busk, 1880; Levinsen, 1914), Newfoundland (Jullien and Calvet, 1903), and southern California (Robertson, 1910).

This is an Arctic-boreal, Pacific species.

V. Family **Corymboporidae** Smitt, 1867

Corymboporidae Smitt, 1867 : 407.

The zoarium is verrucose or free-growing, cylindrical, simple or ramose, or pedunculate and discoid. From the basal plate a large or small number of rows of undeveloped zooids rise radially in all directions along the frontal surface of the zoarium. The frontal surface consists of a row of radially located ligaments, or complex rows of zooids opening through orifices, which are arranged either on the lateral or the frontal side of the zoarium.

Key for Identification of the Genera of the Family Corymboporidae

1 (2). Zoarium cylindrical. Outer frontal side consists of complex rows of zooids originating near the center and directed radially. ....1. *Domopora* d'Orbigny (see below).

2 (1). Zoarium, pedunculate and discoid, consists of a more or less thin stalk ending in a cup-shaped disc whose upper fontal side consists of a central, alveolate surface with complex rows of zooids originating from it............2. *Defrancia* Bronn (see p. 150).

1. Genus **Domopora** d'Orbigny, 1850

Domopora Busk, 1875 : 35; Hincks, 1880a : 481; Borg, 1926 : 295, 375; 1944a : 118, *Coronopora* Gray, 1848 : 140; Smitt, 1867 : 407; *Defrancia* Bronn, 1825 : 12; M.Sars, 1863a : 20.

The zoarium, verrucose in a young stage, and semi-circular in an adult stage, is cylindrical and frequently ramose; zooids are located in radial, simple, or frequently, complex rows, or in ligaments at the upper frontal side of the zoarium; the lateral side of the zoarium is an annular zone of developed zooids. In more mature stages, the upper part of the zoarium is ultimately a free-growing cylindrical structure consisting of a few more or less fused generations. The gonozooid is located along the margin of the disc between a few complex rows of zooids.

Genus type: *Ceriopora diadema* Goldfuss, 1827.

Domopora stellata (Goldfuss, 1827)(Figure 60)

Domopora stellata Hincks, 1880a : 481, pl. LXIII, f. 10-14; Nordgaard, 1918 : 22; Borg, 1926 : 295; *Coronopora truncata* M. Sars, 1851 : 145; Smitt, 1867 : 408, 491; 1879b : 24; *Defrancia truncata* M. Sars, 1863a : 158.

The zoarium is cylindrical, simple, or ramose. From the round basal plate originates a stem that is sometimes taller, sometimes smaller and slightly broader on the upper side, which consists of undeveloped zooids; the stem is usually bifurcated toward the end, and each bifurcation may again be divided into two parts. Zooids reaching up to the frontal surface are arranged in complex radial rows on each stalk. The formation of the radial rows starts from the marginal zone of the zoarium; the rows

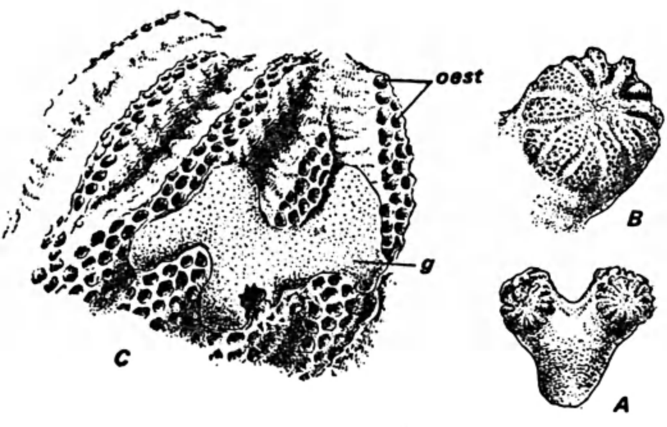


Figure 60. *Domopora stellata* (Goldfuss). *A*—general view of the zoarium; *B*—frontal surface (disc) of the branch; *C*—gonozooid. Norwegian waters.

are initially many, but with the overgrowth of the zoarium and an increase in the frontal surface between them, the rows increase so that the number reaches up to 22 in the adult zoaria. These rows are usually somewhat narrower near the center, initially consisting of 1 to 2 rows of zooids, and then gradually expanding toward the margin of the frontal surface until they consist of 3 to 4 rows of zooids. The zooids closely adjoin in the rows over their entire length, forming rows raised above the surface in the form of radial ribs. The tubes open at one level through polygonal orifices. A small facet is present in the center of the disc, consisting of undeveloped obliterated zooids which establish an alveolate surface form. The lateral sides of the stalks are the annulate zone of the undeveloped zooids. The gonozooid, in the form of a transversely broad, convex, lobate structure densely covered with pseudopores, and located along the margin of the disc between a few complex rows of zooids, almost encloses the latter. The oeciostome is a very short, round tube, in size almost undistinguishable from the neighboring tubes, but strongly inclined toward the underlying zone of growth, stretches almost parallel to the surface of the gonozooid, due to which the cavity of the latter is visible through it on slightly tilting the preparation. The margin of the orifice of the tube, adjoining the gonozooid, is inclined toward the latter. The species lives on stones, calcareous tubes of worms, and shells of bivalved mollusks, at a depth of 72 to 300 m.

Distribution. Reports in literature: This species was not found by me in our waters, but since it was mentioned by Smitt (1879b) as having been located in the coastal waters of Zubovka (Rybachiy Peninsula) at a depth of 126 m, I am giving its description and sketch from the slide[3] made of it in the waters of Norway, on the chance that it may eventually be found in our waters. The species has been found in the boreal region in the deep waters off Great Britain (Hincks, 1880a), and off the western coast of Norway from Bergen to Malangenfiord (M. Sars, 1851, 1863a; Smitt, 1867; Nordgaard, 1918).

This is an Atlantic-boreal species.

2. Genus **Defrancia** Bronn, 1825

Defrancia Bronn, 1825 : 12, 42; M. Sars, 1863a : 157; Smitt, 1867: 408; Busk, 1875 : 36; Borg, 1926 : 298; 1944a : 121; _Domopora_ Nordgaard, 1918 : 22.

The zoarium, pedunculate and discoid, consists of a stalk and a cup-shaped disc. The zooids are arranged in radial complex rows or bundles on the frontal surface of the disc. The calcified surface of the alveolate

[3] In the given slide, the oeciostome was not recorded at the time of drawing.

structure is situated between the rows and surrounded by the latter in the central part of the disc on which one or several gonozooids are located. New daughter zoaria may develop at the margin of the disc on which granddaughter zoaria are formed. The lower side of the disc, as also the stalk, consists of the annulate zone of the developing zooids.

Genus type: *Pelagia clypeata* Lamouroux, 1821.

1 (2). Zoarium simple and single............1. *D. lucernaria* M. Sars.
2 (1). Zoarium complex with one or several generations of similar zoaria on the margin of the discs...1a. *D. lucernaria* var. *prolifera* Kluge.

1. **Defrancia lucernaria** M. Sars, 1851 (Figure 61)

Defrancia lucernaria M. Sars, 1863a : 164; Smitt, 1867 : 408; Busk, 1875 : 36, pl. XXXIII, f. 3; Borg, 1926 : 298.

The stem starts growing in the form a basal plate by which the zoarium is fixed to the substrate. This basal plate is usually round in form. Zooids arise from it, forming a stem which is initially slightly narrow, and then either gradually or abruptly broadens. Zooids grow in the upper and lateral sides. The layer of the developing zooids forms the annulate zone of the stem which varies in height. Zooids, in complex radial rows in the form of radial bundles raised above the surface, are arranged on the upper or frontal side of the stem which widens into a cup-shaped disc. The zooids adjoin each other in the rows and open through polygonal orifices at one level. However, not all of the developing zooids take part in the formation of radial rows. Some of them, after reaching the upper side of the disc, fall between the forming rows and, not developing further, their orifices are covered with calcareous plates. The middle part of the disc consists of kenozooids in the form of oblong, polygonal, alveolar structures arranged in a number of layers. The upper layer forms a continuous middle surface on the alveolar structure. The stem has different forms and sizes, but is relatively thin and short; its upper part abruptly broadens into a wide, flat surface which, if long, gradually broadens and thus

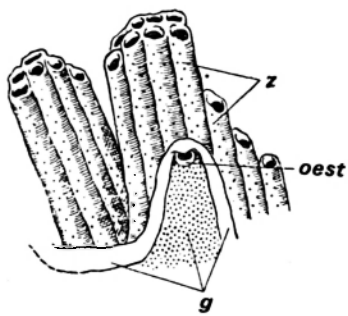


Figure 61. *Defrancia lucernaria* M. Sars. A part of the zoarium with a portion of the gonozooid demarcated by a border.

inconspicuously transforms into a disc. The number of radial rows of zooids in the disc fluctuates from a few up to 22. New rows of the outgrown zoarium are formed, not by the formation of rows between the ones already existing (similar to the situation existing in *Domopora*), but by bifurcation, and the zooids arranged near the margin of the disc stop their growth in the middle of forming the row and become covered with calcareous plates. Because of this, the radial rows in the given species frequently appear to join each other in pairs toward the middle of the disc; they are of almost equal width throughout their length. The gonozooid is located on the frontal surface of the disc and has the appearance of an irregular, transversely oval, flat surface, white in color, densely covered with minute pseudopores, and located below the proximal ends of the radial rows of zooids; from this surface 1 to 3 to 4 narrower lobes originate in the intervals between the radial rows of zooids. Here, one of the lobes is raised along the lateral side of one of the opposite rows of zooids, and opens through the oeciostome on the narrow end in the form of a short, round tube bent in a proximal direction, so that the distal half of the tube overhangs as if it closed the orifice of the tube. A sharply demarcated, more or less narrow, raised border, which is also bent near the oeciostome in a proximal direction covering the distal portion of the tube, encloses the gonozooid along its margin. Gonozooids in the zoarium may number up to 4.

The height of a sexually mature zoarium fluctuates from 4 to 11 mm, the diameter of the stem from $1\frac{1}{2}$ to $2\frac{1}{2}$ mm, the diameter of the disc from 6 to 12 mm.

The species lives on stones, calcareous tubes of worms, and shells of mollusks, at a depth of 25 to 475 m, frequently from 100 to 250 m, on a bed of stones or silt and stone, at temperatures ranging from -1.7 to 3.9°C, in a salt concentration from 31.44 to 34.35‰.

Distribution. The species was found by me in the Barents, Kara, Laptev and East Siberian seas, as well as in the waters off western Greenland. *Reports in literature:* Barents Sea (M. Sars, 1863a; Smitt, 1867, 1879b; Nordgaard, 1900), Kara Sea (Smitt, 1879a; Levinsen, 1887), western Greenland (Smitt, 1867), Gulf of St. Lawrence and the Atlantic coast of New Scotland (Whiteaves, 1901), eastern Greenland (Andersson, 1902), Yan-Maien Island (Lorenz, 1886), northern parts of the Atlantic Ocean (Nordgaard, 1900), western coast of Norway up to the Trondheim Fiord in the south (M. Sars, 1863a; Nordgaard, 1900, 1905, 1918).

The species is Arctic.

1a. **Defrancia lucernaria** var. **prolifera** Kluge, 1946 (Figure 62)

Defrancia Prolifera Kluge, 1946 : 215, t. IV, f. 6.

The zoaria are pedunculate and cup-shaped. One or a few (up to 4) similar daughter zoaria are located on the margin of the basal cup, and these in turn may have granddaughter zoaria of smaller size on their margin, as a result of which a complex margin is formed in 3 tiers; however, the majority of zoaria consist of 2 tiers. The zoaria are usually not large, from 3 to 7 mm high, from 1½ to 7½ mm wide; the

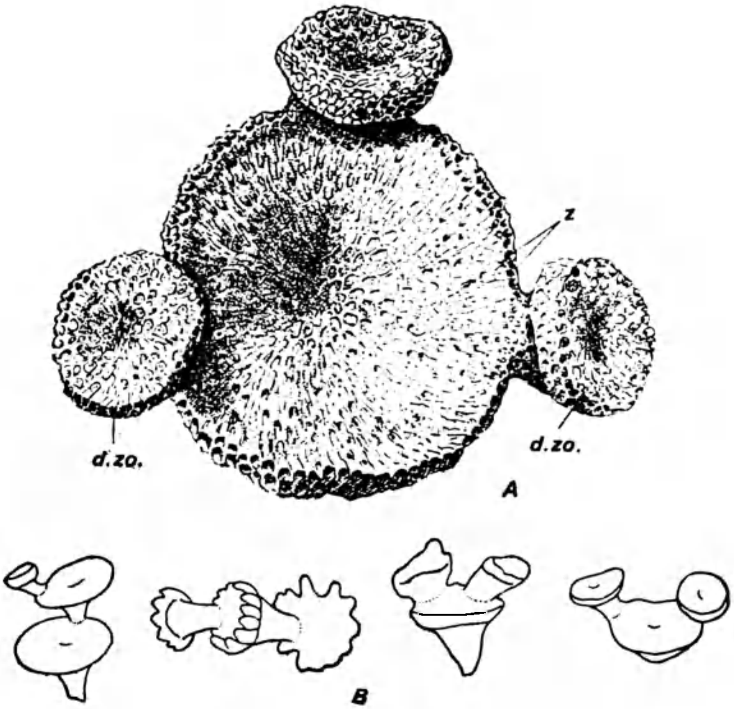


Figure 62. *Defrancia lucernaria* var. *prolifera* Kluge. *A*—view of the zoarium from the frontal side; *B*—forms of zoaria.

diameter of the discs of individual zoaria varies between 1¼ to 5¾ mm. But certain individual zoaria may attain a greater size, reaching up to 12 mm in diameter. A few zoaria have structures close to that of *Defrancia lucernaria.* Radially arranged complex rows or bundles of zooids are located on the upper frontal side; the zooids near the margin of the disc give rise to daughter zoaria; these compound (complex) rows of zooids are almost unnoticeable in other zoaria and are manifested only near the margin of the disc. Gonozooids were not found.

The species lives on calcareous tubes of worms and minute pebbles, at a depth from 58 to 440 m, more frequently from 250 to 300 m, on a bed of silt and stone, under temperatures ranging from −5 to −14°C, in a salt concentration of 34.21 to 34.92‰.

Distribution. This variety was found by me in the Barents Sea, in its southwestern part, and in the Kara Sea, in its northern half.

This is an Arctic species.

VI. Family **Fascigeridae** d'Orbigny, 1853

Fascigeridae (part.) d'Orbigny, 1853 : 665; Borg, 1944a : 127; *Frondiporidae* (part.) Busk, 1886 : 26; Canu and Bassler, 1920 : 807.

The zoaria are free-growing and ramose. The zooids adjoin each other, in the majority of cases, along their entire length, forming ligaments, each of which is either a stem or a lobe, or a bundle opening only at the top. The brood chamber in some cases is a slightly broadened zooid (gonozooid); in other cases where the zooid is not wide, the brood chamber is a common zoarial one.

Genus **Fasciculiporoides** Kluge, 1955

Fasciculipora (part.) d'Orbigny, 1839 : 20; *Fasciculiporoides* Kluge, 1955a : 73.

Although the lateral surface of the bundles or lobes is smooth, sometimes the zooids are separated from it and raised by their distal ends over the surface, which makes this genus closer to the genus *Tubulipora.* Zooids open over a large part at the top of the bundle or the lobe at one level, but sometimes the lateral zooids are raised in the form of individual bundles above the surface.

In the fertile zoaria some bundles or lobes are significantly widened toward the distal end, acquiring the form of a funnel. The broad end of the funnel takes the form of a little disc with a depression toward the center that is densely covered with minute pseudopores, and surrounded by 2 to 3 rows of fused tubes of zooids at the margins. This disc is a lid placed inside the funnel of the zoarial cavity. From the margin of the disc inside, a few tubes (up to 10) stand apart in the shape of a ring. The brood chamber opens in the middle of the disc through a more or less long, straight, cylindrical tube, sometimes broader at the end and opening through a round orifice. This tube is the distal end of the fertile zooid raised above the surface. Under the surface of the disc, inside the funnel, the walls of the given zooid and the adjoining zooids, are subjected to partial absorption, as a result of which a large cavity develops with the buds in it; embryos develop in these buds. This is the main difference between the genus *Fasciculiporoides* and the genus *Fasciculipora* in which the brood chamber is a mildly broadened zooid (gonozooid).

The zoarium develops in a manner similar to that of the genus *Tubulipora.*

Genus type: *Fasciculipora americana* d'Orbigny, 1853.

Fasciculiporoides americana (d'Orbigny, 1853)(Figure 63)

Fasciculipora americana Borg, 1944a : 1, Text f. 1-2; *Tubulipora fasciculiformis* Kluge, 1946 : 209, f. 10.

The zoaria attain a width of 15 mm and a height of 12 mm. Their prostrate base may be quite variable depending upon the substrate—sometimes short and narrow, sometimes wide, and frequently ramified. One or a few continuous bundles of tubes arise from the base. These bundles soon become broad, and either form comparatively broad, multilayered, branched lobes, or give rise to more or less thick bundles that usually widen toward the distal end. Sometimes the bundle, uprising from the prostrate part, first widens into a lobe which then divides into a few ramified bundles. Although the lobes or bundles consist of tubes of zooids fused together along their length, as a result of which their surface appears to be continuous and smooth like that of *Fasciculipora,* nevertheless individual tubes are often raised on their surface. In time, their orifices are covered with calcareous, porous plates. The distal ends of the lobes or bundles either form a continuous surface on the orifices of the tubes (the ends of individual tubes are not raised over their common surface as in *Fasciculipora*), or they rise from the margin over the surface in individual bundles. The lid (cover) of the brood chamber is perforated by 6 to 10 individually standing zooids in the funnel, and these surround the fertile zooid situated between them. The zoarium develops in the same manner as that of *Tubulipora:* the

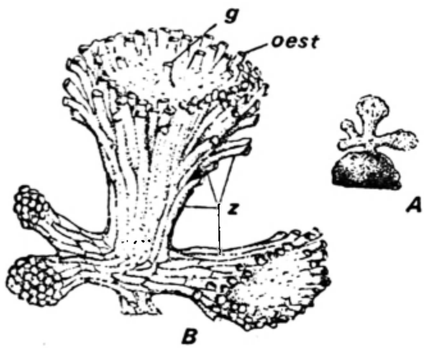


Figure 63. *Fasciculiporoides americana* (d'Orbigny). *A*—general view of a complete zoarium; *B*—zoarium with fertile and sterile lobes.

primary disc gives rise to the first zooid in the form of a more or less long, slanted, raised tube; daughter zooids arise from the base of this tube, one on each side, over a small length to adjoin the first zooid, but later they diverge from it; from the base of the daughter zooids, granddaughter zooids originate on each side, and from the base of the latter, the next generation (great-granddaughter) zooids develop. Depending upon the substrate and the nature of the growth of the zoarium, this phenomenon is distinctly repeated not less than 3 times. The tubes originating in this manner divide again, giving rise to branches, as a result of which either the multilayered lobe or bundle of closely adjoining zooids is formed.

The species lives on hydroids, shells, and small pebbles, at a depth of 19 to 90 m, under temperatures varying from -1.67 to 4.78°C, in a salt concentration of 29.96 to 32‰.

Distribution. The species was found by me in the Laptev, East Siberian, and Chukotsk seas, as well as in the waters off western Greenland and the Gulf of St. Lawrence. *Reports in literature:* the shoals of Newfoundland (d'Orbigny, 1853).

This is an Arctic species.

II. Suborder **Articulata** Busk, 1859

Articulata Busk, 1859 : 92; *Camptostega* Borg, 1926 : 474; 1944a : 133.

The zoaria are free-growing, branched, and divided by articulations into segments or internodes. The primary zooid is free-growing and separated from the primary disc or the pro-ancestrula by a chitinous articulation, but together these are homologues of the ancestrula in the order *Cheilostomata*. Rhizooids are present. The body wall is simple, in the form of a gymnocyst. The terminal pore is closed by a vestibular sphincter. A sexual reproduction takes place by budding; sexual reproduction, taking place in the pyriform, widened gonozooid, is accompanied by polyembryony. The polypide in the gonozooid degenerates until it attains sexual maturity. The primary sac may be simple or divided into two parts.

There is only one family, *Crisiidae* Johnston.

Family **Crisiidae** Johnston, 1838

Crisiidae Johnston, 1838 : 260 (part.); 1847 : 282; Busk, 1859 : 92; *et auctt.*

The zoaria are calcified, free-growing, and branched. The branches consist of segments or internodes joined by chitinous articulations. The internode consists of tubular zooids arranged in 1 or 2 rows, and opening through their own orifices on one (frontal) side. The number of zooids in the internode varies from one to many, reaching up to 36, plus the gonozooid. The zooid, through which the internode or the branch starts, consists of 2 parts separated by a chitinous articulation, but these 2 parts are not independent; they form but one zooid, and its polypide freely enters into the lower or the proximal part in an invaginated position. In instances when a branch forms, the proximal part of the branching zooid, adjoining the zooid from which it originates, is known as the basal branch or *basis rami*. This branch does not always form by chitinous articulations. In some species, such as *Crisiella diversa, C. producta, C. complecta,* etc., the fertile internode, i.e., the internode carrying the gonozooid, divides into a few branches that do not form articulations and consist of one or many zooids. Such branches are known as "extraordinary" branches. The gonozooids are zooids widened in the middle part, in which the sex products develop. The embryo developing after the degeneration of the polypide, is located in the cavity enclosing the polypide and the remaining undegenerated membranous sac. In the majority of the species, this sac is a complete, continuous cavity in which the embryo undergoes further development and division to form a larger number of embryos with the formation of larvae. In some species, such as *Filicrisia geniculata, Crisidia cornuta, Bicrisia abyssicola, F. smitti,* etc., on the internal side of the gonozooid wall, in the place of transition of its narrow proximal part into the wider middle part, an annular nest of ligaments is formed partitions the membranous sac into a proximal, smaller one, and a distal, larger one; the embryos and larvae are located only in the latter. This belt of ligaments is visible through the calcareous wall of the gonozooid in the form of a narrow strip encircling the gonozooid at the point of transformation of its proximal, narrow, oblong part into the widened, middle part. The gonozooid varies in different species in structure, as well as in location in the internode. This has great systemic significance and, therefore, the sterile zoaria, before the development of the gonozooids in them, i.e., before the zoaria become fertile, cannot be identified with certainty. In addition to autozooids and gonozooids, kenozooids are also fairly widely distributed in the zoarium of *Crisiidae* in the form of spines or parts of zooids or rhizooids. These spines are found in a few species and are usually located on the side of the zooid in the form of single- or multi-segmented, thin, thread-like structures. The kenozooids are the proximal parts of the zooid, or the parts of the autozooid, which are separated by chitinous articulations and are devoid of a polypide. Very often they are found to occur near the base of the zoarium, in the first or the first few zooids. Lastly, the rhizooids or radicular tubes consisting of a series of kenozooids, are found in all species, but they may develop to a different degree in different species. They serve to affix the zoarium to the substrate, and assist in the reproduction of the zoaria by performing the function of the stolon. The larvae which develop in the gonozooids, swim in water after coming out, and then settle down on the ground where their shape changes into a semi-circular disc—the primary disc or pro-ancestrula—from the center of which the cylindrical tube of the first tube arises, separated from the disc by a chitinous articulation. This tube is often devoid of a polypide, forming a kenozooid; then it is called a basal tube. This may be followed by a similar basal tube, after which the distal tube starts carrying the polypide. All these tubes, separated from each other and from the primary disc by chitinous articulations, form the primary autozooid, or the zooid. The latter in *Cheilostomata,* together with the primary disc, is the homologue of the ancestrula or the primary disc. Besides the tube uprising from the center, a few more tubes (up to 4) may uprise from the side of the disc—the rhizooids, which are prostrate on the substrate. The rhizooids may form wider portions in their turn, or secondary discs, from the middle of which new zooids arise in the aforementioned manner. The rhizooids usually consist of segments joined by chitinous articulations. For the characterization of the structure of the zoarium of the given species, it is essential to know not only the number of zooids in the internode, but also the type of branching of the internode. Instead of a long description of the number of zooids in the internodes following each other, and the branching of the latter, Smitt (1865) proposed to draw a formula for the structure of the zoarium of the given species, which could completely replace its graphical representation. Since such formulas are often found in literature, we shall introduce the method of their composition using *Filicrisia smitti* as an example; a sketch of its zoarium has been given together with a description of the species.

The formula begins with the primary disc (*Pd*) from which the axial pivot or stem of the zoarium proceeds; this consists of a number of parentheses, each representing an individual internode, and 4 prostrate rhizooids (4 *rz*). As can be seen, the axial stem consists of 2 basal tubes (*tb*), and a third tube with a polypide (1), together constituting the first zooid. Thus, here the axial stem has been represented by one zooid. The *basis rami* starts from this zooid ($_{1}r$) or the base of the branch from which a new branch begins. Since the base of the branch starts from the left side of the zooid, and that too from the first zooid, the number *1* is placed on the left below the letter *r*. The new branch also consists of a series of parentheses or internodes, which constitute a continuous row. Arabic numbers in parentheses indicate the number of zooids in the given internode. If a branch originates from the internode, following the

$(1+x)$

$(4)+(3)+(4+{}_2r+r_2)$

$(6+r_2)$

$(4)+(1+x)$

$(2)+(2)+(3+{}_1r)+(3+r_1)+(3)+(4+r_1)+(4+r_1)$ . . . .

$Pd+(tb)+(tb)+(1+{}_1r)$

$(1+Gz+2+x)$

$4rz$

(4) . . . .

$(3)+(1+tb)+(2+Gz+1)$

$(5)+(1+x)$

$(3)+(4+{}_1r)+(3+{}_1r)+(1+Gr+2+r_1+x$

$(2+x)$

numbers of zooids given in the parentheses, *r* is written on the lower left or right side of the number indicating the placement of the zooid from below and from the side on which the branch starts growing. If several branches start from the internode, the branches are written from bottom to top on one and the other side. In this process each new branch starts with a new row, which is written above or under the given row, and if the number written near *r* is on the left underside, the row is written on the upperside; if it is from the right, the row is written below. If a gonozooid (*Gz*) is located in the internode, first the number of zooids located prior to it is written, followed by the gonozooid, and after this the number of succeeding zooids. If the branch is removed near articulation, after the perenthesis of the last internode, dots are written; if the branch is broken in between, dots are written before closing the parentheses of the given internode. If the internodes end with a growing point or with a zooid beginning development, the letter *x* is written before closing the parentheses. If a species has zooids with spines, this is indicated by the letter *s*, and their location and order in the internode are shown in the same way as the base of a branch (*r*). The formula composed in this manner clearly shows the structure of the entire zoarium, particularly if this formula is rotated by 90° to provide a vertical presentation.

Key for Identification of the Genera of the Family Crisiidae

1 (2). Sterile internodes consist of one zooid carrying a thread-like spine; fertile internodes consist of 1 or 3 zooids. Membranous sac divided into 2 parts.............2. *Crisidia* Milne-Edwards.

2 (1). Sterile internodes, in addition to the basal or lower internodes in the zoarium, consist of a large number of zooids.

3 (6). Sterile internodes consist of 1 to 6 zooids; fertile ones of 3 to 5 zooids. Membranous sac divided into 2 parts.

4 (5). Sterile internodes consist of 2 to 3, rarely up to 6, zooids carrying thread-like spines; fertile internodes consist of 3 to 5 zooids. Gonozooid free for the most part; oeciostome situated on its dorsal side...............................3. *Bicrisia* d'Orbigny.

5 (4). Sterile internodes consist of 1 to 6 zooids devoid of spines; fertile internodes consist of 3 to 5 zooids. Gonozooid adjoins by its entire length the frontal or lateral side behind the advancing zooid. Oeciostome terminal...........1. *Filicrisia* d'Orbigny.

6 (3). Sterile internodes consist of 1 to several (36) zooids; fertile internodes reach a still higher number. Membranous sac not divided into 2 parts.

7 (8). Sterile internodes, besides the basal ones, consist of 1 to 7 zooids

devoid of spines; fertile internodes have a large number of zooids and are divided into a number of "extraordinary" branches. Gonozooid may be twisted to a varying degree on its axis..4. *Crisiella* Borg.

8 (7). Sterile internodes consist of 2 to 36 zooids; fertile internodes of 5 and more. "Extraordinary" branches are absent. In some species, zooids may have spines............5. *Crisia* Lamouroux.

1. Genus **Filicrisia** d'Orbigny, 1853

Filicrisia d'Orbigny, 1853: 603 ; Borg, 1924 : 27, 29; 1944a : 135; *Crisia* (part.) Smitt, 1865 : 115, 126.

The zoaria are not large; they are thin, ramified, and consist of a number of internodes. The zooids in the internodes are devoid of spines. The sterile internodes consist of 1 to 6 zooids, the fertile internodes of 3 to 5. The gonozooid adjoins by its entire length the frontal or lateral wall behind the advancing zooid; the oeciostome is terminal. The membranous sac is divided into 2 parts.

Genus type: *Crisia geniculata* Milne-Edwards, 1838.

1 (2). Srerile internodes consist primarily of 1, rarely of 2 to 3, zooids. Gonozooid adjoins the frontal side behind the advancing zooid ....1. *F. geniculata* Milne-Edwards.

2 (1). Sterile internodes, except for the basal ones, usually consist of 3 to 4, rarely 5, zooids. Gonozooid adjoins the lateral side behind the advancing zooid.......................2. *F. smitti* (Kluge).

1. **Filicrisia geniculata** (Milne-Edwards, 1838) (Figure 64)

Crisia geniculata Milne-Edwards, 1838 : 197, pl. VI, f. 1-1c; Harmer, 1891: 172, pl. XII, f. 7-8; Robertson, 1910 : 235, pl. 18, 19, f. 6-8; Gostilovskaya, 1955 : 101, f. 1; *Crisidia cornuta* var. *geniculata* Busk, 1875 : 3, pl. 1, f. 1-4; *Crisia cornuta* Robertson, 1900 : 328 (part.).

The zoaria, minute and ramose, consist of a row of internodes. The internodes consist primarily of 1 zooid, rarely of 2 to 3. The zooids produce branches from one or both sides. The articulations are brown in the proximal region of the zoarium, and a brighter color in the distal part. The zooids have the appearance of thin, round tubes with a round orifice at the free end. The pseudopores are very small. The fertile internodes consist of 3 to 5 zooids, and the gonozooid occupies the place of the 2nd, 3rd, or 4th zooid. The gonozooid has an oblong form which gradually widens toward the distal portion. The oeciostome is located on the distal end of the gonozooid in the form of a thin tube turned upward, and adjoins the zooid advancing along the dorsal side of the gonozooid. The oeciostome opens upward through a transversely widened oval orifice. The membranous sac of the gonozooid is divided into 2 parts at the boundary between the tapering, proximal, and the wider distal part.

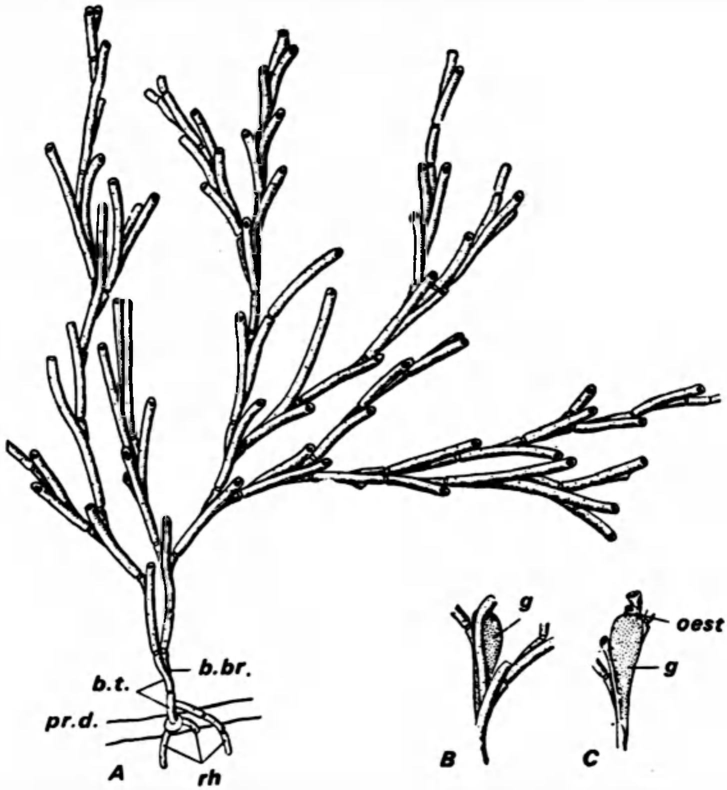


Figure 64. *Filicrisia geniculata* (Milne-Edwards). *A*—sterile zoarium, showing the structure and pattern of branching, and the form and arrangement of the zooids; *B* and *C*—fertile internodes from basal (*B*) and frontal (*C*) sides. (Figure *A*—original; *B* and *C*—from Harmer, 1891).

The base of the zoarium consists of the primary disc from which 2 to 4 prostrate rhizooids and the free-growing part of the zoarium start. The rhizooids are separated from the articulation disc; sometimes, becoming thicker, they form secondary discs which may produce new free-growing parts. The latter begin with 1 to 2 basal tubes and the distal part of the first zooid, which together form the next zooid. This zooid provides 1 or 2 branches and subsequently the main axis in the zoarium develops no further. The proximal parts in *Filicrisia smitti* (Kluge), *Crisiella producta* (Sm.), and possibly *Crisidia cornuta* (Linnaeus) are arranged in this manner. All these forms are so close to each other that sometimes, on the basis of the proximal part of an undeveloped zoarium, it is difficult to decide to which of the aforementioned species a slide (preparation) belongs.

The species lives mostly among laminaria, on a stony bed, at a depth of 2 to 230 m, under a temperature of 5.6°C.

Distribution. The species was found by me in the Barents Sea (Spitsbergen) and near the southern coast of Alaska. *Reports in literature:* White Sea (Gostilovskaya, 1955, 1957), western coast of Norway (Nordgaard, 1912a, 1918), British Channel (Milne-Edwards, 1838; Busk, 1875; Harmer, 1891a), Bay of Biscay (Jullien and Calvet, 1903), Mediterranean Sea (Calvet, 1902), California (Robertson, 1910), and the Torres Straits (Harmer, 1915).

The species is amphiboreal.

2. **Filicrisia smitti** (Kluge, 1946) (Figure 65)

Crisia smitti Kluge, 1946 : 205, f. 7; *C. cornuta* a: sine *cornibus* Smitt, 1865 : 115, 126, t. XVI, f. 2-3; *C. cornuta* Levinsen, 1894 : 74, t. VI, f. 39.

The zoaria are not large; they are thin and branched. The internodes usually consist of 3 to 4 zooids, rarely of 5 to 6. The zooids closely adjoin each other along half or two-thirds of their length, and the distal half or one-third is free and separated on one side upward. The branches in the internodes usually originate from the 1st, or rarely the 2nd, zooid. The *basis rami* is short. Articulations are dark brown in color. The gonozooid develops in the distal part of the zoarium and occupies the place of the 2nd, 3rd, or 4th zooid in the internode. The entire gonozooid lies with its basal side on the lateral wall of the succeeding zooid. The length of the gonozooid is greater than the length of an ordinary zooid. The thin proximal part of the gonozooid, almost equal in length to that of the zooid, abruptly converts into a vesicular widening in the middle part; the oeciostome is located on its tapering distal end in the form of a short bent tube, opening upward through a transversely oval orifice. The membranous sac of the gonozooid is divided into 2 parts at the border between the tapering proximal part, and the wider middle one. The proximal part of the zoarium consists of the primary disc with the prostrate rhizooids branching out from it (numbering 2 to 4); these rhizooids form, on their path, widenings or secondary discs. From the middle of the primary disc, similar to the secondary ones, the free-growing part of the zoarium uprises and is separated by articulations. This part

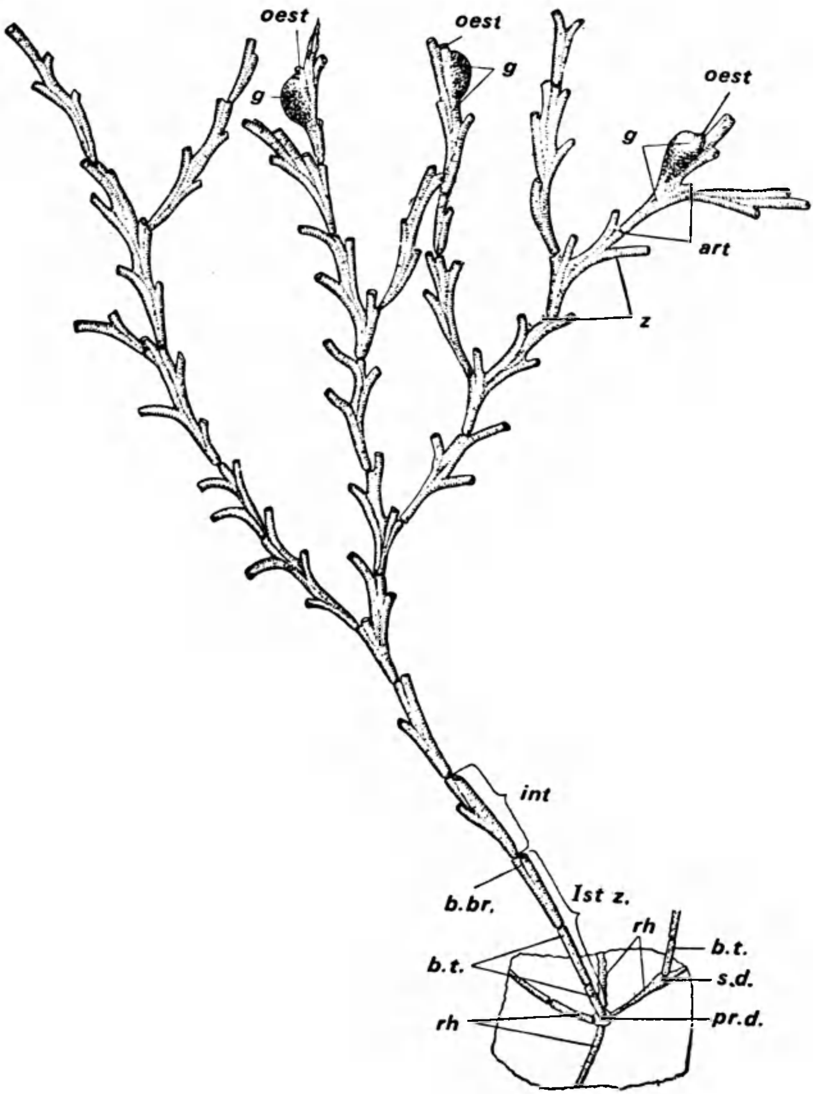


Figure 65. *Filicrisia smitti* (Kluge). Complete zoarium, showing its structure, formation of the secondary disc (*s.d.*) of the zoarium, and the form and arrangement of the zooids and gonozooids.

starts with one or several basal tubes followed by the distal part of the first zooid. These are separated from each other by articulations. The first zooid produces a branch which forms the whole of the remaining part of the zoarium.

The species lives on shells and stones, at depths from 7 to 698 m, more frequently from 100 to 300 m, on a bed of silt and stone, under temperatures ranging from —1.35 to 3.5°C, in a salt concentration from 34.27 to 35.01‰.

Distribution. The species was found by me in the Barents, Kara, and East Siberian seas, and in the coastal waters off western and eastern Greenland. *Reports in literature:* Barents Sea (Waters, 1904; Kuznetsov, 1941), and the waters of Boguslen (Smitt, 1865), and Kattegat (Levinsen, 1894).

This is an Arctic species.

2. Genus **Crisidia** Milne-Edwards, 1838, char. emend.

Crisidia Milne-Edwards, 1838 : 203; *Crisia* (part.) auctt.; *Crisidia* Borg, 1924 : 26, 28.

The zoaria are small, thin, and branched, and consist of a number of internodes. Each sterile internode consists of one zooid with a thread-like spine. The fertile internode consists either of 1 gonozooid with branching originating out of it on the sides, or of 3 zooids of which the gonozooid preempts the place of the 2nd. The membranous sac is divided into 2 parts.

Genus type: *Sertularia cornuta* Linnaeus, 1758.

1 (2). Fertile internode consists of 1 gonozooid with branches originating out of it on the sides................1. *C. cornuta* (Linnaeus).

2 (1). Fertile internode consists of 3 zooids of which the gonozooid preempts the place of the 2nd.......2. *C. orientalis* Kluge sp. n.

1. **Crisidia cornuta** (Linnaeus, 1758) (Figure 66)

Crisia cornuta Busk, 1875 : 3, pl. I, f. 5-10; Hincks, 1880a : 419, pl. 56, f. 1-3; *Crisidia cornuta* Borg, 1930 : 38, f. 11; Marcus, 1940 : 37, f. 18.

The zoaria are not large (up to 15 mm); they are thin and branched. Each internode is represented by 1 zooid. The zooids usually have a branch from one side; from the other side they have a fairly long, bent, and jointed spine; rarely, branches or spines may appear on both sides. The *basis rami* are located a little above the middle part of the zooid. The articulations are brown in color. The *basis rami* of the spines are in the form of very thin tubes, and when the spines are broken one can easily look through them. The fertile internode is represented by 1 gonozooid, which is free; branches originate from it, one on each side. The gonozooid is thin in the proximal half, abruptly widens in the distal half, and tapering toward the distal end, has a somewhat bent, tubular opening at the tip toward the basal side, which opens outward and upward through a round orifice. Usually the gonozooid does not have a spine. The membranous sac of the gonozooid is divided into 2 parts on the margin between the tapering, proximal section, and the wider, middle one.

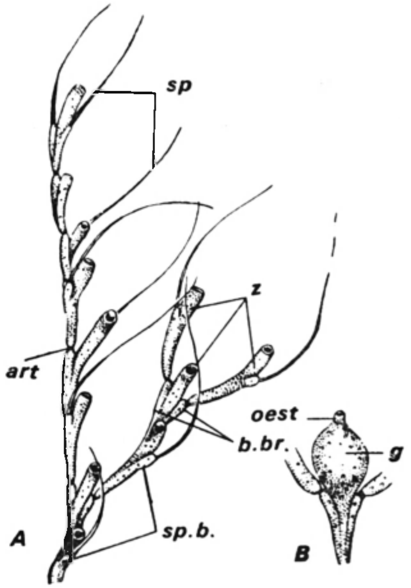


Figure 66. *Crisidia cornuta* (L.). *A*—part of the zoarium; *B*—gonozooid (from Busk, 1875).

The species lives on algae, in the boreal region, at a shallow depth of 1 to 15 m, and in the Arctic region, at deeper levels of 140 to 180 m, on a bed of stone with silt, under temperatures ranging from 3.5 to 3.9°C, in a salt concentration of 34.69‰.

Distribution. The species was found by me in the Barents and Kara seas. *Reports in literature:* western Greenland (Smitt, 1868c; Levinsen, 1914), western coast of Iceland (Nordgaard, 1924), western and southern coasts of Norway (Nordgaard, 1912a, 1918), Skagerrack, Kattegat, and Lille (Store) Belt (Smitt, 1865; Marcus, 1940), Shetland and British Islands (Hincks, 1880a), western coast of France (Joliet, 1877), and the Mediterranean Sea (Calvet, 1902).

This is an Arctic-boreal species.

2. **Crisidia orientalis** Kluge sp. n. (Figure 67)

Crisia cornuta Robertson, 1900 : 328; O'Donoghue, 1923 : 7; 1926 : 18; *C. edwardsiana* Robertson, 1910 : 237, pl. 19, f. 9-10.

In the structure of its sterile internodes, the zoarium does not differ from the Atlantic species *Crisidia cornuta;* the difference lies in the structure of the fertile internodes. In the Atlantic form, the fertile internode consists of 1 gonozooid with branches spreading on the side, while in the given species it is made up of 3 zooids, the gonozooid preempting the place of the 2nd zooid. The gonozooid is distinguished by an oblong form, which is slightly bent toward the distal end which is more or less projected toward the front. Near the upper end, on the basal side of the gonozooid, is located a short, tubular oeciostome whose upper end opens through a round orifice. The membranous sac is divided into 2 parts.

The species lives on algae in the belt of ebb and flow, at a depth of 28 to 54 m.

Distribution. The form was found by me in the waters off the southern coast of Alaska. *Reports in literature:* southern coastal waters of Alaska and California (Robertson, 1900, 1910). This is a Pacific, boreal species.

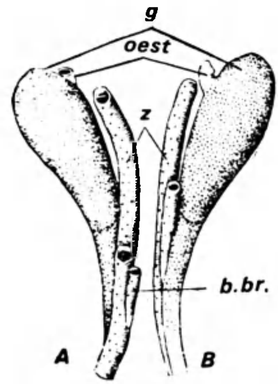


Figure 67. *Crisidia orientalis* Kluge sp. n. Fertile internode. *A*—from the frontal side; *B*—from the side.

3. Genus **Bicrisia** d'Orbigny, 1853

Bicrisia d'Orbigny, 1853 : 601; *Crisia* (part.) Smitt, 1865 : 116; *Bicrisia* Borg, 1924 : 28, 1944a : 139.

The zoaria are not large; they are branched and consist of a number of internodes. Sterile internodes comprise 2 to 3, and up to 6, zooids. Most of the zooids have thread-like spines. Fertile internodes consist of 3 to 5 zooids. The gonozooid is free for the most part, and the oeciostome is located on the basal (dorsal) side. The membranous sac is divided into 2 parts.

Genus type: *Bicrisia edwardsiana* d'Orbigny, 1852.

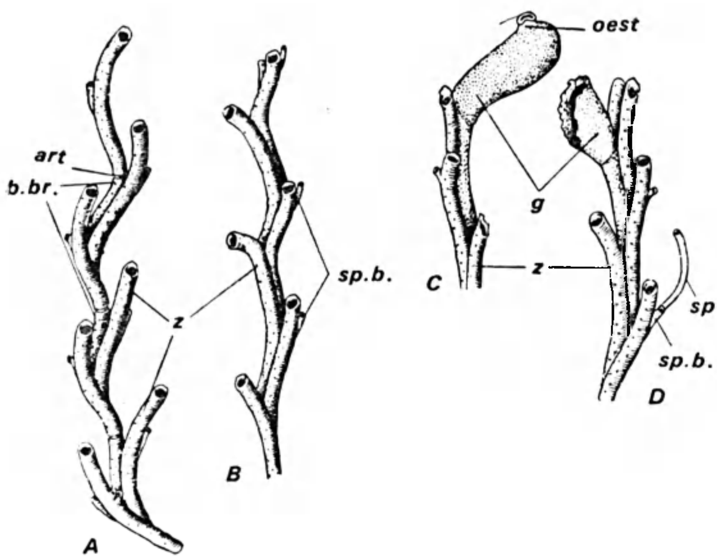


Figure 68. *Bicrisia abyssicola* Kluge, sp. n. *A*—sterile zoarium with 1 to 2 zooids in the internode; *B*—sterile internode with 6 zooids; *C* and *D*—fertile internodes with developed (*C*) and under-developed (*D*) gonozooid.

***Bicrisia abyssicola** Kluge sp. n. (Figure 68)

Crisia cornuta (part.) Smitt, 1865 : 116.

The gonozooid occupies the place of the 3rd to the 4th zooid in the internode, and its greater, broader part is very prominently raised upward and forward. Near its distal end, on the basal side, is located the oeciostome in the form of a short tube, transversely opening upward through an oval orifice.

Distribution. The form was found at a "great depth outside Norway, on coral ground" (Smitt, 1865).

The species is found in the deep waters of the northern part of the Atlantic Ocean.

4. Genus **Crisiella** Borg, 1924

Crisiella Borg, 1924 : 3 etc.; *Crisia* (part.) Smitt, 1865 : 116.

The zoaria are not large; they are thin, branched, and consist of a number of internodes. Sterile internodes consist of 1 to 7 zooids; fertile internodes consist of a large number of zooids and are divided into a variable number of individual "extraordinary" branches. The gonozooid, together with its surrounding "extraordinary" branches, may be twisted to a varying degree on its axis. The membranous sac is not divided into 2 parts.

Genus type: *Crisia producta* Smitt, 1865.

1 (2). Fertile internode consists of 2 "extraordinary" branches. Gonozooid not twisted on its axis; its distal half drifts to the side away from the main branch..........1. *C. diversa* (Kluge).

2 (1). Fertile internode consists of many "extraordinary" branches. Gonozooid, together with its surrounding "extraordinary" branches, may be twisted on its axis up to 180°.

3 (4). "Extraordinary" branches separate and terminate at different levels. Gonozooid, fairly long and narrow, is of uniform width in its distal half..........................2. *C. producta* (Smitt).

4 (3). "Extraordinary" branches, more closely collected together in the form of a funnel, terminate almost at the same level. Gonozooid shorter; its proximal half narrow; it strongly broadens toward the distal end and occupies the entire funnel.........
..............................3. *C. complecta* (Kluge).

1. **Crisiella diversa** (Kluge, 1955) (Figure 69)

Crisia diversa Kluge, 1955a : 63, fig. 1-3.

The zoaria are small, less branched, and mature early; the gonozooids are typical of the species. The thin branches forming the zooids which have a round orifice, are freely raised at the ends. From the primary disc, 3 to 4 prostrate rhizooids and the basal tube originate, and are separated from the disc and the succeeding distal part of the first zooid, by a chitinous articulation. Usually 1 to 3 sterile internodes originate from the first zooid with 2 to 6 zooids on each, after which the fertile

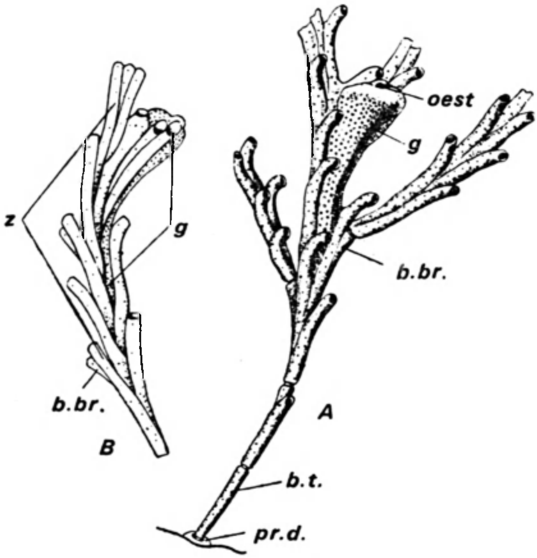


Figure 69. *Crisiella diversa* (Kluge). *A*—fertile zoarium from the frontal side; *B*—fertile internode from the basal side. Isfjorden in Spitsbergen.

internode follows, but in some cases the fertile internode originates directly from the first zooid. The branches usually originate from the first zooid on one or the other side and, in the terminal or fertile internode, frequently even from the second zooid on both sides. The *basis rami* are short. The fertile internode consists of 9 to 12 zooids, and usually carries one gonozooid occupying a place between the 2nd and 7th zooids. The gonozooid is oblong, gradually widens, and in the distal half drifts away with its branches from the middle line. Near the upper end, it is rather strongly projected, but drops back toward the oeciostome. The oeciostome is a short, broad tube which opens outward through a transversely oval orifice.

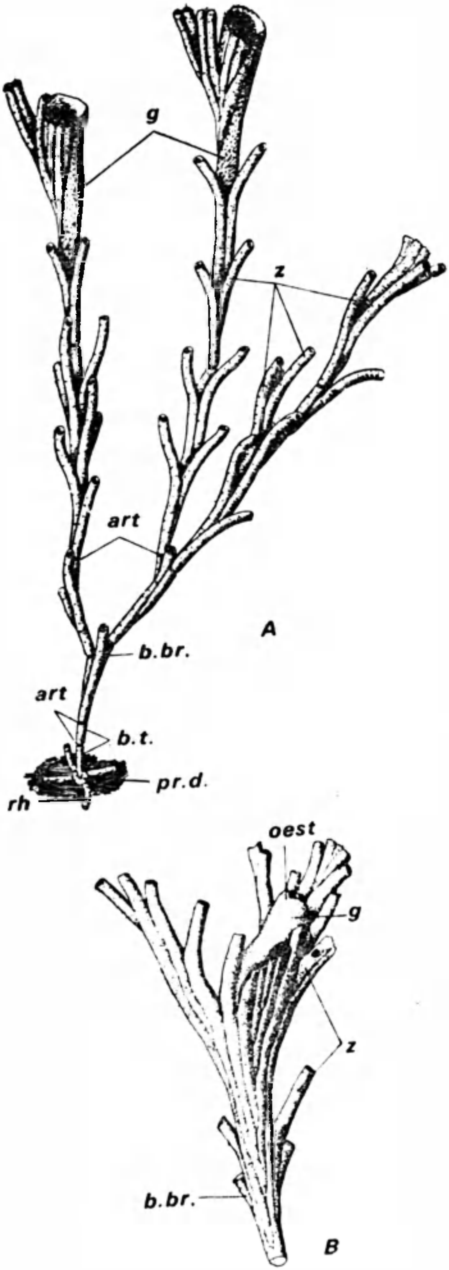


Figure 70. *Crisiella producta* (Smitt). *A*—complete zoarium with 2 undeveloped gonozooids; *B*—gonozooid enclosed with dense branches.

On the branch, usually consisting of 2, rarely 1 or 3, zooids, is located the distal part of the gonozooid. Although the gonozooid is not twisted, the drifting of its distal part together with the "extraordinary" branches formed by it, and the light turn of the zooids of the opposite side toward the gonozooid, provide a basis for considering this species as the initial stage of development for the genus *Crisiella*.

The species lives on stony ground among algae, at a depth from 36 to 140 m, under temperatures ranging from −0.26 to 1.71°C.

Distribution. The species was found by me in the Barents and Kara seas.

This is an Artic species.

2. **Crisiella producta** (Smitt, 1865) (Figure 70)

Crisia producta Smitt, 1865 : 116, 131, t. XVI, f. 4-6; *Crisiella producta* Borg, 1924 : 3, f. 1-9.

The zoaria are small, fairly branched, and bushy. The zoarium starts with the primary disc from which 3 to 4 prostrate rhizooids originate. The basal tube, rising from the middle of the disc, is separated by a chitinous articulation of a dark color, representing the proximal part of the first zooid, which is also separated from the distal part by a chitinous articulation. This articulated first zooid is the first internode of the zoarium. Sometimes instead of 1 basal tube, 2 are found which are also divided by articulations. Branches, one on each side, originate from the first zooid; these branches do not start at the same level; one is slightly above the other. Their *basis rami* are short, cuneate, and located a little above or below the middle of their zooid. The first originating branch, and frequently even the second originating from the first, consists of one zooid, with new branches on one or both sides. Thus the zoarium of this species is devoid of a main axis, representing the direct continuation of the first internode. The sterile internodes following after this consist of 1 to 5, rarely 7, zooids; the fertile internodes consist of a large number of zooids (11 to 12, and more than 20). The internodes are straight and consist of zooids in the form of long tubes, closely adjoining their neighboring zooid along two-thirds to three-fourths its length. The remaining part, or the free distal end of the zooid, drifts to the side away from the branch and opens through a round orifice. The ramification in the internodes varies quite strongly. The branches start from any zooid of the internode on one or the other side. With a small number of zooids in the internode, the branch usually starts from the first zooid, but the number of branches in the internode is not restricted; in internodes with a large number of zooids in the distal part of the zoarium, usually 2 to 3 branches are produced, and they, too, are from the zooids placed higher in the internode. The fertile internodes are usually located in the distal parts of the zoarium, and are characterized by a large number of zooids and their peculiar arrangement around the gonozooid. The gonozooid has an oblong, cylindrical, or stick-like form, and occupies a place between the 2nd and 7th zooid, while closely adjoining the neighboring zooids. Usually 1, rarely 2, small gonozooid develops in the internode. The gonozooid occupies the position of the 2nd to 7th zooid in the internode. The oeciostome is located on its distal end in the form of a short, more or less forwardly bent tube, which is wide near the base and tapers toward the distal end; its orifice is transversely oval. Unlike other species of the genus *Crisiella*, the fertile internode in *C. producta* is distinguished by two peculiarities: first, the zooids following the gonozooid, owing to their more or less strong branching, flabellately surround the latter, rising above it by their free distal parts in bundles or singly; second, because of such a branching, the gonozooid is turned around on its own axis by 90°, or sometimes even 180°, i.e., in a half-circle. But the ramification of the zooids, as well as the twisting of the gonozooids, is subject to a significant variation in different zoaria. In the more northern and eastern regions, fertile internodes are distinguished by a smaller number of zooids (frequently 11 to 12) and a relatively weak twisting.

The prostrate rhizooids originate from the primary disc through a widening in one or the other place, from which the free-growing branch is raised, giving rise to a new zoarium, similar to the one arising from the primary disc. These widenings are like secondary discs. Frequently, secondary branches originate from them which may give rise to a new secondary disc with independent branches growing out of it. The articulations are brown-yellow in the old parts of the zoarium, and yellow in the younger parts. The pseudopores are closer to each other in the gonozooids than they are in the zooids.

The species lives primarily on laminaria and other algae, on a bed of stone, at depths from 1 to 273 m, but small depths from 1 to 20 m are more frequent, under temperatures ranging from 1.7 to 4°C.

Distribution. The species was found by me in the Barents, White, and Kara seas. *Reports in literature:* Barents Sea (Smitt, 1879b; ?Vigelius, 1881-82; Kuznetsov, 1941), White Sea (Kluge, 1908a; Kluge in Deryugin, 1928; Gostilovskaya, 1955, 1957), western coast of Norway in the north up to Finmark (Nordgaard, 1912a, 1918), western coast of Sweden (Smitt, 1865; Borg, 1924), Strait of Large Belt (Levinsen, 1894; Marcus, 1940), western coast of Greenland (Norman, 1906; Levinsen, 1914).

The species is Arctic-boreal.

3. **Crisiella complecta** (Kluge, 1955) (Figure 71)

Crisia complecta Kluge, 1955a : 65, f. 4.

The zoaria are small (5 to 6 mm in height), less branched, mature early, and consist of a few internodes. The sterile internodes consist of 1 to 2 zooids; the fertile ones comprise a larger number (up to 30). The zooids are in the form of thin (0.1 mm), long, round tubes which closely adjoin each other over two-thirds their length, the remaining one-third, free portion being bent upward. The bases of the branches are short and arranged, for the most part, around the middle portion of the zooid. The fertile internodes are devoid of articulated branches. The gonozooid occupies the place of the 5th or 6th, rarely the 3rd, zooid. The zooids next to the gonozooid branch out into the lateral zooids which are arranged in the young internode, in the form of an almost single-layered circle. As further branching in the zooids and the formation of the gonozooid occur, the latter starts twisting, and the zooids surrounding it differentiate and split into 3 to 4 zooids; tilted toward the middle of the gonozooid, these zooids give rise to 3 to 4 "extraordinary" branches which drift away from the gonozooid. The gonozooid is long and gradually widens from the proximal end to the middle where, by its strong

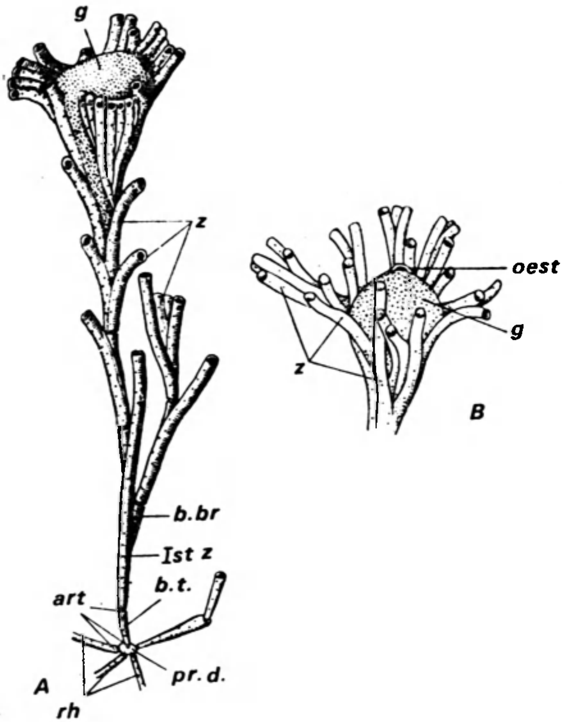


Figure 71. *Crisiella complecta* (Kluge). *A*—complete zoarium; *B*—gonozooid surrounded by branches of zooids.

widening, it occupies all the funnels falsely formed by the zooids. The gonozooid is turned at an angle of 180° in relation to the frontal side of the proximal half of the internode, and the oeciostome adjoins the zooids, which are turned toward the internode side of the basal part. The oeciostome is a short oval tube, the free end of which bends upward; it opens through a transversely oval orifice. The zoarium starts growing with the primary disc which has 3 to 4 prostrate rhizooids; these often give rise to secondary discs. The free-growing zoarium originates articulately from the disc, which originates with the basal tube of the first and only zooid of the main axis. The branches grow out of this zooid either on one side, or on both. The branches form 1 or 2 sterile internodes from 1 zooid, from which the fertile internode branches out with many zooids, and the gonozooid on the distal end surrounded by its "extraordinary" branches. The membranous sac is not divided into 2 parts.

The species lives on algae, on a bed of stone, at a depth from 7 to 53 m.

Distribution. The species was found by me in the Barents and Kara seas.

This is an Arctic species.

5. Genus **Crisia** Lamouroux, 1812

Crisia (part.) Smitt, 1865 : 115; Hincks, 1880a : 418; Harmer, 1891 : 127 etc.; Borg, 1926 : 183; 1944a : 150.

The zoaria are different sizes and more or less strongly branched. The branches consist of a number of internodes in a double-rowed arrangement. The sterile internodes consist of a variable number of zooids, from 2 to 36 plus the gonozooid. The fertile internodes consist of 5 and more zooids (up to 36). The zooids of some species may have spines. The membranous sac is not divided into 2 parts.

Genus type: *Sertularia eburnea* Linnaeus, 1758.

1 (2). Gonozooid not located on the frontal side of the internode, but directed laterally from the sides. Internodes of the branches short, broad, flat, and straight. Zooids tightly adjoin each other along their entire length, and only their distal ends are raised in the form of short, round tubes ....4. *C. constans* Kluge.

2 (1). Gonozooid located on the frontal side of the internode.

3 (6). Some zooids in the internodes of the zoarium have spines.

4 (5). Zoaria branched and thin. Individual zooids of some internodes have articulated spines, mostly originating from the lower zooids of the internode. Gonozooids occupy the place of the 3rd, 4th, or 5th zooid in the internode...........1. *C. aculeata* Hassall.

5 (4). Zoaria less branched. Almost all zooids have short, monomeric (one-segmented) spines. Gonozooid occupies the place of the 10th zooid in the internode...1a. *C. aculeata* var. *bathyalis* Kluge.

6 (3). Zooids in the zoarial internodes have no spines.

7 (8). Branches turned inward, particularly in their distal part. Sterile internodes have from 3 to 7 zooids; fertile internodes from 8 to 12. Branches originate from the 1st zooid, rarely from the 2nd. *Basis rami* short. Gonozooid occupies the place of the 2nd, rarely the 3rd zooid, and has a pyriform shape; oeciostome bent like a tube with a round orifice...2. *C. eburnea* (L.).

8 (7). Branches do not turn inward, but have a lateral turn sometimes on one side, sometimes on the other. Internodes are long.

9 (10). Branches thin and short; distal ends of zooids bend at a right angle toward the frontal side, forming short tubes with round orifices. Sterile internodes have 11 to 13 zooids; fertile internodes have up to 20. Branches originate from the 1st to the 6th zooid. Gonozooid occupies the place of the 3rd or 4th zooid in the internode.....3. *C. eburneo-denticulata* Smitt.

10 (9). Branches thicker and broader. Distal ends of zooids not bent at a right angle toward the frontal side; internode has a large number of zooids. Gonozooid occupies a higher place in the internode.

11 (12). Zoaria not large. Number of zooids in the internode 2 to 18, often 13 to 14. Branches in the internode originate from the 2nd to the 7th zooid. Branch base short, thick and wedged by its lower and between the zooid by which it rests, and the underlying one. Gonozooids occupy the place of the 5th to the 10th zooid in the internode; oeciostome has the form of a slightly noticeable, transversely oval orifice, closely adjoining the base of the zooid advancing from behind..5. *C. denticulata* Lamarck.

12 (11). Zoaria large. Internodes longer; the number of zooids in them may be greater than 30. Branches in the internode start at a significantly higher position. Gonozooids in the internode occupy a higher position. Oeciostome in the form of a flattened, short tube, opens through a slit-like orifice.

13 (14). Number of zooids in the internode reaches up to 32, but mostly 12 to 15. Branch base long. Zooids usually have a pointed protuberance (denticle) in the upper outer corner. Gonozooids convex; their distal ends (often conically pointed) strongly project forward and upward and close the oeciostome whose slit-like orifice at the end is directed forward...........................5a. *C. denticulata* var. *borgi* Kluge var. n.

14 (13). Number of zooids in the internode reaches up to 37, but mostly 20 to 28. Zooids, except for the younger ones, mostly without a denticle in the outer corner. Branch base thick and short. Distal widened upper ends of gonozooids do not project forward. Distal end of oeciostome bent and turned upward; oeciostome opens through a slit-like orifice...................................5b. *C. denticulata* var. *arctica* M. Sars.

*1. **Crisia aculeata** Hassall, 1841 (Figure 72)

Crisia aculeata Hassall, 1841a : 170, pl. VII, f. 3-4; Harmer, 1891 : 132, pl. XII, f. 4; Marcus, 1940 : 43, f. 22.

The zoaria are branched and attain a height of 15 to 20 mm. The thin branches, exhibiting a tendency to bend inward, consist of a number of more or less short internodes. The sterile internode usually consists of 5 to 7 zooids, but in the terminal parts of the branches, and particularly in the fertile internodes, a larger number of zooids are located. The branches usually originate from the 1st or 2nd zooid in the internode from one or the other side; the terminal internodes may produce 2 branches. The base of the branch is short and adjoins the distal part of the zooid. Articulation is usually of a yellow color, being brighter in the growing part of the branches. The zooids closely adjoin each other over a large part; their free distal ends, terminating in a round orifice, are slightly bent toward one side and upward; the free ends are not found in the lower parts. In addition to common branches, the zooids of some internodes have articulated spines. These spines, often arising from the lower zooids of the internode, and from the upper ones in the terminal internodes, bend slightly inward under the frontal surface. They consist of a few segments which are joined by chitinous articulations. The gonozooids are not large and occupy the place of the 3rd, 4th, or 5th zooid in the internode. They are narrow in the proximal region, and become broader in the distal half where, by a strong projection toward the front, they abruptly drop toward the oeciostome which adjoins the zooid located along the basal side of the gonozooid, and bend above the oeciostome; the oeciostome has the form of a small orifice devoid of a tube.

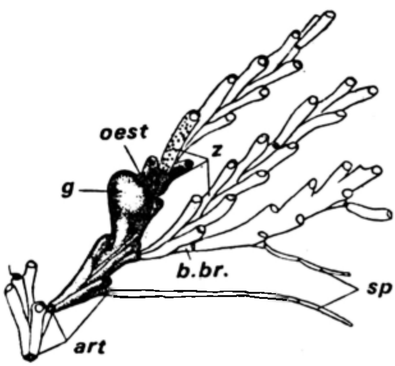


Figure 72. *Crisia aculeata* Hassall. A part of a fertile zoarium from the fertile side (from Harmer, 1891).

The species lives on red and other algae, on a bed of stone, in depths from 7 to 150 m.

Distribution. Reports in literature: coastal waters of Boguslen (Smitt, 1865), British Islands (Hincks, 1880a), and western France (Fischer, 1870; Joliet, 1877).

The species is boreal.

1a. **Crisia aculeata** var. **bathyalis** Kluge, 1946 (Figure 73)

Crisia aculeata var. *bathyalis* Kluge, 1946 : 204, t. VI, f. 4.

The zoaria are not large, attain a height up to 20 to 25 mm, and are less branched. The branches consist of internodes and have a tendency to bend inward. The internodes are usually short and consist of 3 to 5 zooids, but in the distal parts of the zoarium, their number may reach 8 to 10. The large, proximal parts of these zooids closely adjoin each other and more or less taper on the frontal side, thereby giving the impression that the lateral margins of the zooids are sharp; the distal part, in the form of a round tube, begins freely raised slightly on one side, and then abruptly lifts upward opening through a round orifice. The branches originate from the 1st or 2nd zooid on both sides, rarely from the 3rd zooid; usually 1 branch uprises from an internode. The articulation is yellow-brown in color, becoming colorless toward the margin of the zoarium. Sometimes, instead of a normal zooid, the kenozooid starts from the *basis rami*, producing a branch, and sometimes even a normal new zooid. There are monomeric (one-segmented) spines in almost all the zooids.

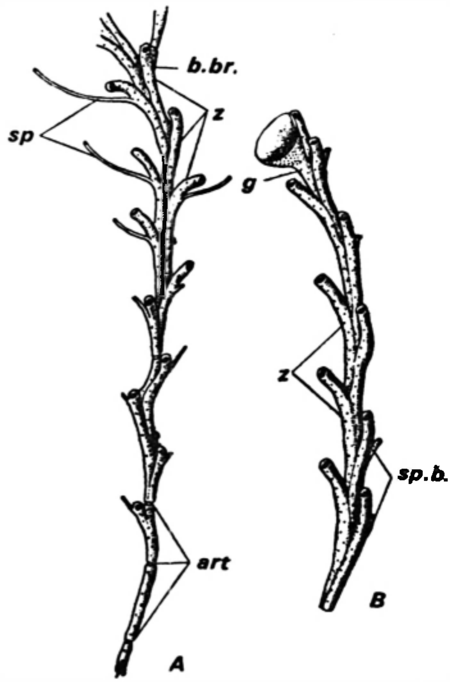


Figure 73. *Crisia aculeata* var. *bathyalis* Kluge. *A*—part of a zoarium; *B*—internode with undeveloped gonozooid.

The base of the spine is almost twice shorter and thinner than the base of the branch, and adjoins with the outer, lateral side of the zooid in the place of the turn of its free and distal part. A completely developed gonozooid was not found, but in one distal internode a vestige of a gonozooid was present, occupying the place of the 10th zooid; consequently, the gonozooid is placed high in the internode. It consists of a narrow, short, proximal part, and the middle which follows is abruptly broadened; there its development stops. The proximal part of the zoarium starts with the primary disc from which the free-growing portion begins in the form of several basal tubes, one following the other, changing into the distal part of the 1st zooid. This zooid has *basis rami* from which the branch starts that gives rise to the higher placed part of the zoarium.

The species lives at a depth of 700 m, on a bed of stone and silt, under a temperature of −0.92°C, in a salt concentration of 34.81‰.

Distribution. This variety was found by me in the northern part of the Kara Sea on the slope of the continental shelf.

This is an Arctic species which dwells in deep water.

2. **Crisia eburnea** (Linnaeus, 1758) (Figure 74)

Crisia eburnea; sine *cornibus* Smitt, 1865 : 117, t. XVI, f. 7, 10-11; *C. eburnea* Harmer, 1891a : 131, 154, pl. XII, f. 6; Borg, 1930a : 40, f. 14-15.

The zoaria are ramose and from 1 to 3 cm in height. The branches are usually bent inward, particularly in their distal part, due to which the zoarium acquires a typical agminate form. The branches consist of more or less short internodes. The majority of sterile internodes usually consist of 5 to 7 zooids; the fertile internodes of 8 to 12. The branches usually originate from the 1st zooid on both sides, rarely from the 2nd. The articulations are brown in color, turning pale toward the distal end of the branches. The *basis rami* is short, adjoining the distal half of the zooid. The zooids in the internode are arranged in alternate rows, which are more or less bent and adjoin almost throughout their entire length; their distal part is bent upward, opens through a round orifice, and often has a denticle on the outer corner. The gonozooid is situated in the proximal part of the internode, and more frequently preempts the place of the 2nd, rarely the 3rd, zooid. The gonozooid is pyriform in shape, and the oeciostome located on its distal end in the form of a well-developed and slightly bent tube, is wider at the base, tapering gradually toward the round or transversely oval orifice, and directed toward the frontal side and upward.

Figure 74. *Crisia eburnea* (L.). Part of a zoarium with sterile and fertile internodes.

The species lives on algae, shells, and stones, at a depth of 0 to 235 m, more frequently from 0 to 100 m, under temperatures ranging from —1.6 to 5.6°C, in the White Sea up to 10.5°C, in a salt concentration from normal to a very pronounced fresh-water state in estuaries of rivers.

Distribution. The species was found by me in the Barents, White, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and in the coastal waters of Labrador and Greenland. *Reports in literature:* Barents Sea (Smitt, 1865, 1879b; Bidenkap, 1897, 1900a; Andersson, 1902; Norman, 1903a; Waters, 1904; Kluge in Deryugin, 1915; Nordgaard, 1923; Kuznetsov, 1941), White Sea (Kluge, 1908a; Kluge in Deryugin, 1928; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Levinsen, 1887), Archipelago of the Canadian Islands (Verrill, 1879a, 1879b), western Greenland (Smitt, 1868c; Kluge, 1908b; Levinsen, 1914; Osburn, 1919), Labrador (Hincks, 1877a; Packard, 1868), Gulf of St. Lawrence (Whiteaves, 1901), and Yan-Maien Island (Lorenz, 1886).

In the boreal region, this species is widely distributed along the eastern coast of the Atlantic Ocean from northern Norway to the Mediterranean Sea (Smitt, 1865; Ortmann, 1894; Levinsen, 1894; Joliet, 1877; Hincks, 1880a; Calvet, 1902; Nordgaard, 1918).

This is an Arctic-boreal species.

3. **Crisia eburneo-denticulata** Smitt (Mss) (Figure 75)

Crisia eburneo-denticulata Smitt (manuscript) in Busk, 1875 : 5, pl. VI.

The zoaria are more of less thin and stretched with branches bent slightly inward. The branches consist of narrow internodes which bend laterally on one or the other side. The number of zooids in the internodes reaches up to 18 to 20, and sometimes even higher; usually they number 11 to 13. The branches originate from the 1st to the 6th zooid, but mostly from the 2nd and 3rd.

Usually, 1 to 2 branches originate from the internode, but in rare cases even 3 are found. The *basis rami* occupy about two-third of the zooids on which they are located. The zooids compactly adjoin each other, except for the terminal, distal part which is bent upward in the form of a tube that has an orifice at the end. Pointed protuberances on the outer upper corner of the tubes or denticles are never found. The gonozooid is seldom situated

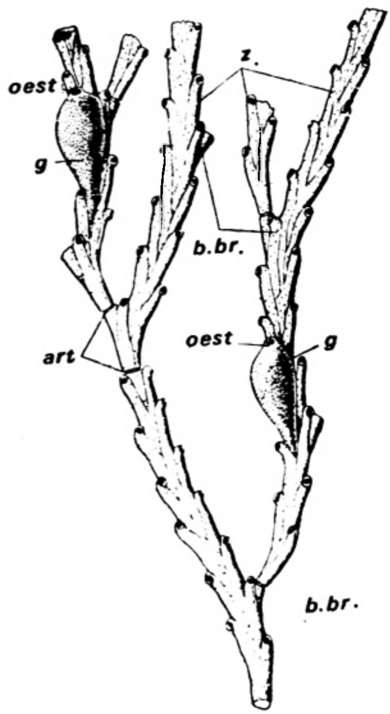


Figure 75. *Crisia eburneo-denticulata* Smitt. Part of a zoarium with sterile and fertile internodes.

high in the internode, occupying the position of the 3rd or 4th zooid, but sometimes it is higher. The gonozooid is well-proportioned and oblong, and attains maximum width and convexity at about one-third its length, taking into account the distal end. The oeciostome is a very short, low tube, broader on the lower side and slightly tapering toward the distal end, with a roundish, somewhat widened orifice that angles upward in a transverse direction. Its distal margin is the upwardly bent distal end of the basal wall of the tube, which adjoins the frontal surface of the zooid placed on the back side. The radicular fibers have dark brown articulations, and do not form a dense intertwining near the base of the zoarium.

The species lives on hydroids, tubes of annelids, Bryozoa, ascidia, shells of mollusks, and stones, at a depth of 7 to 440 m, more often at 40 to 150 m, on a bed of silt and stone or silt and sand, under temperatures ranging from —1.9 to 3.5°C, in a salt concentration of 32.25 to 35‰.

Distribution. The species was found by me in the Barents, White, Kara, Laptev, and East Siberian seas, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1879b; Kluge in Deryugin, 1915), White Sea (Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Kluge, 1929), Laptev Sea (Kluge, 1929), western Greenland (Smitt, 1868c), Gulf of St. Lawrence (Whiteaves, 1901), and Yan-Maien Islands (Lorenz, 1886, Andersson, 1902).

This is an Arctic, circumpolar species.

4. **Crisia constans** Kluge, 1946 (Figure 76)

Crisia constans Kluge, 1946 : 206, t. V, f. 1-2.

The zoarium is frequently branched and grows uniformly in height and width. The branches consist of more or less short, wide, flat, and straight internodes. The branches originate from the 1st to the 3rd zooids, from one or the other side of the internode. They mostly originate from the 1st zooid in the main series and alternate sides in succeeding internodes; however, the lateral branches originate from the 2nd zooid, and all their succeeding branches originate on the same side where the 1st lateral branch begins. The basal branches are short and constitute almost half the length of the zooid they adjoin; their articulation is on a level with the orifice of the zooid. The chitinous articulations of the internodes are jet-black in color, turning pale toward the distal end. The internodes of the axial series consist of 3 to 10 zooids, mostly of 5 and 7; the number of zooids in the lateral rows may reach up to 15 to 18 in an internode. The walls of the zooid are thick, strongly calcified, and closely adjoin each other along their entire length; their distal ends are raised in the form of a short, round tube, often pointed toward the outer upper corner. The fertile internodes are located in the distal parts of the zoarium. The gonozooid occupies a position in the internode from the 1st to the 10th zooid, but more frequently preempts the 5th or 6th. The thin proximal part of the gonozooid, similar to the neighboring zooid's, abruptly widens into an almost spherical distal part; the gonozooid is not located on the frontal side of the internode, but directed laterally from the sides. The gonozooid fuses by its dorsal side with the lateral side of the next upper zooid, or along its entire length, or by only the proximal part of its upper half, in which case its distal part becomes free. The oeciostome is located on the distal end of the gonozooid in the form of a short, wide tube near the margin of the dorsal side; the hind portion of the oeciostome is slightly longer than its front, because of which the oeciostome opens transversely through an oval orifice toward the front and upward.

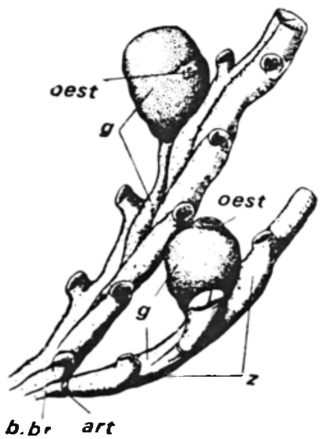


Figure 76. *Crisia constans* Kluge. Part of a zoarium with 2 gonozooids.

The species lives on shells and stones, at a depth varying from 212 to 350 m, on a bed of silt and stone, under temperatures ranging from -0.40 to -1.20°C, in a salt concentration of 34.27 to 34.90°/oo.

Distribution. The species was found by me in the northern part of the Kara Sea.

This is a high Arctic species.

5. **Crisia denticulata** (Lamarck, 1816) (Figure 77)

Crisia denticulata Busk, 1875 : 4 (part.), pl. IV, f. 1-4 ; Hincks, 1880a : 422 (part.), pl. LVI, f. 7; Harmer, 1891: 129, pl. XII, f. 1-3 ; Marcus, 1940 : 47, f. 24.

The zoaria are not large (up to 20 mm in height), are dense, and have very little branching. The branches are thick, wide, and flat. The internodes are more or less long and straight, and consist of 2 to 18, mostly 13 to 14 zooids. The zooids closely adjoin each other along their length, and their ends are sometimes turned upward in the form of short, round tubes; sometimes they open through a roundish orifice with a denticle on the outer upper corner. On each side of the 2nd to the

7th internode, 1 to 3 branches originate. The articulations are brown turning pale toward the end of the branch. The base of the branch is usually short and thick, placed low on the zooid, and wedged by its lower end between the zooid to which it adjoins, and the underlying one.

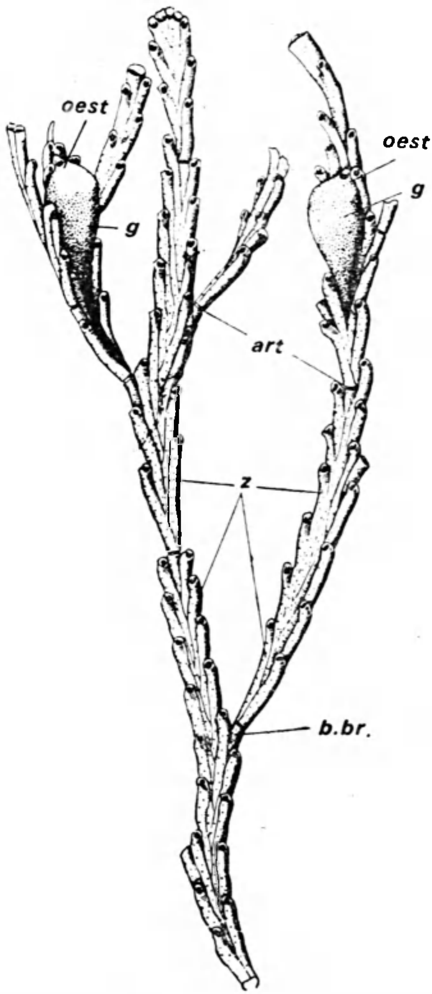


Figure 77. *Crisia denticulata* (Lamarck). Part of a zooid with 2 gonozooids.

The gonozooids are located in the distal internodes of the branches and occupy a position from the 1st to the 10th zooid. The gonozooids are large, have a pyriform shape, are broad and convex in the distal half, but drop sharply at the distal end; they form a slightly raised surface on which is located the barely noticeable oeciostome near the basal margin, in the form of a transversely oval orifice. The basal wall of the latter closely adjoins the wall of the zooid growing from behind.

A large number of rhizooids are located in the proximal part of the zoarium; each consists of many short, thick, basal tubes.

The species lives on algae and hydroids, on a rocky bed, at a depth of 17 to 100 m.

Distribution. This species was found by me in the Arctic region on individual stations in the Kara and Chukotsk seas, and in the waters off western Greenland. *Reports in literature:* Chukotsk Sea (Osburn, 1923), northern coast of North America (Osburn, 1923), boreal region—waters off the western coast of Norway from Finmark to Christianzund (M. Sars, 1851, 1863b; Nordgaard, 1912a, 1918), British Islands (Busk, 1875; Hincks, 1880a), and the vicinity of Bundshol, along the eastern coast of North America (Osburn, 1912).

This is an Arctic-boreal species.

5a. **Crisia denticulata** var. **borgi** Kluge var. n. (Figure 78)

Crisia denticulata Borg, 1926 : 353, f. 60-61; 1930a : 41, f. 16.

The zoaria are spread out and have almost straight branches. The internodes have an average width, with a lateral bend sometimes on one side, sometimes on the other; a maximum bulging corresponds to the point of origin of the new lateral side. The number of zooids in the internode reaches up to 31 without the gonozooid; usually the zooids number 12 to 15. The branches originate from the 2nd to the 15th zooid, but mostly from the 2nd to the 7th. The number of branches originating from the internode may be quite high, up to 6. The articulations between the internodes are dark brown in color, becoming brighter toward the end of the branches. The base of the branch is usually long, equal to the length of the part of the zooid on which it is located, and rests against the underlying zooid by a fairly wide proximal end; but sometimes the base is shorter, and then its distal end does not reach up to the lower margin of the orifice of its own zooid. The zooids closely adjoin each other along their entire length and terminate in a round orifice. A sharp protuberance develops at the outer upper corner, thus forming the so-called denticle, which is not raised above the surface of the internode. The gonozooids are usually located high in the internode, preempting the place of the 7th to the 24th zooid, mostly from the 12th to the 16th. The gonozooids are large, and the extended distal ends of their middle and wider parts are usually raised upward and forward; these ends are generally conically pointed. The oeciostome is a more or less short tube, flattened on the frontal surface of the closely adjoining zooid, but not fused with the surface, and looks like a more or less narrow, transverse slit directed toward the front.

The radicular fibers are few and have dark brown articulations.

The species lives on hydroids, shells, and stones, rarely on algae, at a depth ranging from 3 to 400 m, frequently from 40 to 150 m, on a bed of silt, stone, and shells, under temperatures ranging from —1.8 to 8.5°C.

Distribution. The species was found by me in the Barents, Kara, Laptev and East Siberian seas, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1865, 1879a, 1879b; Nordgaard, 1897, 1900, 1918; Andersson, 1902; Norman, 1903a), White Sea (Gostilovskaya, 1957), western Greenland (Smitt, 1868c; Kluge, 1908b) and Yan-Maien Island (Lorenz, 1886).

This is an Arctic, circumpolar species.

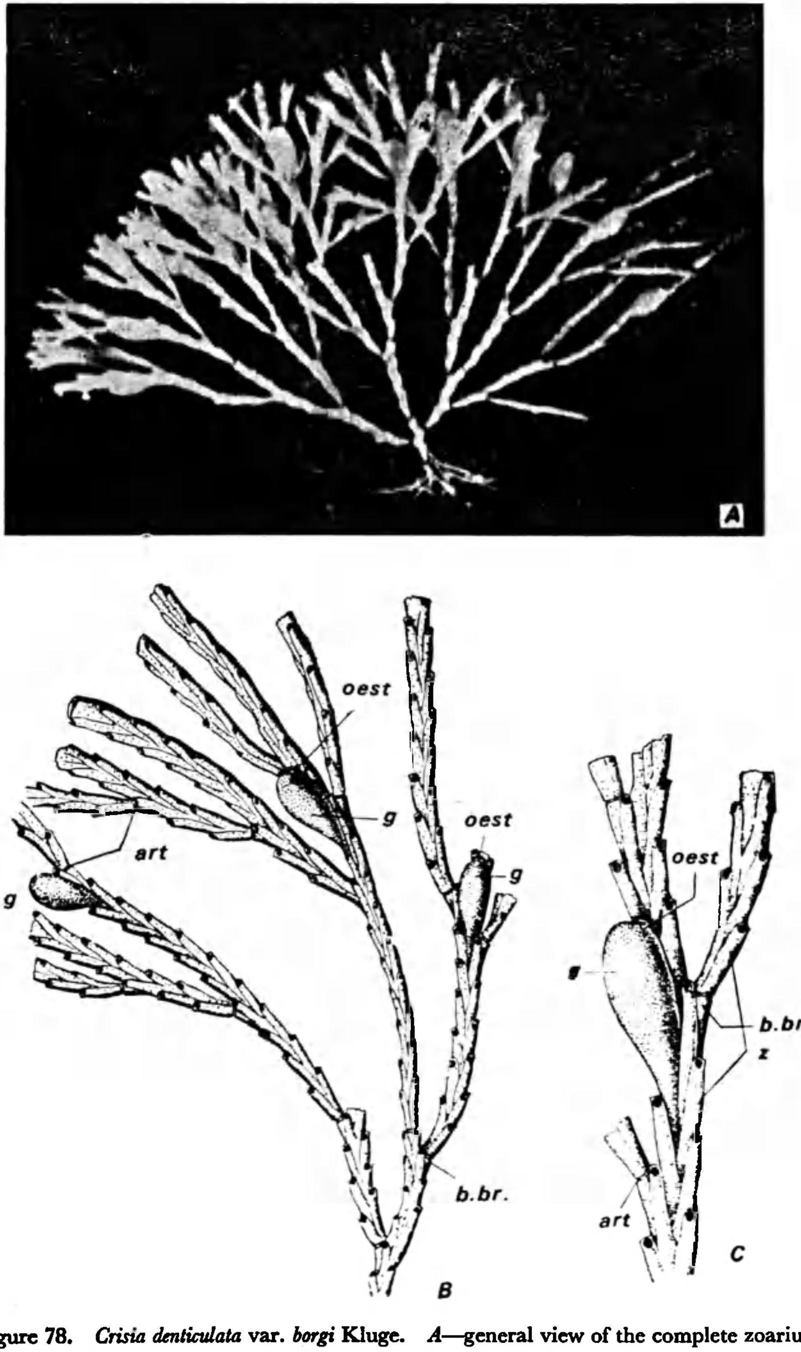


Figure 78. *Crisia denticulata* var. *borgi* Kluge. *A*—general view of the complete zoarium; *B* and *C*—parts of the zoarium showing ramification, form, and arrangement of zooids and gonozooids with the oeciostome.

5b. **Crisia denticulata** var. **arctica** M. Sars, 1863 (Figure 79)

Crisia arctica M. Sars, 1863b : 283 ;? *C. cribraria* Osburn, 1912 : 215, pl. XVIII, f. 7; 1933 : 8, pl. 1, f. 1, 2, 10; pl. 4, f. 2.

The zoaria are large with thick straight branches. The internodes are long, thick, and wide with a lateral bend corresponding to the origin of the branches from one or the other side. The number of zooids in the internode reaches up to 36 (without the gonozooid), but more frequently,

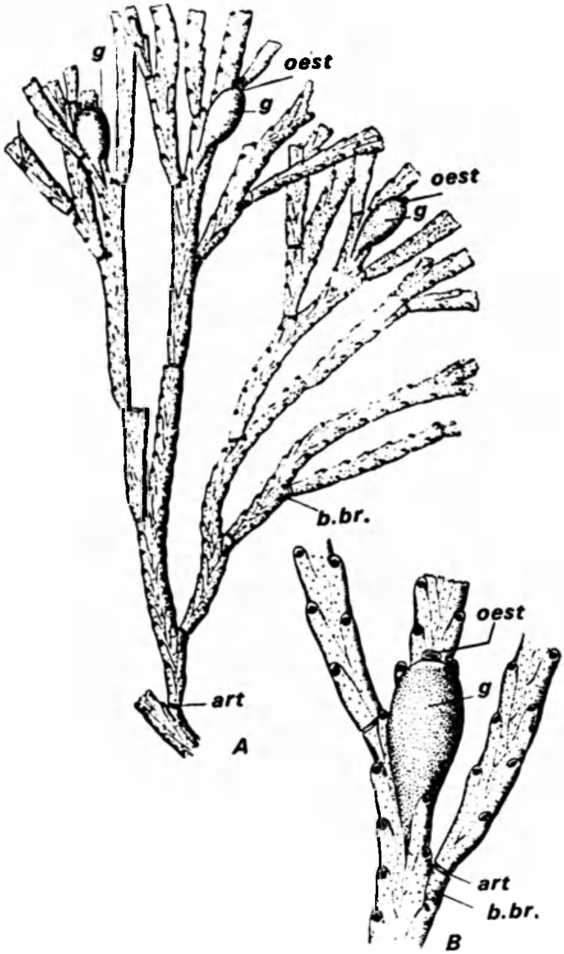


Figure 79. *Crisia denticulata* var. *arctica* M. Sars. *A*—part of a zoarium with sterile and fertile internodes; *B*—gonozooid with oeciostome from the frontal side. III. Suborder *Pachystega*.

20 to 28. The branches originate from the 2nd to the 18th zooid, more frequently from the 6th to the 11th. Usually 2 to 3 branches originate from the internode. The articulations are brown, turning pale toward the distal end. The base of the branch is thick, resting against the underlying zooid by its broad proximal end, with the distal end not reaching up to the lower margin of the orifice of the zooid where it is located. The zooids are thick, closely adjoin each other along their full length, and have a round orifice on their internode over the surface. In the young and growing internodes, a denticle develops on the upper outer corner of the zooid, but it disappears with time.

The gonozooids are placed high in the internodes, from the 12th to the 36th zooid, mostly from the 16th to the 24th. The gonozooids are large and raised, but their distal upper ends are not projected forward. The oeciostome is a short and transversely flattened tube with its distal end turned upward; it opens through an orifice in the form of a broad, transverse, upward-turned slit.

The radicular fibers are few and have short articulations.

The species lives on hydroids, shells, and stones, at depths of 10 to 450 m, more often at 50 to 150 m, on a bed of stone, silt, and sand, and in the majority of cases, under minus temperatures ranging from −1.7 to −1.4°C.

Distribution. The species was found by me in the Barents, Kara, Laptev and Chukotsk seas, and in the waters off western Greenland. *Reports in literature:* western Greenland (Smitt, 1868c; Kluge, 1908b) and the Greenland Sea (Andersson, 1902).

This is an Arctic, circumpolar species.

III. Suborder **Pachystega** Borg, 1926

Pachystega Borg, 1926 : 475 ; 1944a : 175; *Inarticulata*, A, *Erectae* (part.) Busk, 1875 : 10.

The zoarium is free-growing, unjointed, and ramified. The primary zooid is free-growing and not separated from the pro-ancestrula by a chitinous articulation. The body wall is double. As was mentioned earlier, the outer walls of the autozooids in this case are made of a gymnocyst consisting of a cuticle, ectoderm, and mesoderm, and a cryptocyst, i.e., the calcareous layer surrounded by the ectoderm and mesoderm on both sides. There is a slit-like space between the gymnocyst and the cryptocyst called the hypostegial coelemic cavity. Since the gymnocyst originates from the terminal membrane of the primary common bud, it does not encircle the entire zooid, but only its raised distal end, covering the whole zoarium with its body. The calcareous layer of the cryptocyst is formed by ectodermal cells, enclosing it from the inner as well as the outer side. As the secretion of calcium on the inner side possibly lessens where the polypide is situated, thickening is therefore more or less restricted. A greater amount of thickening may and does take place on the outer side of the cryptocyst, which is subject to a process of secondary calcification, because of which the zoarium becomes quite significantly calcified in its older parts. The zoarium of *Pachystega* is fixed to the substrate by its "sub-tentacular disc", which consists of a tube of kenozooids deviating in a radial direction from the place of origin of the primary zooid, i.e., from the pro-ancestrula. The zooids usually open on the frontal side, and rarely, around the cylindrical stem. The gonozooid is the reproductive organ.

Representatives of the family *Horneridae* are found in our waters.

Family **Horneridae** Smitt, 1867

Horneridae Smitt, 1867 : 404; Harmer, 1915 : 147; Borg, 1926 : 304 ; 1944a : 185; *Idmoneidae* Busk, 1875 : 10 (part.); *Horneridae*+*Stegohorneridae* Borg, 1944a : 179.

The zoaria grow freely after branching at one level. The stem and branches are almost round in a cross section. The zooids open on one frontal side of the zoarium. Representatives of this family are distinguished by thick-walled branches caused by the strong development of the cryptocyst on the outer walls of the zooids, or a more complete development of the calcareous layer, separated by (deposited with) the gymnocyst. The gonozooids are situated either on the frontal or the basal side of the zoarium or at the bifurcation between the branches.

Key for Identification of the Species of the Family Horneridae

1 (2). A continuous, finely granulated or smooth, calcareous mass is located on the frontal side of the branches between the zooids; separated from the gymnocyst, the basal side also covered with a similar continuous mass. Gonozooids located on the frontal side of the branches or in the corners of the bifurcation of the branches. . . . . 1. Genus *Stegohornera* Borg (see p. 188).

2 (1). Strips of the calcareous hairs of the cryptocyst stretch on the frontal surface of the branches between the zooids; the basal side consists of strips of the calcareous hairs of the cryptocyst with minute pores between them. Gonozooids located on the basal side of the branches. . . . . 2. Genus *Hornera* Lamouroux (see p. 193).

1. Genus **Stegohornera** Borg, 1944

Hornera Smitt (part.), 1867 : 404 ; *Stegohornera* Borg, 1944a : 5; *Horneroides* Kluge, 1946 : 214.

The branches are irregularly ramose and often situated on one plane. The margins between individual zooids can be very easily distinguished in the distal half of the zoarium. In the proximal part only the free ends of the zooids are visible, surrounded by a white, finely granulated, or completely smooth, calcareous layer, separated by the gymnocyst. The basal side of the branch is also covered with a similar layer. The zooids fuse over a larger part into bundles or rows of 2 to 3 each. The cryptocyst is developed to a variable degeee, sometimes strongly (*St. violacea*), sometimes rather weakly (*St. arctica*). The calcareous layer, separated by the gymnocyst, also varies in its development from a poor (*St. violacea*) to a pronounced one (*St. arctica*). The gonozooids are located on the frontal side of the zoarium near the bifurcation of the branches or at the fork itself. They have a round or oval form, are raised above the surface, and the flat or slightly convex surface of their cryptocyst is covered with numerous pores bordered on the sides by the more or less broad, calcified layer of the gymnocyst.

Genus type: *Hornera violacea* M. Sars, 1863.

1 (4). Branches thick-skinned, white, opaque, covered with a continuous, finely granulated layer, separated by a gymnocyst. A funnel-shaped depression occurs on the frontal surface between the zooids.

2 (3). Gonozooids large, saccate, and located in the axis of the bifurcation of the branches; one half, with the oeciostome, situated on the frontal side, the other half, on the basal side. . . . . 1. *S. violacea* (M. Sars).

3 (2). Gonozooids large, round, and located on the frontal side of the branches . . . . 1a. *S. violacea* var. *proboscina* (Smitt).

4 (1). Branches are less thick-walled, translucent, covered with a continuous, smooth, calcareous layer, and separated by a gymnocyst. Funnel-shaped depression between the zooids almost non-existent. Gonozooids small, oval, and located on the frontal side of the branches . . . . 2. *S. arctica* (Kluge).

1. **Stegohornera violacea** (M. Sars, 1863) (Figure 80)

Hornera violacea forma *violacea* Smitt, 1867 : 404, t. VI, f. 6-9 ; Hincks, 1880a : 469, pl. 67, f. 68, pl. 62, f. 2-3; Borg, 1930a : 50, f. 30-31; *Tubulipora violacea* Jullien and Calvet, 1903 : 115, pl. XIV, f. 8.

The zoaria are not large, are strongly branched, attain 2 cm in height, and are stained a violet color in a live state. The branches are roundish; zooids are unevenly distributed on the branch, sometimes 1, sometimes 2 to 3 together, sometimes fused in bundles or rows; their free ends diverge. The walls of the tubes are covered with minute pores. Because of the slower development of the cryptocyst, the margins of the zooids are easily noticeable over a major portion of the zoarium. In the proximal part of the younger zoaria, and in the older and greater part of the zoarium, the margins of the zooids are covered with a thin, granulated, calcareous layer, separated in the gymnocyst, which gives the appearance of a continuous, even, white, and very finely granulated surface to the frontal, and even more to the basal side; this makes this species markedly

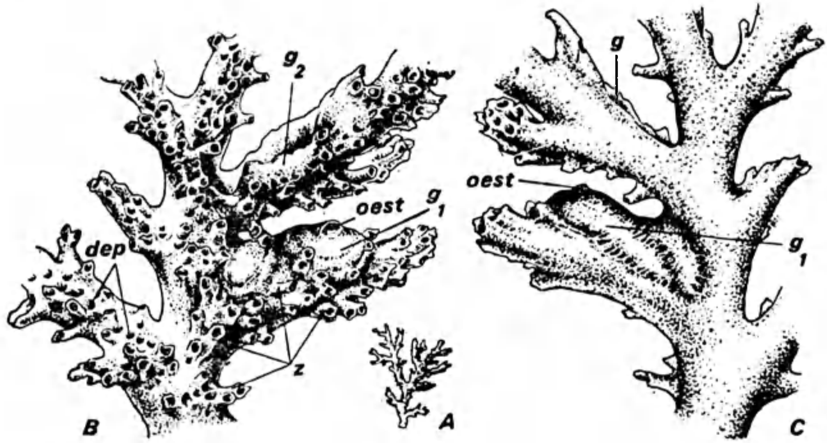


Figure 80. *Stegohornera violacea* (M. Sars). *A*—general view of the zoarium in natural size; *B*—part of a zoarium from the frontal side, with a funnel-shaped (*dep*), a developed (g_1), and an undeveloped (g_2) gonozooid; *C*—the same part from the basal side.

distinct from *Hornera lichenoides*. On the frontal side between the zooids, small funnel-shaped depressions are located in different places; their significance is still not known. The gonozooids are located near the distal margin of the zoarium in the fork between the branches; one-half of the gonozooid, together with the oeciostome, is located on the frontal side; the other half, on the basal side of the zoarium. The gonozooid looks like a saccate structure raised above the surface, and its form and location strongly vary in different preparations; either it is placed like a saddle in the very corner of the bifurcation, or its larger, distal part with the oeciostome, is located on the frontal side of one branch, while the smaller, proximal part is pushed into the axis of the corner on the basal side. Its surface is covered with very small pores; the sides are covered with a thin, white, calcareous, smooth layer, separated by the gymnocyst. The oeciostome is located in the middle of the distal half of the porous surface, in the form of a very short, broad, slanted tube that opens through an oval orifice, and frequently covers the narrow, straight, transverse slit in the wall of the oecium with its own body. The dimensions of the oecium shown here are as follows: length, 2.13 mm; width in the distal half, 1.13 mm; height in the distal, slightly convex half, 0.60 mm; in the proximal part, 0.38 mm; and the orifice of the oeciostome, 0.25×0.17 mm. As can be seen from Figure 80, along with the developed gonozooid in the neighboring bifurcation, another gonozooid has begun to develop; consequently, a number of gonozooids may develop in the zoarium.

The species lives on stones and corals, on a rocky bed, at a depth of 35 to 414 m, under temperatures ranging from 3 to 3.5°C, in a salt concentration of 35.01‰.

Distribution. The species was found by me in the Barents Sea, in the southwestern deep water trough and on the western side of Spitsbergen. *Reports in literature:* Barents Sea (Smitt, 1867), waters along the western and southern coast of Norway (M. Sars, 1863b; Norman, 1894; Nordgaard, 1897, 1905, 1912a, 1918), Shetland Islands (Norman, 1869), North Sea (Kirchenpauer, 1875), Bay of Biscay and the Mediterranean Sea near the Island of Corsica (Jullien and Calvet, 1903), along the western coast of the Atlantic Ocean in the Gulf of St. Lawrence (Jullien and Calvet, 1903).

The species is boreal and Atlantic, and dwells in deep water.

*1a. **Stegohornera violacea** var. **proboscina** (Smitt, 1867) (Figure 81)

Hornera violacea forma *proboscina* Smitt (part.), 1867 : 404, 466, t. VI, f. 2-5.

The zoaria are not large, are strongly branched, and attain up to 1.5 cm in height. The branches are roundish. The stem is thicker near the base but soon divides into 3 or 4 thick branches, which continue to divide dichotomously. The zooids are randomly distributed on the branches, singly, or in groups of 2 or 3, or fused together in still longer rows or bundles. Because of the slow development of the cryptocyst, the margins of the zooids are observable over a major portion of the zoarium, but in all adult zoaria they are covered with a finely granulated, calcareous layer, separated by the gymnocyst, which gives the zoarium the appearance of having a continuous, even, white, and finely granulated surface.

On the frontal side, here and there between the zooids, are located small funnel-shaped depressions similar to those of *St. violacea.* The gonozooid, placed low in the zoarium near the 1st branching of the main stem, is

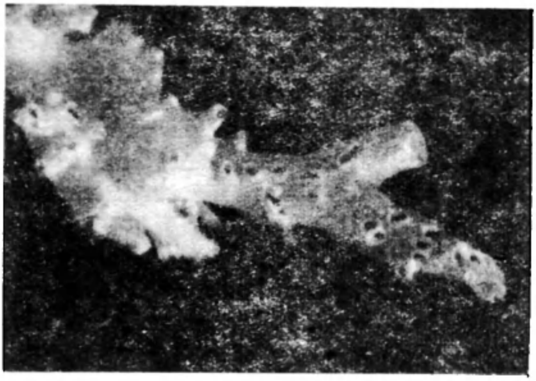


Figure 81. *Stegohornera violacea* var. *proboscina* (Smitt). Part of a zoarium with gonozooid.

located on the frontal side of the branch near its base. The gonozooid is almost round (1.13 × 1.00 mm), tall (0.50 mm), and surrounded by single or double zooids. Its surface is convex but appears to be irregularly roundish (0.95 × 0.83 mm); it is a flattened cryptocyst covered with numerous minute pores. The oeciostome is located in the middle of this surface in the form of a very short, broad, slanted tube opening through an oval orifice. The gonozooid is covered with a broad (0.38 mm) strip of the smooth, white, calcareous layer, and separated by the gymnocyst. Thus this species is close to *Stegohornera violacea* in the structure of the zoarium, but in the location and structure of the gonozooid, it differs from the latter and is closer to *S. arctica* Kluge.

This species lives on the coral polipary of *Oculina* at a depth of 500 to 750 m.

Distribution. Reports in literature: Atlantic Ocean "off Norway" (Smitt, 1867).

2. **Stegohornera arctica** (Kluge, 1946) (Figure 82)

Horneroides arctica Kluge, 1946 : 214, t. V, f. 3-4; *Hornera violacea* forma *proboscina* Smitt (part.), 1879a: 15.

The zoaria are small, attaining a height of 1½ cm, free-growing, and irregularly branched. The branches, sometimes quite thin, sometimes thick, consist of zooids grouped in bundles with their free ends directed toward the frontal side. The branches often lie in one plane, but sometimes, because of an irregular ramification, they lie on different planes. Individual zooids in the terminal parts of the branches can be clearly seen over a large section, but as the distance increases from the ends, the branches acquire the appearance of roundish stems covered with a translucent, smooth, calcareous layer, appearing dull white in color. This is the result of small deposits of the cryptocyst in the depressions between the raised surfaces of the tubes of the neighboring zooids, and these surfaces being covered by the even, translucent, smooth, calcareous layer of the gymnocyst. On the frontal surface of the zoarium, one can see funnel-shaped depressions which are characteristic of *S. violacea*. In the present species, the calcareous layer deposited in the gymnocyst, is generally more strongly developed and thus more easily observed in the axis of the bifurcations between the branches where a fairly thick, translucent layer of calcium is deposited. That this layer is not the cryptocyst, can be easily seen by the fact that when foreign matter falls on the zoarium, mostly pieces of *Crisia*, the latter is very rapidly enveloped by the gymnocyst with a fairly thick, translucent, calcareous layer. Sometimes, possibly under the influence of external irritations, the gymnocyst is highly outgrown, forming large, calcareous plates with a wavy, pectinate margin from the sides or on the basal side. The gonozooids are located in the upper parts of the zoarium, on the frontal side, near the bifurcation of the branches. They are not large in size, have an oval shape (length 0.63 mm, width 0.25 mm), and are raised above the surface of the zoarium (height of the gonozooid, 0.13 mm); the slightly convex surface of their cryptocyst is covered with dense pores. From the sides, the cryptocyst of the gonozooid is bordered with a more or less broad (equal to the height of the gonozooid), calcified layer of the gymnocyst, a continuation of the general cover of the branch. The oeciostome, in the form of a short, cylindrical tube, is located almost in the middle of the frontal side. The bottom of the tube-like oeciostome leads to the cavity of the gonozooid, and the outer side opens through a round or oval orifice.

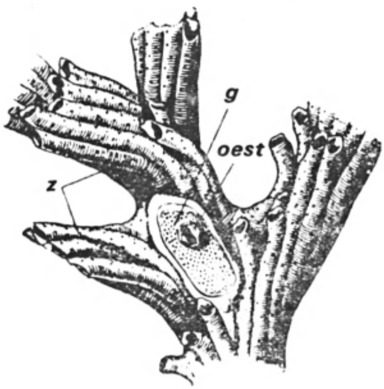


Figure 82. *Stegohornera arctica* (Kluge). Part of a zoarium with gonozooid from the frontal side. Kara Sea.

The species lives on Bryozoa and small stones, at a depth from 43 to 530 m, often from 100 to 150 m, on a bed of silt and stone, under temperatures ranging from -1.11 to $-1.96°C$, in a salt concentration of 34.60 to 34.83‰.

Distribution. The species was found by me in the Barents, Kara, and East Siberian seas. *Reports in literature:* Kara Sea (Smitt, 1879a).

This is a high Arctic species.

2. Genus **Hornera** Lamouroux, 1821

Hornera Lamouroux, 1821 : 41; Hincks, 1880a : 467.

The branches are dichotomously branched, but for the most part, located in one plane. In young zoaria, at the extreme end of the branches, the margins of individual zooids are observable over a short distance, but in more mature zoaria, the margins between the individual zooids on the outer side are not distinct because of the strong development of the cryptocyst between them, in the form of more or less broad strips which consist of individual calcareous hairs and pores. The zooids open on the frontal side of the branches; their short, free ends are barely raised above the surface of the branch, and are located singly, either in a checkered pattern, or in transverse rows.

The basal side of the branches consists of individual calcareous hairs stretched in the direction of the branches, with orifices or pores between them. The gonozooids, or more accurately, their middle wider parts in the form of an oval sac, are located on the basal side of the branches; their cryptocyst consists of radially extended rebra with depressions between them.

Genus type: *Hornera frondiculata* Lamouroux, 1821.

Hornera lichenoides (Linnaeus, 1758) (Figure 83)

Hornera lichenoides Smitt, 1867: 404; t. VI, f. 10, t. VII, f. 1-4; Hincks, 1880a: 468, pl. 67, f. 1-5; Borg, 1930a : 49, f. 28-29, *et auctt.*

The zoaria are strong, strongly branched, and attain a height up to 5 to 6 cm. The branches divide dichotomously and are frequently placed on one plane; however, they are also found to occur on different planes. The zooids are short, and their orifices are very slightly raised on the frontal surface of the branches; they are located singly, either in a checkered pattern, or in almost transverse rows with 3 to 4 to 5 zooids in each row. Near the end of the branches, individual zooids are usually well marked and closely adjoin each other; their short, distal ends rise upward and open through a round orifice; on the sides of the frontal surface, the free distal ends of the zooids are slightly longer and obliquely cut, as a result of which the orifices acquire an oval form and the margin, directed upward and toward the end of the branch, is often extended as if in the form of a denticle. The development of the cryptocyst is strengthened as the distance increases from the end, initially in the

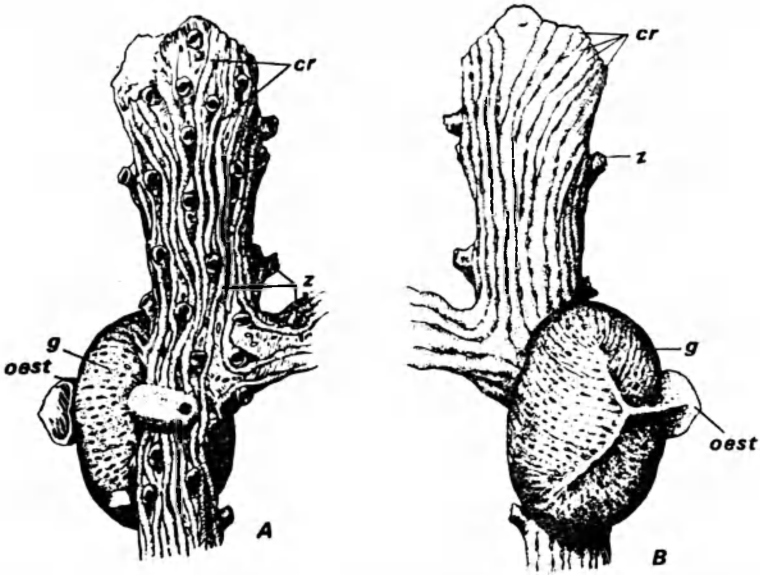


Figure 83. *Hornera lichenoides* (L.). Distal part of a branch with gonozooid. *A*—from the frontal side; *B*—from the basal side.

form of individual hairs on the tubes of zooids, which later fuse into wavy strips stretching in the direction of the long axis of the stem. The thickness of the cryptocyst increases at such a fast rate that soon the margins between the zooids completely disappear, and the frontal surface is a striped, calcareous mass in which the orifice of the zooids is only slightly raised above the surface. Initially, depressions are located between the individual hairs, inside which one or more pores of the zooidal walls pass, but together with the growth of the zoarium, the depressions gradually narrow down to the size of the pores passing through them, and become, as it were, their continuation. On the basal side of the branches, rows of calcareous granules develop first; soon these fuse into calcareous rebra which join together in more or less wide strips, between which the pores or orifices of the zooidal walls (initially located between the depressions) pass.

The gonozooids are often located in the terminal parts of the branches, and their middle, wider part is located on the basal side of the latter. The gonozooid is a strongly calcified oval sac with a clearly expressed, oblong, middle section on the surface, from which thin rebra, with pores between them, spread toward the margins. Usually in the middle, from the sides, and sometimes from the top, the gonozooids open through the oeciostome in the form of a short, thick, round, or oval, slightly bent tube, with a round or oval orifice which is often slightly broader at the tip. From the middle of the longitudinal pecten, a shorter pecten usually originates in the direction of the oeciostome. The proximal part of the gonozooid, initially having the appearance of an ordinary zooid, acquires the form of a slightly bulging, broad tube, almost at the level of the oeciostome or slightly above it; the tube advances toward the longitudinal axis of the branch in the direction of the gonozooid. This tube covers the orifice of the fertile zooid by its proximal end and, gradually widening, proceeds toward the lower side of the broader part of the gonozooid; at the level of the oeciostome, it opens through an oval orifice into the cavity of the gonozooid.

The species lives on stones or hard rocky ground, at depths from 3 to 1,000 m, often from 100 to 200 m, under temperatures ranging from 1.6 to 6°C, in a salt concentration of 31.44 to 35.00‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, and East Siberian seas, and in the waters off eastern Greenland. *Reports in literature:* Barents Sea (Danielssen, 1861; Smitt, 1867, 1879a, 1879b; Vigelius, 1881-82; Bidenkap, 1897, 1900a, 1900b; Nordgaard, 1800, 1905, 1907b; Andersson, 1902; Norman, 1903a, Waters, 1904; Grieg, 1925), Kara Sea (Smitt, 1879a; Nordgaard, 1912b), Laptev Sea (Kluge, 1929), waters of western Greenland (Smitt, 1868c; Norman, 1906; Levinsen, 1914), Gulf of St. Lawrence (Whiteaves, 1901), eastern Greenland (Kirchenpauer, 1874; Andersson, 1902; Nordgaard, 1907a), Yan-Maien Island (Lorenz, 1886), toward the east and southeast from Iceland (Nordgaard, 1907b), western and southern coast of Norway (M. Sars, 1851; Smitt, 1867; Norman, 1894; Nordgaard, 1896, 1900, 1905, 1912a, 1918), western coast of Sweden (Smitt, 1867), and the Shetland and Hebrides Islands (Hincks, 1880a).

This is an Arctic-boreal, Atlantic species.

IV. Suborder **Calyptrostega** Borg, 1926

Rectangulata (part.) Waters, 1887 : 337; *Calyptrostega* Borg, 1926 : 475; 1944a : 211.

The zoarium is prostrate and verrucose; the basal wall is simple, and the frontal one is double, consisting of the gymnocyst and the cryptocyst. The alveoli are located between the zooids and restricted by calcareous walls. The primary zooid is prostrate over the surface, and not separated from the pro-ancestrula by a chitinous articulation. The vestibular sphincter is absent. The brood chamber is zoarial, originating from the dissolution of the walls of the alveoli, and surrounds the fertile zooid in which the polypide degenerates only after the sex products mature.

The zoarium, in the beginning of its growth, is a funnel-shaped common bud which, along with the formation of zooids in it, gradually broadens, until the wall of the funnel no longer comes in contact with the substrate around the original pro-ancestrula. The wall of the funnel, overgrowing the substrate, forms the foundation on which a zoarium grows, and is called the basal plate. Its distal margin is surrounded by undifferentiated tissue in which the calcareous septa are formed, and with their help new parts are separated, giving rise to zooids. Since the zooids develop along the margins of the zoarium in a manner specific for each species, in the center of the zoarium and between the zooids or rows of zooids, a free space remains in which the calcareous septa develop and give rise to the alveoli. During the development of the fertile zooids of the sex products, the walls of many alveoli are dissolved and in their place a brood chamber develops, which includes the gradually overgrowing membranous sac from the fertile zooid and the developing embryos in it. Thus, the whole zoarium can be looked upon as a strongly overgrown, common bud, the terminal membrance of which, i.e., the gymnocyst, covers the entire zoarium, and all the calcareous parts under it are covered with the ectoderm and the mesoderm, forming the cryptocyst. As in the case of *Pachystega,* a secondary calcification may also take place in the form of pectens or spines at the outer walls of the zooids, and new alveoli appear above the existing alveoli.

Family **Lichenoporidae** Smitt, 1867

Lichenoporidae Smitt, 1867 : 405; *Discoporellidae* Busk, 1875 : 30.

The zoaria are discoid, verrucose, simple or compound, prostrate or partially free-growing. The zooids are tubular, erect or slanted, either arranged in a checkered pattern, or in regular or irregular, radial rows, originating from the free central surface; the surface of the latter and the intervals between the rows is alveolar or porous.

Genus **Lichenopora** Defrance, 1823

Lichenopora (part.) Defrance, 1823 : 256; Hincks, 1880a : 471; Harmer, 1915 : 153; Borg, 1926 : 184; 1944a : 235; *Discoporella* Busk, 1859 : 115; 1875 : 30; Smitt, 1867 : 405.

Compound zoaria are formed by regenerative budding. The zooids are in the form of round or oval, erect or slanted tubes, with or without rebra which originate from the central free surface toward the margins of the zoarium, either in a checkered pattern, or in a radial direction. The margins of the orifices of the zooids may be stretched into one or more sharp spines. Inside the rows, the zooids are either separate, or contact each other. The zooids touching each other are arranged in one or several rows. The central surface and the intervals between the zooids, or rows of zooids, are full of open or closed, thin-walled, multifaceted, or thick-skinned alveoli, which have a round orifice in the middle. In fertile zoaria, the alveoli encircling the fertile zooids, are closed by thin, calcareous, porous plates, the lateral walls of which dissolve to give rise to the zoarial brood chamber, that opens through the orifices in the form of tubes which structurally vary in different species.

Genus type: *Lichenopora turbinata* Defrance, 1823: 139.

1 (8). Alveoli thin-skinned, multifaceted, open or closed; brood chambers fuse into one common cavity occupying the central part of the zoarium (their number determined by the number of orifices in the common cavity).

2 (3). Zooids separate and arranged in a checkered pattern, or in short rows........................1. *L. verrucaria* Fabricius.

3 (2). Zooids located in radial rows.

4 (5). Rows straight, numerous, and arranged in a strictly radial manner..........................4. *L. radiata* (Audouin).

5 (4). Rows not straight, arranged in an irregular radial pattern.

6 (7). Zooids appear as rows of fused oval tubes; along their frontal surface, a more or less sharp section stretches, continuing up to the margins of the orifice of the zooid in the form of a sharp spine. Zoaria simple or compound.............. ....2. *L. multicentra* Kluge.

7 (6). Zooids appear as individual or thin-walled tubes which fuse together in rows, and open on the upper side through an oval orifice with an even margin............3. *L. sibirica* Kluge.

8 (1). Alveoli, thick-walled, open or closed, have a round orifice; brood chambers either separate or fused into a common cavity.

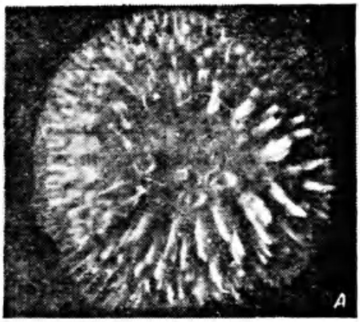
9 (10). Alveoli multifaceted with a round orifice in the middle; brood chambers are markedly separate and covered with a continuous, minutely porous, vesicular, calcareous layer. Zoaria simple or compound.....................5. *L. hispida* (Fleming).

10 (9). Alveoli remain open and have a round orifice which varies in size; their walls are not multifaceted; brood chambers are not covered with a continuous, minutely porous, calcareous layer..........................6. *L. crassiuscula* (Smitt).

1. **Lichenopora verrucaria** (Fabricius, 1780) (Figure 84)

Discoporella verrucaria Smitt, 1867 : 405, t. X, f. 6-8; t. XI, f. 1-6; *Lichenopora verrucaria* Hincks, 1880a : 478, pl. 64, f. 4-5; Borg, 1930a : 52, f. 33; 1944a : 218, *et auctt.*

The zoaria are prostrate, single, round or oval, convex or verrucose. The zooids are separate and located in a checkered pattern; they spread out from the central surface in the form of round tubes, almost in a vertical manner, and approaching the margins of the zoarium, become more and more slanted and short, before fusing with the marginal budding plate on the border. The latter encloses the zoarium like a periople. The walls of the zooids sometimes have rebra, and the upper margins of their oval orifices often stretch into a pointed spine.



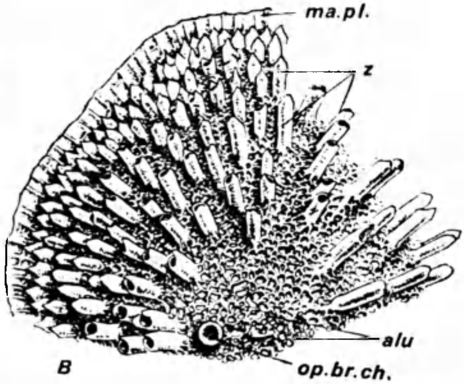


Figure 84. *Lichenopora verrucaria* (Fabricius). *A*—complete zoarium from the frontal side. Barents Sea. *B*—part of a zoarium from the frontal side. Polar basin.

The central surface and the interstices between the zooids are filled in with thin-walled, irregularly multifaceted alveoli in the young (sterile) zoaria; in sexually mature (fertile) zoaria whose developed fertile zooids surround their alveoli, the same are closed with thin, calcareous, porous plates, and their lateral walls dissolve; it is here that the zoarial brood chamber in which the larvae grow, develops. As the number of fertile zooids increases, a further dissolution of their surrounding alveoli takes place and new brood chambers are formed, which unite into one common, central brood chamber; since each brood chamber opens by an orifice raised above the surface of the zoarium in the form of a fairly large, short tube with a broad funnel at the end, their number provides a basis for judging the number of brood chambers fused together. On the tops of the already closed, more mature alveoli, such as the sterile ones and those fused into the brood chamber, small, secondary alveoli form, and tertiary alveoli often develop on the secondary.

The species lives mostly on laminaria and hydroids, at a depth of 0 to 700 m, on a bed of stone, or silt and stone, or silt and sand, under temperatures ranging from —2.1 to 5.2°C, in a salt concentration of 30.81 to 34.83‰.

Distribution. The species was found by me in the Barents, White, Kara, Laptev, East Siberian, Chukotsk, and Okhotsk seas, and in the waters off western Greenland and Labrador. *Reports in literature:* Barents Sea (Smitt, 1867, 1879a, 1879b; Urban, 1880; Ridley, 1881; Vigelius, 1881-82; Nordgaard, 1897, 1900, 1907a, 1923; Bidenkap, 1897, 1900a; Andersson, 1902; Waters, 1904; Kluge, 1906), White Sea (Bidenkap, 1900a; Kluge, 1908a; Kluge in Deryugin, 1928; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Levinsen, 1887; Kluge, 1929), Laptev Sea, East Siberian Sea, and Chukotsk Sea (Kluge, 1929), northern coast of North America and the Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1923, 1936), western Greenland (Smitt, 1868c; Hincks, 1877a; Hennig, 1896; Vanhöffen, 1897; Norman, 1906; Kluge, 1908b; Levinsen, 1914; Osburn, 1919, 1936), Labrador (Packard, 1863, 1866-69; Hincks, 1877a), Gulf of St. Lawrence (Whiteaves, 1901), eastern Greenland (Kirchenpauer, 1874; Levinsen, 1916), Yan-Maien Island (Lorenz, 1886), northern Norway (Nordgaard, 1897, 1918), Skaggerack and Kattegat (Smitt, 1867; Levinsen, 1894; Marcus, 1940), North Sea (Ortmann, 1894; Borg, 1930a), Great Britain (Hincks, 1880a), ?Mediterranean Sea (Waters, 1879; Calvet, 1902), the western coast of the Atlantic Ocean from the Bay of Fundi to Cape Cod (Osburn, 1912, 1933), Japanese Sea (Sakakura, 1935), western coastal waters of North America from Queen Charlotte Islands to Vancouver Island (Hincks, 1884; O'Donoghue, 1923, 1926) and California (Robertson, 1908).

This is an Arctic-boreal, circumpolar species.

2. **Lichenopora multicentra** Kluge, 1955 (Figure 85)

Lichenopora multicentra Kluge, 1955a : 71, f. 12-13.

The zoaria are prostrate, more or less large, attaining up to 8 mm in a cross section, round or oval, and solitary or compound; they consist of many daughter zoaria originating as a result of a lateral regenerative budding. The zooids look like fused oval tubes which spread from the center in radial rows. A more or less sharp pecten stretches along the middle of the central (frontal) side of the zooidal wall, which acquires the form of a pointed spine near the upper margin of the orifice of the zooid. The central surface and the interstices between the rows of zooids are filled in young zoaria with thin-walled, open, multifaceted alveoli; in sexually mature zoaria, as the fertile zooids develop, three activities occur simultaneously; their surrounding alveoli are closed by a thin, calcareous, porous plate; their lateral walls dissolve; and zoarial brood

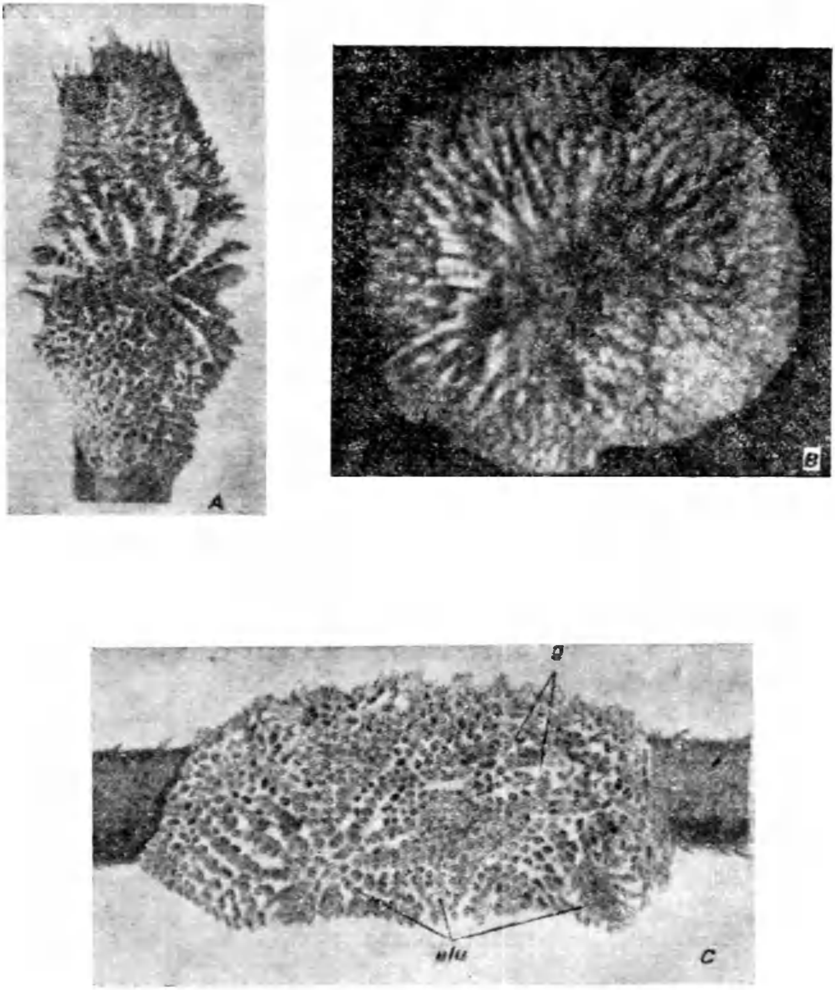


Figure 85. *Lichenopora multicentra* Kluge. *A* and *B*—solitary zoarium from the frontal side; *C*—compound zoarium. Laptev Sea.

chambers form. In solitary zoaria, 4 to 5 brood chambers were found to fuse together into one common, central, zoarial brood chamber with 4 to 5 exhalant orifices in the form of large, round tubes on the upper side, ending in a broad funnel (in compound zoaria, exhalant orifices were found in individual central surfaces). Thus, this species has the same method of formation for compound zoaria as was observed in *L. hispida:* daughter zoaria formed by a lateral regenerative process in the budding zone of the maternal zoarium, and attached to the substrate with their sides adjoining the maternal zoarium. The size of the zoarium ranges from

6×9 mm to 8×9 mm. The height of the zooids near the center is 0.38 to 0.50 mm. The dimensions of the orifices of the zooids are 0.08×0.10 mm. The dimensions of the outer orifice of the brood chamber are 0.15 to 0.23 mm.

The species lives on laminaria and stalks of pantapods at a depth of 38 to 51 m, on silty ground.

Distribution. The species was found by me in the Laptev Sea between the Taymyr Peninsula and Kotelnyy Island, and still higher than the latter.

The species is Arctic.

3. **Lichenopora sibirica** Kluge, 1955 (Figure 86)

Lichenopora sibirica Kluge, 1955a : 72, fig. 14.

The zoaria are small (5 mm in diameter) and partly prostrate and simple. The zooids are in the form of short, thin-walled, oval tubes, slanted on the side of the zoarial margin, and located in more or less regular

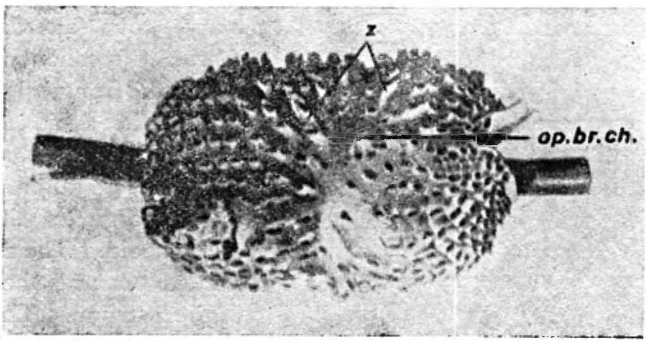


Figure 86. *Lichenopora sibirica* Kluge. Complete zoarium from the frontal side. Laptev Sea.

radial rows, starting almost from the very center of the zoarium. The zooids are either separated or touch each other in rows which open upward through an oval orifice that has an even margin. The small middle surface of the zoarium, and the interstices between the rows of zooids, are filled in with open, thin-walled, irregularly multifaceted alveoli in the sterile zoaria; in the fertile zoaria, the alveoli are closed with a thin, five-pored, slightly bulging, calcareous layer. The brood chamber opens through an orifice in the form of an oval tube which adjoins the zooid near the central surface, and is bent almost at a right angle; broadening toward the end, it opens through a broad, oval orifice directed obliquely to the side of the margin of the zoarium. The dimensions of the zoarium are 4×6 mm. The height of the zooids near the center is 0.15 mm. The dimensions of the zooidal orifice are 0.06×0.10 mm. The dimension of the outer orifice of the brood chamber is 0.15 mm.

The species lives on hydroids, at a depth of 51 m, on a bed of silt.

Distribution. The species was found by me in the Laptev Sea, on the northern side of the delta of the Lena River.

The species is Arctic.

4. **Lichenopora radiata** (Audouin, 1828) (Figure 87)

Discoporella radiata Busk, 1875 : 32, pl. XXXIV, f. 3; *Lichenopora radiata* Hincks, 1880a : 476, pl. 68, f. 9-10.

The zoaria are prostrate, simple, and round, attaining up to 8 mm in diameter. Numerous, straight, single rows of oval zooids fuse and spread from the depressions of the median surface of the zoarium in a strictly radial order. Longer (primary) rows alternate with shorter (secondary) rows. Along the frontal side of the wall of the zooids, stretches a slightly noticeable pecten that is a little raised near the upper margin of the orifice of the zooid. The zooids are slanted toward the margin of the zoarium. The central surface is filled with multifaceted, thin-walled alveoli, and the interstices between the radial rows of the zooids are filled with 1, rarely 2, rows of rectangular, thin-walled alveoli. As the fertile zooids develop, the alveoli surrounding them are covered with thin, calcareous, porous plates, their lateral sides dissolve, and the zoarial brood chambers form, which open through orifices in the form of straight, short tubes slightly broadened near the upper margin of the orifice. There may be several orifices.

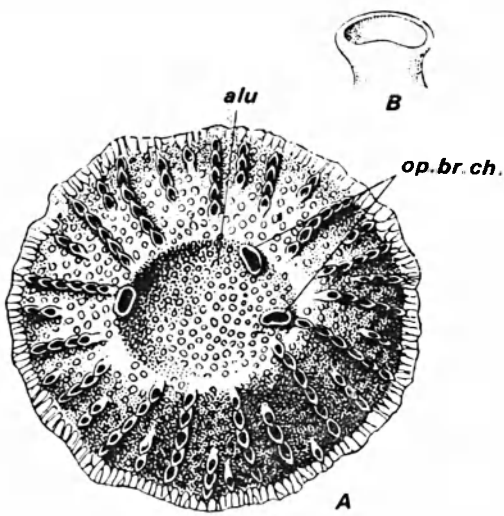


Figure 87. *Lichenopora radiata* (Audouin). *A*—fertile zoarium from frontal side; *B*—orifice of brood chamber (from Hincks, 1880a).

The species lives on laminaria and shells, at a depth of 53 m, on a bed of silty sand, at a temperature of 4.78°C, in a salt concentration of 31.80‰.

Distribution. The species was found by me in the Chukotsk Sea, in the southeastern part of the open sea. *Reports in literature:* Great Britain (Hincks, 1880a), Bay of Biscay (Jullien, 1903), and the Mediterranean Sea (Waters, 1879).

This is a boreal species.

5. **Lichenopora hispida** (Fleming, 1828) (Figure 88)

Discoporella hispida Smitt, 1867 : 406, t. XI, f. 10-12; *Lichenopora hispida* Hincks, 1880a : 473, pl. 68, f. 1-8; Borg, 1930a : 51 (part.); *et auctt.; Disporella hispida* Borg, 1944a : 230 (part.).

The zoaria are prostrate or almost prostrate, and often have a broad, marginal, basal plate freely raised on the margins; the solitary or compound, round or irregular form, sometimes attains a large size (up to 10 to 16 mm in diameter). The zooids have the appearance of round, thin-walled, short tubes, almost vertically raised near the center of the zoarium and slanted toward the marginal plate. The latter usually envelops the zoarium in the form of a broad periople, which consists of concentric rings of overgrowth. The walls of the zooids rarely have rebra on them, but sometimes the central (frontal) side of the wall located near the center, is thickened and markedly extended, and terminates even with a mucro;

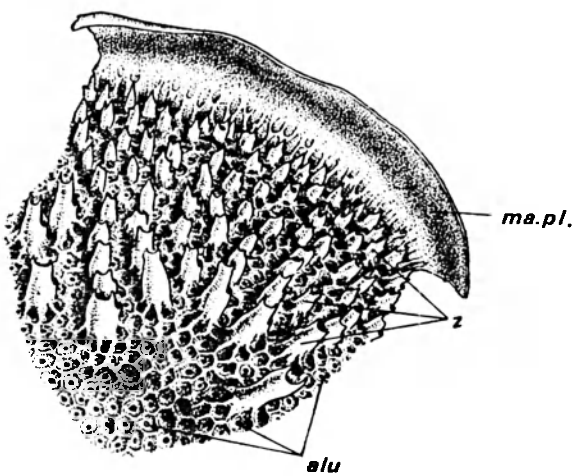


Figure 88. *Lichenopora hispida* (Fleming). Part of a zoarium.

the margins of the upper orifices usually extend into 2 lateral mucrones and, in the zooids near the marginal plate, even into 3 thin mucrones. The zooids are often arranged in a checkered pattern, although sometimes individual radial rows are observed. The central surface and the inter-surface between the zooids, are filled with multifaceted, thick-skinned alveoli in the young, sexually immature zoaria; these alveoli always have a round orifice in the middle. In fertile zoaria, the ceilings over the brood chambers are completely calcified and covered with minute pores. The brood chambers develop in the same manner as in *L. verrucaria*—by the dissolution of the lateral walls of the known number of alveoli—and also have a similar structure; but in contrast to *L. verrucaria*, they are formed in *L. hispida* at a relatively later stage of zoarial development and so frequently do not cover the entire central area, but rather just a part of it, and are distributed between the rows of zooids. They are not large but, depending upon the number of developing fertile zooids, there may be several in a zoarium; these are separated on the outer side over a large part. These cavities open through an orifice in the form of a short, cylindrical tube which is very slightly raised above the surface, mildly broadens upward, and is therefore less prominent.

The species lives primarily on shells and stones, rarely on red algae and hydroids, at a depth of 15 to 366 m, on a bed of stone and shells, under temperatures ranging from −1.6 to 6.3°C, in a normal salt concentration (34.27 to 35‰).

Distribution. The species was found by me in the Barents and Kara seas, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Ridley, 1881; Nordgaard, 1897; Bidenkap, 1900a; Andersson, 1902; Norman, 1903), White Sea (Gostilovskaya, 1957), northern coast of North America (Osburn, 1923), waters off western Greenland (Smitt, 1868c; Levinsen, 1914; Osburn, 1919), Labrador (Packard, 1863, 1866-69), Gulf of St. Lawrence (Whiteaves, 1901), eastern Greenland (Kirchenpauer, 1874; Andersson, 1902), Yan-Maien (Lorenz, 1886), western coast of Norway (M. Sars, 1851; Norman, 1894; Nordgaard, 1906b, 1912a, 1918), Skagerrack and Kattegat (Smitt, 1867; Levinsen, 1894; Marcus, 1940), North Sea (Borg, 1930a), Great Britain (Norman, 1869; Hincks, 1880a), France (Fischer, 1870; Joliet, 1877), Bay of Fundy on the eastern coast of North America (Osburn, 1933), western coastal waters of North America from Queen Charlotte Islands up to Vancouver Island (Hincks, 1884; O'Donoghue, 1923, 1926).

This is an Arctic-boreal species.

6. **Lichenopora crassiuscula** (Smitt, 1867) (Figure 89)

Discoporella crassiuscula Smitt, 1867 : 406, t. XI, f. 7-9.

The zoaria are prostrate, small, round, convex, and surrounded by a narrow, marginal, basal plate. The zooids, roundish and not very tall, are sometimes arranged in a checkered pattern, sometimes in short rows. Along the middle of the central (frontal) side of the wall of zooids, a pointed keel frequently forms which reaches up to the upper orifice, and the lateral walls of the orifice extend into 2 pointed spines. The central surface of the zoarium, and the interstices between the zooids, are filled with thick-skinned alveoli which have nearly circular orifices. The orifices vary in size; those located near the base of the zooids are larger than the central ones, but contrary to the round orifices of *L. hispida,* these are never surrounded by the thick, multifaceted walls of the alveoli, a characteristic of the latter species. With the development

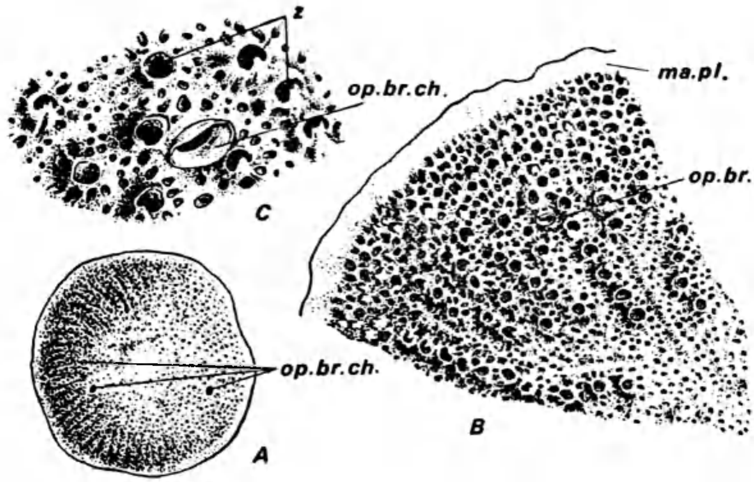


Figure 89. *Lichenopora crassiuscula* Smitt. *A*—general view of a zoarium; *B*—part of a zoarium; *C*—oeciostome. Barents Sea.

of fertile zooids, a new layer of alveoli develops, but the alveoli of the underlying layer do not close; they remain open and, reducing only the orifices, cause several minute orifices to be visible on the bottom of the new alveoli. The alveoli situated near the zooids are larger, and between them, as well as on the central surface, smaller alveoli are located. Owing to the dissolution of the lateral walls of the alveoli surrounding the fertile zooids, small zoarial alveoli form in the cavity. The latter open through a large oval aperture in the form of oval tubes with a more or less wide funnel; one-half of the funnel is usually bent toward the middle, and slightly covers the orifice of the tube. The orifices are located along the margin of the central surface, and their number reaches up to 4.

The species lives on algae and shells, at a depth of 11 to 225 m, on a bed of stone and silt, under temperatures ranging from −1.7 to 3.5°C, in a salt concentration of 32.86 to 35‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, and Chukotsk seas, and in the waters off western Greenland. *Reports in literature:* Archipelago of the Canadian Island (Nordgaard, 1906a), western Greenland (Norman, 1906; Kluge, 1908b; Levinsen, 1914; Osburn, 1919), eastern Greenland (Levinsen, 1916).

This is an Arctic, circumpolar species.

V. Suborder **Heteroporina** Borg, 1933

Cerioporina (part.) Hagenow, 1851 : 36; *Heteroporina* Borg, 1933b : 375; *Cerioporina* Osburn, 1953 : 692.

The zoarium, prostrate or free-growing, consists of a double row of zooids, the larger autozooids, and the smaller kenozooids; the latter surround the former. The autozooids and kenozooids open almost at a right angle to the surface of the zoarium. The double body wall consists of a gymnocyst and a cryptocyst. The primary zooid is prostrate or partly free-growing. The brood chamber is zoarial, and formed by the dissolution of the upper parts of the autozooids and kenozooids, which surround the fertile zooid; it is located under the gymnocyst.

The common bud develops from the pro-ancestrula, and the former is attached to the substrate. With the development of new zooids on the margin all along its periphery, the funnel gradually broadens until the whole of its wall comes in contact with the substrate. The young zoarium then changes its form from funnel-shaped to verrucose, and attaches to the substrate with the primary wall of the funnel which now becomes the plate. The budding zone surrounds the verrucose colony, occupying its periphery, and thus the whole zoarium may be considered a strongly outgrown and complex common bud, covered with a terminal membrane or gymnocyst. Further development of this initial form proceeds along different lines in different groups of this suborder.

Only representatives of the family *Heteroporidae* Waters are found in our waters.

Family **Heteroporidae** Waters, 1880

Heteroporidae Waters, 1880 : 157; Borg, 1933b : 253.

The zoaria are capitate or ramose. The surface of the zoarium is smooth or rough, or uneven with raised portions and depressions, and has 2 types of orifices: the larger, round, or multifaceted autozooids, and the smaller kenozooids. The number of kenozooids may be more or less than the number of autozooids. The brood chamber is zoarial.

Many species of this family were recovered during the excavations of deposits of the cretaceous period.

Key for Identification of the Genera of the Family Heteroporidae

1 (2). Zoarium free-growing, strongly ramified; branches round; surface even and smooth.. ....1. *Heteropora* de Blainville (see below).

2 (1). Zoarium prostrate, overgrowing; surface uniformly grumous.... ....2. *Borgella* Kluge (see p. 209).

1. Genus **Heteropora** de Blainville, 1830

Heteropora de Blainville, 1830 : 382; Borg, 1933b : 283; 1944a : 210.

The zoaria are branched. The surface of the zoarium is smooth or rough. The autozooids or kenozooids may be open, or covered with thin, porous, calcareous plates. The number of kenozooids is greater than the autozooids, and surrounding the latter, separate them.

Genus type: *Heteropora pelliculata* Waters, 1879.

Heteropora pelliculata Waters, 1879 (Figure 90)

Heteropora pelliculata Waters, 1879 : 390, pl. XV, f. 1-4, 7; Borg, 1933b : 285, pl. 3, f. 1-4, pl. 4, f. 1-9, pl. 6, f. 1-2, pl. 7, f. 4-6, Text f. 7-12; non Borg, 1932 : 2, f. 1-2.

The zoaria attain up to 5 to 7 cm in height, and 10 to 12 cm in diameter. Branching is quite frequent and irregular, but near the branchial ends often becomes dichotomous. The zoaria is attached to the hard substrate by its basal sub-tentacular plate, which has a roundish form from which a short, thick stem uprises, often dividing into 3 secondary branches; these divide into tertiary branches, and so on. When the zoarium first forms, the branches reach up to 5 to 7 mm in diameter; later on they become thinner with the ends of the branches being about 2 mm in diameter. The branches rarely anastomose with each other. They have round or oval cross sections. Their surface is smooth with 2 types of orifices, the large and round autozooids, and the smaller, multifaceted kenozooids which surround the former. The latter are proportionately greater in number than the former. The orifices of the autozooids are almost always open, but sometimes they close, particularly in the older parts of the zoarium. The orifices of the kenozooids are everywhere except in the terminal parts of the branches and, sometimes, in the older parts of the zoarium; they are usually closed with thin, porous, calcareous plates—the terminal diaphragm. The orifices of the auto-

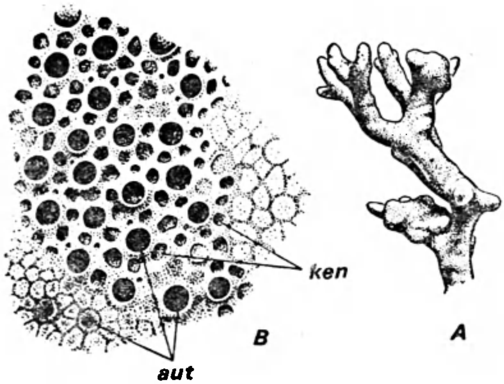


Figure 90. *Heteropora pelliculata* Waters. *A*—branched stem of the zoarium, showing the system of branching and the ends of the branches; *B*—a part of the frontal surface of the zoarium with open and closed autozooids, and kenozooids as well. Kurile Islands, Anama Bay (Shikotan Island).

zooids, surrounded by kenozooids, are not always uniformly arranged on the surface of the branches; often they are collected into groups or bundles of varying size, and usually stretch obliquely on the surface of the stem. The space between the bundles is filled with closed kenozooids forming depressed surfaces in relation to the latter. Because of this, the surface of the branches acquires a beaded (moniliform) appearance. The walls of the zooidal tubes consist of alternate thin and wide layers, perforated with pores, which join the cavities of the neighboring zooids with the thicker and narrower layers devoid of pores.

The calcareous, spiny hoods of the walls, though small in size and few in number, are visible in the cavities of the zooids. A typical feature of the given species is the structure of the ends of some of the branches. In some samples, the apex was not narrowed down as usually happens, but on the contrary, was thicker and appeared to have a roundish or spherically thickened structure; in others, this thickening appeared a little away from the apex of the branch and seemed to be semi-circular or oval, usually on one side of the branch. These bulges, owing to their convex surface, are easily noticeable, but there are instances when they are flattened to a lesser or greater degree, and thus become visible only at the larger widening of the branch near its end. On these thickenings, the kenozooids are covered with terminal diaphragms; the autozooids are also closed in exactly the same manner, although some may be found to be open. At the opening of these thickenings under the surface layer, a cavity is found which was initially formed by the dissolution of the tubes of the kenozooids at the middle parts, which is followed by the dissolution of a few autozooids also. In the cavity thus formed, larvae develop, emerging out of the eggs of the partly dissolved fertile zooid, and perhaps, including some fertile zooids as well. The distal parts of the closed kenozooids and autozooids form, as it were, the lid of the cavity in which, together with the further budding of the primary and secondary embryos and their overgrowth, still further dissolution of the neighboring autozooids takes place, causing the cavity's enlargement. When the maturation of the larvae is completed, the surface layer or the lid of the brood chamber dissolves and the larvae emerge.

The species lives on the tubes of segmented worms, shells of gastropod mollusks, and stones, at a depth of 25 to 67 m.

Distribution. The species was found by me in the Chukotsk (Cape Aiskeip), Bering, Okhotsk, and Japanese seas. *Reports in literature:* Laperuzov Strait (Waters, 1879), and Iturup Island in the middle of the South Kurile Islands (Borg, 1933b).

This is an Arctic-boreal, Pacific species.

2. Genus **Borgella** Kluge, 1955

Borgella Kluge, 1955a : 75; *Borgiola* Osburn, 1953 : 696.

The zoaria, prostrate and overgrowing, with a grumous surface, have more or less evenly located, small, gently sloping tubercles. The orifices of the autozooids and the kenozooids are uniformly distributed all over the surface of the zoarium, independent of the tubercles. The orifices of the autozooids are round and not raised; the kenozooids are smaller, outnumber and surround the latter, and remain separated.

Genus type: *Borgella tumulosa* Kluge.

Borgella tumulosa Kluge, 1955 (Figure 91)

Borgella tumulosa Kluge, 1955a : 75; *Borgiola pustulosa* Osburn, 1953 : 698.

The zoarium, prostrate and overgrowing, is oblong and irregular in form, being thicker in the middle and narrower toward the margins. The length of the zoarium is 65 mm, the width 26 mm, and the height in the thickest part about 10 mm. The surface of the zoarium is grumous,

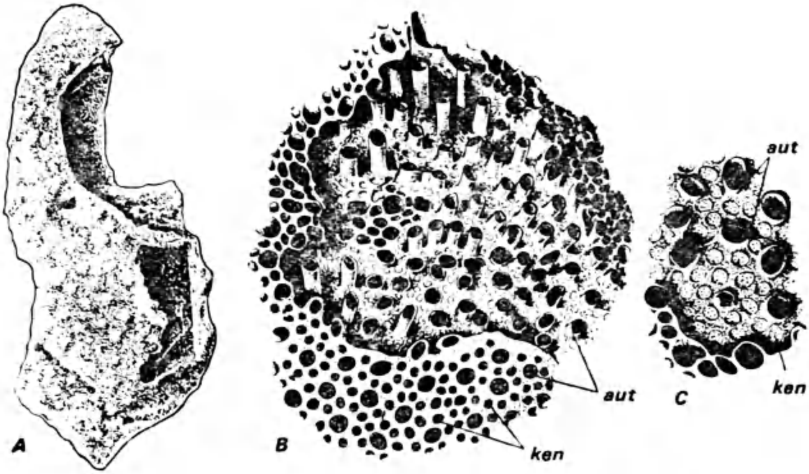


Figure 91. *Borgella tumulosa* Kluge. *A*—part of the zoarium from the frontal surface; *B*—open brood chamber; *C*—bottom of the brood chamber. Bering Strait.

covered with a uniform spread of low and gently sloping tubercles. The orifices of the autozooids and kenozooids are uniformly distributed on the entire surface, i.e., on the tubercles as well as between them. Kenozooids outnumber the autozooids. Each autozooid is surrounded by 6 to 8 kenozooids which, in the majority of cases, are common to the neighboring autozooids, but sometimes every autozooid has its own circle of kenozooids. The orifices of the autozooids are round and almost similar in height (from 0.12 to 1.15 mm in diameter), on the average 0.13 mm, while the orifices of the kenozooids significantly vary in form (ranging from oval to round) and in size (from 0.03 to 0.08 mm, on the average 0.06 mm in diameter). Both of these orifices are open; the margins of the autozooids are more or less even, sometimes forming small, sharp outgrowths with a broad base on any side. Near the middle of the zoarium, but toward one end and close to the surface of the zoaria, 2 open and shallow cavities are visible in which the open, long, thin-walled, round, and white tubes of the autozooids can be seen; between these is located a soft tissue on which the embryos are situated. These cavities are brood chambers. It is difficult to say whether there are 2 such brood chambers or whether they are parts of one large cavity, because the outer surface wall of the zoarium (also the ceiling of the brood chamber) was torn out in this sample and it is quite possible that along with it, a part of the bottom of the common brood chamber was also torn out: 2 surfaces on the bottom of the chamber were observed, which consisted of the proximal parts of the autozooids and kenozooids, separated by a small interstice. In 2 chambers, on removing the soft parts between the tubes of the autozooids, the orifices of the proximal parts encircling their kenozooids, were found to be covered with thin, calcareous plates perforated with pores.

The species lives on stones at a depth of 48 m.

Distribution. The species was found by me in the Chukotsk Sea (in the Bering Strait).

VI. Suborder **Isoporina** Kluge Subordo n[4]

The zoarium is free-growing, capitate, or fungiform. The body wall is double. The zooids open on the upper frontal surface of the zoarium through large orifices of uniform size and hexagonal shape.

Family **Fungellidae** Kluge, 1955

Fungellidae Kluge, 1955a : 74.

The zoaria are free-growing, capitate, or fungiform, simple or ramose, sessile on a short, round, or oval peduncle, and gradually broaden toward the distal end. The zooids open at one level through more or less regular orifices covered with thin, calcareous plates, which are perforated by a large number of minute pores. The lateral wall of the head is smooth and covered with a more or less thin layer of polygonal kenozooids perforated with minute pores.

Genus **Fungella** Hagenow, 1851

Fungella Hagenow, 1851 : 37.

The zoaria, free-growing and capitate, rest on a short peduncle, branch sometimes, and produce buds sometimes from the base. The zoaria consist of closely adjoining, polygonal, ramose, zooidal tubes along their entire length, which open at the upper convex, frontal side of the zoarium through polygonal orifices, which are covered with thin, porous, and calcareous plates. The outer surface of the zoarium is smooth and faceted, more or less striped longitudinally or transversely, and sometimes

[4] The given suborder was isolated by the late G. A. Kluge, but the description was not found in his manuscripts. Therefore, the identification of the suborder and its inclusion in the identification key of the suborders was done during the editing of the manuscript by M. G. Gostilovskaya.

covered with very small pores.

Genus type: *Fungella dujardini* Hagenow, 1851.

All 3 species of the genus, *F. prolifera, F. plicata,* and *F. dujardini,* described by Hagenow, belong to the fossil species discovered in the cretaceous depositions of Maastricht on the left bank of the Maas River. Borg (1933b: 260) has proposed that 2 of the aforementioned species belong to the genus *Fasciculipora,* because they are devoid of kenozooids and the zooids open on the upper frontal surface of the head. The 3rd species, *F. dujardini,* was isolated as a type of the given genus by Gregory (1909: 46), who considered that it was distinguished by the presence of the kenozooids, stood quite close to the genus *Heteropora,* and was characterized only by a simple, clavate form of zoarium. Borg, rightly questioning the correctness of Gregory's view, expressed further doubt as to whether the species *Heteropora claviformis* Waters, investigated by him, could be included in the genus *Fungella.* Considering it impossible to arrange the present species under the genus meant for extinct species, unless absolute similarity could be established between them, Borg suggested a new genus for the *H. claviformis* studied by him, namely, *Neofungella.* But in my opinion, Borg unnecessarily put *H. claviformis,* as related to the genus *Fungella,* first; *H. claviformis* differs by the presence of open orifices on the zooids, not only on the surface of the zoarium, but on the lateral surface as well, while the genus *Fungella* is particularly distinguished by the fact that the zooids open only on the upper frontal side. Borg was inclined to include the first 2 species, discovered by Hagenow, under the genus *Fasciculipora* which, except for its gonozooid, is characterized by zooids that open on the upper side through polygonal orifices of irregular form, and a zoarium whose lateral surface is not covered with kenozooids. The genus *Fungella,* however, is distinguished first in that the orifices of the zooids open on the upper frontal side through more or less regular polygonal orifices, which are covered with simple calcareous plates; second, the lateral surface of the zoarium is covered with a layer of kenozooids that form either a smooth, or a more or less striped (longitudinally and transversely) surface, which is covered in some cases with minute pores; and third, the adult zoaria may sometimes give rise to protuberances—buds near the base which develop into new zoaria. All these features, reported by Hagenow for the genus *Fungella,* are present in the species described by me, and therefore I include this species in the genus *Fungella.*

Fungella dalli Kluge, 1955 (Figure 92)

Fungella dalli Kluge, 1955a : 74.f. 15, The zoarium is capitate. From a small, prostrate, and roundish base, a short stem uprises which, tapered initially, soon starts to broaden gradually, and acquire the form of a funnel. The zoarium consists of closely adjoining polygonal, often hexagonal, tubes of zooids which, because of their ramification, form a gradually widening, capitate structure. The zooids open on the upper frontal surface of the zoarium through large, hexagonal orifices that are covered with thin, calcareous plates, and perforated by a large number of minute pores.

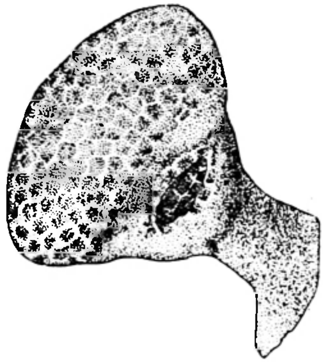


Figure 92. *Fungella dalli* Kluge. Zoaria.

The outer lateral surface of the zoarium is smooth and faceted, and consists of minute, polygonal kenozooids, which are closed with minutely porous, calcareous plates that form a thin outer layer.

II. Order **Ctenostomata** Busk, 1852

Ctenostomata Busk, 1852a : 346; *Halcyonellea* (part.) Ehrenberg, 1839 : t. II.

The zoaria are prostrate, overgrowing or free-growing, simple or ramose, and variable in form; all of them are distinguished by a more or less soft consistency, which results from the absence of calcium in the body wall of their zooids. All are covered with a chitinous layer which may be thick, leathery, or gelatinous, or it may be very thin in the form of a delicate, transparent membrane. In some representatives of the suborder *Paludicellea* Allman, the wall appears to be calcified and, therefore, they appear opaque, but in reality their surface layer is covered with minute, calcified or clay-like particles, although their chitinous layer is not internally saturated with calcium as in the calcified forms. This is a major characteristic of the representatives of the group *Ctenostomata*. A second major characteristic of this group is the absence of a special organ, the so-called collar. Often it can be seen in the preparations, on the incompletely retracted polyps, as though a bundle of bristles were hanging out of the orifice of the zooid in the form of a pecten; from this the whole group received the unsuitable name of ctenostomates. In reality, neither bristles (seta) and, consequently, nor pecten, exist. On close examination under large magnification, the "pecten" appears to be a thin chitinous membrane in the form of a collar, consisting of longitudinal folds, whose thick margins in the folded state give the impression of a pecten. The significance of this organ lies in the tight closure of the orifice of the zooid, when the polypide is retracted into the zooid. This happens in the following manner. In the retracted position of the polypide, the body wall near the margin of the zooidal orifice is plunged inside in the form of a short tube, and the cavity enclosed by it, becomes the so-called vestibule. It has 2 orifices—the upper, outer, and the lower, internal—leading to the underlying cavity, the so-called atrium, in which the tentacles are enclosed in a tentacular sheath. The upper orifice tapers down owing to the action of the circular musculature; the closing of the lower orifice takes place with the help of a circular fold, the diaphragm, in which the circular muscle or the sphincter is also situated. The aforementioned collar rises along the margin of the diaphragm around the orifice from the chitinous membrane. When the collar is retracted in the vestibule, it closes the outer orifice as well as the opening of the atrium. During the projection of the tentacular apparatus, the tentacular sheath also unfolds outwardly, but not being projected up to the end, it forms a narrow, round fold in the region of the orifice—the duplicature—out of which the collar rises, enclosing the proximal, jugular (neck) portion of the polypide. This collar is developed to a different degree in various families.

The next peculiarity in the structure of this group is the complex structure of the alimentary (digestive) apparatus due to the appearance of a new structure in certain families, the masticatory stomach or gizzard. Between the usually widened proximal end of the esophagus (proventricle) and the stomach (ventricle) in some members of *Ctenostomata,* mainly in the family *Vesiculariidae,* an organ develops in the form of a round or oblong structure, the internal part of which consists of more or less high cells, the distal half of which is keratinized and dented, and the cells located in the abanal and anal quadrants are longer, strongly chitinized, and dented, while the cells in both the other quadrants are less high and their free ends appear as chitinized bristles (seta). The gizzard is encircled by strongly developed and circular musculature. This organ varies in its structure in different species and may serve as a good taxonomic index.

Several members of *Ctenostomata* are distinguished by the development of a so-called stolon (*Stolonifera*). From the primary zooids, tubes which have neither polypide nor orifice, develop by budding. Through subsequent budding on the distal end, long tubes (the stolons) form which the membranous septa divide into separate segments or internodes. The autozooids or zooids develop on these by lateral or surface budding. The chitinous walls of the kenozooids are covered from the inside, as in ordinary zooids, with the parietal layer and mesodermal tissue, serving the purpose of feeding and excretion. According to the findings of Joliet (1877), the stolons, together with the zooids place on them, can be broken from the common zoarium under the influence of external or internal factors, and may be carried away to new places by the current where, after adhering to the substrate, they may give rise to new zoaria.

The body form in the members of *Ctenostomata* is generally saccate; in most of them (*Stolonifera, Paludicellea*), it is straight, cylindrical, or fusiform, with the orifice lying on the upper end of the zooid; in *Carnosa,* the zooids are broad and flattened with the orifice located near the distal septum (diaphragm).

The zooids communicate with each other, or with the stolon, aided by the pores of the septa separating them. Of the muscles, mention should be made of the muscular bundles and fibers regulating the projection of the frontal part of the body outward. These include the muscular bundles operating in a direction opposite to the aforementioned circular musculature of the vestibule, and the sphincter of the diaphragm—these are the parieto-vaginal muscular bundles located, in the majority of representatives, in numbers of 4 arranged at 2 levels, and fixed to the wall of the vestibule on one side, and to the body wall on the other side; these are not stretched in a transverse direction, but rather in an oblique one from upside down, because of which, during their retraction, the fore end of the body simultaneous with the broadening of the vestibular cavity, is slightly lowered. At the same time the 4 muscular bundles fixed to the diaphragm on one end, and to the body wall on the other, are also contracted and bud, stretching in a transverse direction; by their contraction, they increase the opening of the orifice of the diaphragm. Because of the reduction of the cavity in the upper part of the body, the cavity fluid is transferred to the lower part of the body, and immediately after this the frontal part of the polypide is pushed out with the tentacles, due to a successive contraction of the parietal muscles located on both sides along the whole body, in the form of rows of transverse fibers.

While in the majority of *Ctenostomata* representatives, the fertilized eggs develop further in the cavity of the wall of the zooids, in some members the egg is released either through the simple orifice formed in the body wall inside the tentacular crown (in *Hypophorella*) (Figure 93, A), or is helped out by the so-called "intertentacular organ" which appears only in sexually mature zooids (*Alcyonidium gelatinosum, A. albidum, Flustrella hispida,* etc., Figure 93, B). This organ is situated between 2 tentacles on the middle line of the anal side and has the appearance of a bottle at the thickened margin; it is internally lined with a ciliated epithelium; its height is up to one-third that of a tentacle. The presence of this organ places the *Ctenostomata* in closer relationship to the simplest forms of *Cheilostomata,* especially with the members of the family *Membraniporidae* (*Electra pilosa, E. reticulum,* and others). One more characteristic links these 2 groups—*Flustrella hispida, Farella* and *Hypohorella* among the *Ctenostomata,* and *Electra pilosa* and *E. crustulenta* among the

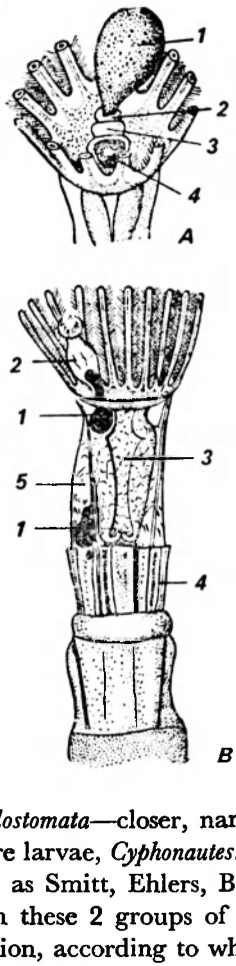


Figure 93. *A*—Hypophorella expansa: *Release of a fertilized egg* (1) *through the orifice* (2) *of the body wall inside the tentacular collar* (3—*nerve ganglion;* 4—*oral orifice*) (*from Prouho,* 1892); *B*—Alcyonidium albidum: *Outstretched part of the zooid* (*polypide*) *showing the release of a fertilized egg* (1) *from the body cavity through the intertentacular organ* (2); 3—*pharynx;* 4—*collar;* 5—*spermatozooids;* 1—*egg in the body cavity* (*from Prouho,* 1892).

Cheilostomata—closer, namely, the presence of a changed form of trochophore larvae, *Cyphonautes.* These and other facts made some investigators such as Smitt, Ehlers, Barrow, and others, accept a still closer link between these 2 groups of Bryozoa. Contrary to the earlier predominant opinion, according to which the group of *Ctenostomata* was considered the progenitor of the *Cheilostomata* group, recently Levinsen, Borg, Silen, and others, consider the *Ctenostomata* group as having originated from the simpler representatives of the *Cheilostomata* group.

Key for Identification of the Suborders of the Order Ctenostomata

1 (2). Zooids joined from all sides directly, or with the help of keno-

zooids, form a continuous or overgrowing, fleshy or leathery layer, or a free-growing, soft, gelatinous, or leathery, simple, or ramified, lobate, or cylindrical zoaria...I. *Carnosa* Gray (see below).

2 (1). Zooids, fused together only near their base, are prostrate or uprising freely, singly, or in bundles, and form thin, prostrate nets, or prostrate or free-growing stems (stolons).

3 (4). Zooids, originating from the common stem or stolon, are divided into internodes by internal septa (diaphragm)..III. *Stolonifera* Ehlers (see p. 253).

4 (3). Zooids originate one from the other with the help of thin, tubular, proximal parts.............II. *Paludicellea* Allman (see p. 247).

I. Suborder **Carnosa** Gray 1841

Carnosa Gray, 1848 : 91, 144; Harmer, 1915 : 35; Borg, 1930a : 97; *Halcyonellea* Smitt, 1867 : 496; Hincks, 1880a : 490; Silen, 1942a : 9.

The zoaria are prostrate, overgrowing or free-growing, simple or ramose, lobate or cylindrical structures. The zoaria develop by the means of distal and lateral budding, and the zooids formed are tightly fused with each other either directly (family *Alcyonidiidae)*, or by the spines on the kenozooids located between them (family *Flustrellidae)*. In both cases the zoarium is one continuous structure and only in rare cases, are the rows of zooids separated. The gizzard is absent.

Key for Identification of the Families of the Suborder Carnosa

1 (2). Zoaria whitish or yellowish-brown in color. Orifice of the zooid round and not raised though located at the end of the raised, round nipples. Chitinous spines absent.......................................I. *Alcyonidiidae* Johnston (see below).

2 (1). Zoaria yellowish-brown in color. Orifice of the zooid bilabial. Surface of the zoarium covered with a large number of chitinous, brown, unbranched or branched spines.......................................II. *Flustrellidae* Hincks (see p. 239).

I. Family **Alcyonidiidae** Johnston, 1837

Alcyonidiidae Johnston, 1837 : 108; Hincks, 1880a : 490.

The zooids are fully or partially plunged into a more or less soft crust of gelatinous consistency, which is either prostrate and overgrowing the substrate, or forms free-growing branched, flattened, lobate or cylindrical, or even unbranched cylindrical structures. The surface of the zoarium is covered with either a thin, translucent, chitinous membrane, or with a thicker, chitinous, almost leathery layer that is either smooth or covered with raised cylindrical nipples with the orifice of the zooid located at the end, or with minute, conical, hollow, chitinous nipples (suckers) which encircle the orifices of the zooids. The zooids more or less closely adjoin each other. The orifices of the zooids are located either in the middle of the small, polygonal surfaces, or near the distal end of the oblong, often hexagonal surface of the frontal surfaces of the zooids. The orifices, simple and round, close the body walls by a round valve, and are not covered by the raised labia.

Genus **Alcyonidium** Lamouroux, 1813

Alcyonidium Lamouroux, 1813 : 285; 1821 : 71; *Alcyonium* Linnaeus, 1767 : 1295 (part.); *Halodactylus* Farre, 1837 : 405.

There is only one genus and its characteristics are the same as of the family.

Genus type: *Alcyonium gelatinosum* Linnaeus.

1 (20). Zoarium free-growing.
2 (9). Zoarium ramose.
3 (8). Zoarium lobate or cylindrical, with a more or less soft, gelatinous consistency. Zooids without raised, cylindrical nipples.
4 (7). Surface of the zoarium translucent, smooth, without the conical, chitinous papillae.
5 (6). Zoarium adheres to the substrate by a small surface; its surface consists of barely distinguishable, irregular, polygonal surfaces which form the frontal wall of the zooids with the orifice located near the middle. Polypides are located almost at a right angle to the surface of the zoarium.............. ....1. *A. gelatinosum* (L.).
6 (5). Free-growing part of the zoarium adheres to the substrate with a wide base; its surface consists of more or less well-defined, oblong, *Flustra*-like surfaces—the zooids. Polypides are situated almost parallel to the surface of the zoarium.............. ....1a. *A. gelatinosum* var. *diaphanum* (Farre).
7 (4). Surface of the zoarium with conical, hollow, chitinous papillae. ....5. *A. hirsutum* (Fleming).

8 (3). Zoarium cylindrical; oblong zooids are located in and around the central, longitudinal axis; near the distal end they have a raised nipple with the orifice on the end.................................. 8a. *A. mamillatum* var. *erectum* Andersson.

9 (2). Zoarium unbranched.

10 (11). Zoarium in the form of a single-layered circle or ring, the upper end of which consists of the frontal surfaces of the zooids in the form of a rhomb or six-faceted surface; the lower end gives the impression of being covered with a single or double radial row of short, radicular fibers from the center of the zoarium to the periphery......... 11. *A. disciforme* Smitt.

10 (17). Zoarium cylindrical; zooids arranged on all sides around the central, longitudinal axis of the zoarium.

11 (12). Thin, radicular tubes exist near the lower, proximal end of the zoarium...................... 2. *A. radicellatum* Kluge.

12 (11). Radicular tubes absent near the lower end of the cylindrical zoarium.

13 (16). Zoarium not of uniform diameter throughout its length, either gradually or sharply tapering toward the base; it is translucent and soft, or opaque and dense.

14 (15). Zoarium digitate or cylindrical, gradually tapering toward the base; it is covered with a thin, translucent, chitinous layer. Zoaria usually short (not exceeding 15 cm).................................. 1b. *A. gelatinosum* var. *anderssoni* Abrikossov.

15 (14). Zoarium cylindrical, thick, sharply changing into a very thin, short stem near the base; covered with opaque, thick, leathery, chitinous layer; reaches up to 50 cm in height............................ 1c. *A. gelatinosum* var. *pachydermatum* Kluge.

16 (13). Zoarium long, thin, vermiform, with uniform diameter throughout its length, attains up to a height of 100 cm or more.................................... 3. *A. vermiculare* Okada.

17 (10). Zoarium not cylindrical, one-layered. Zooids located on one frontal side.

18 (19). Zoarium in the form of a circle or ring, the upper side of which consists of the frontal surfaces of the zooids in the form of a rhomb or six-faceted surface; the lower side appears to be covered with a single or double radial row of radicular fibers from the center of the zoarium to the periphery... 11. *A. disciforme* Smitt.

19 (18). Zoarium clavate, small, with a convex, frontal side, and a concave, basal one................. 4. *A. excavatum* Hincks.

20 (1). Zoarium prostrate, overgrowing.

21 (22). Surface of the zoarium covered with small, conical, hollow,

chitinous papillae, located around the orifices of the zooids. ....5. *A. hirsutum* (Fleming).

22 (21). Surface of the zoarium not covered with hollow, chitinous papillae.

23 (24). Zoarium covered with clay particles which give it the appearance of being a layer of clay colored greenish-gray. Polygonal membranous areas distinguished on the surface with difficulty, are surrounded by longer and finer papillae...... ....12. *A. parasiticum* (Fleming).

24 (23). Zoarium covered with clay particles.

25 (28). Zooids near the distal end and not stretched in the form of a free protuberance with the orifice at the end.

26 (27). Zoarium in the form of a more or less thin, flat, transparent layer, consists of sharply bordered zooids of hexagonal or tetragonal form. A round orifice is located near the distal end, and slightly raised above the surface................ ....6. *A. mytili* Dalyell.

27 (26). Zoarium in the form of a more or less thick white layer, consists of quite irregularly arranged zooids, some of which are slightly procumbent, others semi-erect or even erect. Zooids are oblong, slightly tapering toward the distal end, with either a smooth convex surface or a more or less round one. Orifice at the end of the zooid............7. *A. irregulare* Kluge.

28 (25). Zooids, near the distal end, stretched into a free protuberance with the orifice at the end.

29 (30). Free protuberance shortened and, therefore, its surface transversely annulate..................8. *A. mamillatum* Alder.

30 (31). Free protuberance more or less strongly chitinized, and its surface smooth and not transversely annulate.

31 (32). Zooids of medium size; a strongly developed round proboscis is located near the distal end of the zooid; the length of the proboscis is greater than half the length of the zooid...... ....9. *A. proboscideum* Kluge.

32 (31). Zooids minute. Near the distal end of the zooid is located a gradually tapering tube, the length of which is less than half the length of the zooid..........10. *A. albidum* Alder.

1. **Alcyonidium gelatinosum** (Linnaeus, 1767) (Figure 94)

Alcyonidium gelatinosum Smitt, 1867 : 497, 512, t. XII, f. 9-13; Hincks, 1880a : 491, pl. 69, f. 1-3; Levinsen, 1894 : 80, t. VII, f. 22-25; Borg, 1930a : 97, f. 120; Marcus, 1940 : 301, f. 155.

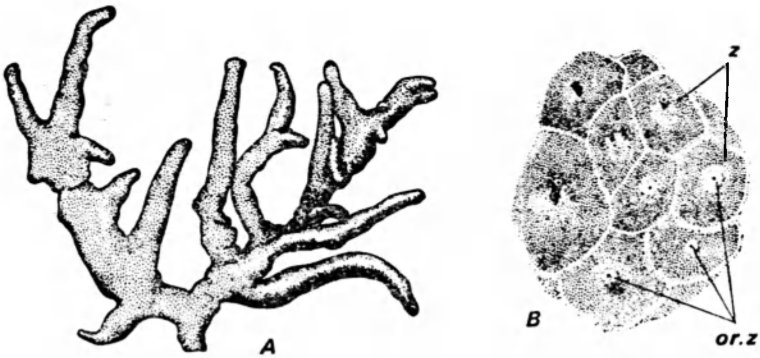


Figure 94. *Alcyonidium gelatinosum* (L.). *A*—distal part of the zoarium (natural size); *B*—part of the surface of the zoarium. Barents Sea.

The zoaria are free-growing, yellowish, yellowish-brown, or grayish in color, and softly gelatinous in structure. The form and size of the zoaria is fairly variable; often they are ramose in the middle wider part, with lobate or cylindrical protuberances originating there, or they are narrow, almost cylindrical, with many similar cylindrical branches which are sometimes shorter, sometimes longer. The zoaria often affix to a hard ground with a small wide surface, and from it they rise, initially by a short, narrow stem, which then spreads out.

The size of the zoaria fluctuates from a few centimeters to several decimeters, reaching up to 150 cm. The zoaria are distinguished by a gelatinous consistency. The surface of the zoarium, covered with a more or less thin, chitinous layer, usually consists of small, irregular, polygonal surfaces (0.50×0.40 mm), forming the fertile surface of the zooids. Located near the middle of the surface is the orifice of the zooid which is sometimes raised above the surface in the form of a small, low papilla. The tentacular sheath starts from the orifice inward with the polypide, the longitudinal axis of which is located at a right angle to the surface of the zoarium. The zooids contact each other through their thin, transparent walls, because of which the continuous surface layer of the zooids is formed below the surface, attaining a thickness of 1.00 to 1.10 mm. The middle of the zoarium, under the surface layer of the zooids, is alveolar tissue filled with fluid, mainly marine water. The zoaria grow in length because of the formation of daughter zooids on the distal end of the maternal zooid, and in thickness due to the lateral budding of the zooids, which can be observed on the surface of the zoarium where younger buds wedge themselves between the adult zooids, forming a triangular or polygonal shape with the internal primordium of the polypide; by overgrowing, they push the old zooids inward, the polypides of which are subjected to histolysis, and their membranous walls form the aforementioned alveolar tissue. This tissue may grow out strongly, sometimes significantly increasing more in size than the zooids, and attain a height of 1.25×1.50 mm. The larger zooids contain minute grains of calcium carbonate in the alimentary canal, which forms oblong bodies in the rectum. The number of tentacles is from 15 to 17 according to Hincks (1880a), and from 17 to 19 according to Andersson (1902).

The zoaria are attached to stones and other substrate, at a depth from 1 to 475 m, often from 50 to 150 m, on a bed of silt, stone, and shells, under temperatures ranging from -1.9 to 4.5°C, in the North Sea up to 11.05°C in a salt concentration of 17.39 to 34.75‰.

Distribution. The species was found by me in the Barents, White (?), Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas. *Reports in literature:* Barents Sea (Smitt, 1867, 1879a, 1879c; Ridley, 1881; Vigelius, 1881-82; Bidenkap, 1900a, 1900b; Nordgaard, 1900, 1907a, 1907b, 1923; Andersson, 1902; Waters, 1904), Kara Sea (Smitt, 1879a; Levinsen, 1887; Nordgaard, 1912b; Kluge, 1929), Laptev Sea (Kluge, 1929; Abrikossov, 1932), Hudson Strait (Osburn, 1932), western Greenland (Smitt, 1868c; Norman, 1876, 1906; Vanhöffen, 1897; Levinsen, 1914), Gulf of St. Lawrence (Whiteaves, 1901), Gulf of Mein (Osburn, 1933), eastern Greenland (Andersson, 1902; Levinsen, 1914), Yan-Maien Island (Andersson, 1902; Nordgaard, 1907b), western coast of Norway and the North Sea (Nordgaard, 1907b, 1918), Skagerrack (Smitt, 1867), Kattegat (Levinsen, 1894; Marcus, 1940), British Isles (Hincks, 1880a), Belgium (van Beneden, 1845), along the western coast of North America from Alaska up to the Queen Charlotte Islands (Hincks, 1884; Robertson, 1900).

This is an Arctic-boreal, circumpolar species.

1a. **Alcyonidium gelatinosum** var. **diaphanum** (Farre, 1837) (Figure 95)

Halodactylus diaphanus Farre, 1837 : 405 (part.), pl. XXV, f. 5.

The free-growing, ramose, grayish colored protuberances uprise from the prostrate base of the zoarium and overgrow the substrate. The zoaria are small in size (5 to 6 cm in height); their consistency is slightly dense and gelatinous. The surface of the zoarium is covered with a thin, chitinous shell which consists of the somewhat *Flustra*-like surfaces of the zooids (length 0.68 mm, width 0.35 mm); the polypides are located almost parallel to the surface of the zoarium, because of which the thickness of the surface layer of the zooids is thinner (about 0.50 mm). There is an "intertentacular organ" in the sexually mature zooids. The number

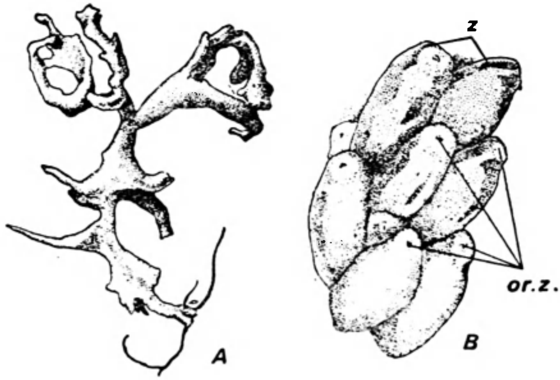


Figure 95. *Alcyonidium gelatinosum* var. *diaphanum* (Farre). *A*—complete zoarium (natural size); *B*—part of the surface of the zoarium. Novaya Zemlya (Matochkin Shar).

of tentacles in the examined sections was always 18, rarely 17; however, Farre (1837) reported 16 tentacles.

The species lives on fuci, hydroids, and gastropod mollusks, at a depth from 1.5 to 20 m, on a bed of stones with fuci and laminaria, under temperatures varying from 3.0 to 5.5°C.

Distribution. I found this species in the Barents Sea (Isfjorden, Matochkin Shar, and along the western coast of the southern part of Novaya Zemlya Island). *Reports in literature:* coastal waters of Great Britain (Farre, 1837).

This is an Arctic-boreal species.

1b. **Alcyonidium gelatinosum** var. **anderssoni** Abrikossov, 1932 (Figure 96)

Alcyonidium gelatinosum morpha *anderssoni* Abrikossov, 1932 : 142; *A. gelatinosum* Smitt, 1879b : 22 (part.); Andersson, 1902 : 552 (part.).

The zoaria are free-growing, unbranched, digitate or cylindrical and gradually taper toward the base. The zoaria are usually small (5 to 6 cm) with a thickness of 4 to 5 mm, but larger ones are found which attain a length of 12 to 15.5 cm with a thickness of 8 to 8.5 mm. The consistency of the zoarium is more or less soft and gelatinous. The surface of the zoarium is covered with a more or less thin, chitinous layer, and consists of small polygonal surfaces on the frontal side of the zooids with the orifice in the middle. The zooids are more or less closely located perpendicular to the surface of the zoarium. The lower proximal part of the zoarium is often devoid of autozooids and consists of kenozooids.

The number of tentacles is usually 18 to 19, but Andersson (1902) reported 20.

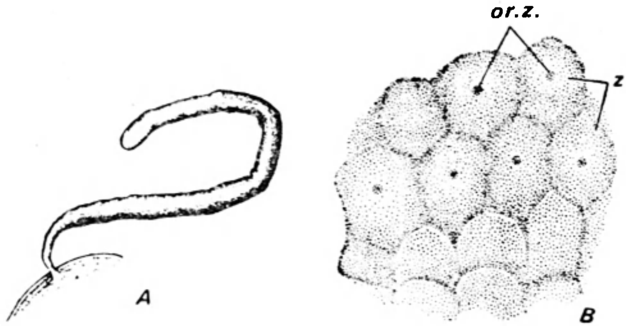


Figure 96. *Alcyonidium gelatinosum* var. *anderssoni* Abrikossov. *A*—a complete zoarium (natural size); *B*—a part of the surface of the zoarium. Polar basin (north of Franz Josef Land).

The species is usually found on shells, especially on *Arca glacialis* and *Astarte crenata,* at depths from 1.5 to 610 m, more often from 40 to 200 m, on a bed of silt and stone, under temperatures ranging from -1.7 to 2.2°C, in a salt concentration of 31.44 to 34.92‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian and Chukotsk seas. *Reports in literature:* Barents Sea (Smitt, 1879b; Ridley, 1881; Bidenkap, 1900a; Andersson 1902; Nordgaard, 1918), Laptev Sea (Abrikossov, 1932).

This is an Arctic form.

1c. **Alcyonidium gelatinosum** var. **pachydermatum** Kluge var. n. (Figure 97)

Alcyonidium gelatinosum Waters, 1904 : 179 (part.).

The zoaria are free-growing, cylindrical, unbranched, white or yellowish in color, and attain a marked length (more than 48 cm) and thickness (diameter up to 12 mm). The consistency of the zoarium is dense. The surface of the zoarium is covered with a more or less thick chitinous layer (0.05 to 0.10 mm), and consists of small polygonal surfaces with the orifice in the middle. The polypides start perpendicularly from the orifice to the surface of the zoarium, forming a continuous, thin, surface layer of zooids (1.25 mm). The middle of the zoarium is full of large alveoli with their own walls, which reach up to 1.25×1.50 mm. In the surface layer of the zooids, ovaries are frequently seen with many (up to 10 to

12) large eggs, surrounded by a common, multilayered coat. A thin, cylindrical stem (from 2 to 3 to 4 mm) rises from the small, round, flat layer of kenozooids over a small length (15 to 18 mm); the stem consists of more or less stretched alveoli (kenozooids), after which the zoarium abruptly widens (up to 7 to 8 mm), reaching more than 10 to 12 mm in thickness. This structure and form of the zoarium is already found in young zoaria which have attained a length of 14 and 29 mm. An "intertentacular organ" is found in sexually mature zooids. When the latter is present, the number of tentacles is 20; when it is absent, mostly 19.

The zoaria are attached to shells and stones, at a depth from 27 to 54 m, on a bed of silt and stone, under temperatures ranging from −1.24 to −1.6°C, in a salt concentration of 34.27 to 34.83‰.

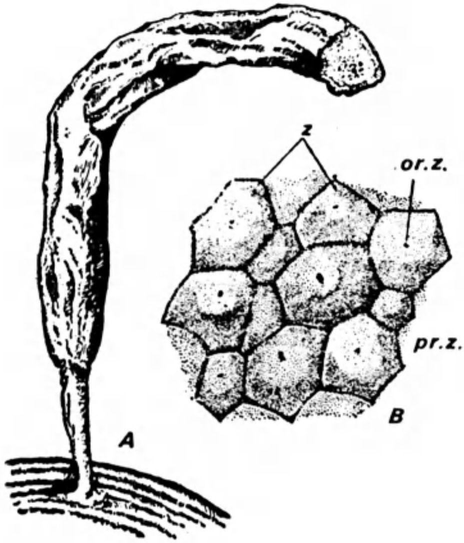


Figure 97. *Alcyonidium gelatinosum* var. *pachydermatum* Kluge. *A*—proximal part of the zoarium; *B*—part of the surface of the zoarium. Kara Sea.

Distribution. This form was found by me in the Northern Strait of the Kara Sea. *Reports in literature:* waters of Franz Josef Land (Waters, 1904).

This is a high Arctic species.

2. **Alcyonidium radicellatum** Kluge, 1946 (Figure 98)

Alcyonidium radicellatum Kluge, 1946 : 215, t. III, f. 6.

The zoaria are free-growing, unbranched, thin, cylindrical, and attain up to 7 cm in height. The zoarium consists of 3 parts: the proximal one or the base of the zoarium is densely covered with thin, more or less long, radicular fibers; the middle section is thinner and more transparent; and lastly, the distal part consists of autozooids. The proximal part usually has the appearance of a more or less compact, continuous, somewhat fleshy stem with a thickness of 0.65 to 1.13 mm, covered with a dense, thin, chitinous layer which is sometimes white, sometimes yellow, from which colorless, hollow tubes with a thickness of 0.03 to

0.10 mm protrude on all sides, sometimes closely together, and sometimes sparsely distributed, in which case they tend to be more or less long (up to 8 mm). The tubes sometimes produce branches and their surface has a transverse pattern. Internally, this part consists of somewhat oblong, irregular, polygonal alveoli which are either densely or sparsely filled with a fine-grained mass that is flesh-tinged-yellow or white in color. The middle part is covered with a thinner, transparent, chitinous layer, consisting of large, oblong, irregular surfaces, which form the outer walls of the alveoli, and fill the entire internal cavity of this part of the zoarium. These alveoli are devoid of polypides and are the kenozooids. The thickness of this part varies from 0.50 to 0.88 mm. Lastly, the distal part is the thickest, varying from 1.25 to 2.00 mm in diameter. This part is covered with a thin, translucent, chitinous layer consisting of large and slightly oblong, mildly bordered, polygonal surfaces, which form the frontal wall of the autozooids. The longitudinal axis of the zooids is obliquely directed toward the surface of the zoarium, and since the polypides are deep-seated, the impression is given that they originate in a radial direction as if from the central axis of the distal part of the zoarium. The number of tentacles is 20.

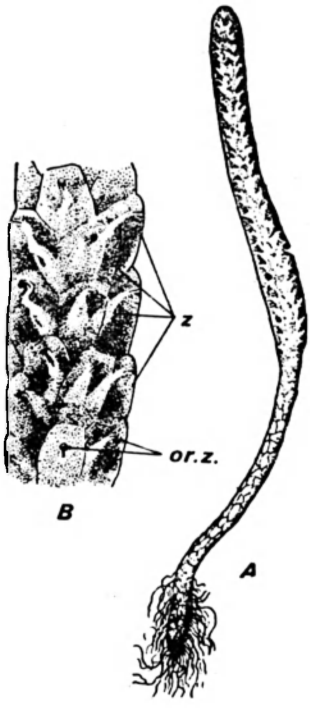


Figure 98. *Alcyonidium radicellatum* Kluge. *A*—a complete zoarium; *B*—part of the surface of a zoarium; polypide visible through the frontal wall of the zooids. East Siberian Sea.

The size of these 3 parts in the zoarium varies: thus, in a zoarium 20 mm in length, the radicular part with fibers is 1 mm, the middle with kenozooids is 1 mm, and the distal with autozooids is 8 mm; in a zoarium 70 mm in length, the radicular part is 15 mm, the middle one 20 mm, and the distal part 35 mm. But the radicular part with the threads does not always form a continuous fleshy part; sometimes it partly consists of empty kenozooids, and partly of those filled with a granular mass; however, the whole of it has radicular thread-like fibers. On the other hand, one sometimes finds the radicular part with the threads stretched, followed at some distance by kenozooids without threads, succeeded by kenozooids filled with the granular mass and covered with radicular fibers, then again kenozooids without threads (fibers), and finally, the distal part with the autozooids.

The zoaria attach to small pebbles and calcareous or chitinous tubes of worms; the radicular tubes are densely covered with minute quartz grains, while the middle part of the zoarium is very often densely covered with the shells of foraminifera. They are found at depths varying from 50 to 680 m, often from 140 to 300 m, on a bed of sand, silt, and gravel, under temperatures varying from -1.38 to 1.53°C, in a salt concentration of 34.53 to 34.85‰.

Distribution. The species was found by me in the Barents Sea, north and northwest of Spitsbergen, in the waters of Franz Josef Land, and in the Kara, Laptev, and East Siberian seas.

This is a high Arctic species.

3. **Alcyonidium vermiculare** Okada, 1925 (Figure 99)

Alcyonidium (*Paralcyonidium*) *vermiculare* Okada, 1925 : 281, f. 1.

The zoaria are free-growing, vermiform, cylindrical, and of uniform thickness (up to 4 mm) throughout their considerable length (up to 96.5 cm and more). The surface of the zoarium is covered with a more or less thin, chitinous layer, consisting of indistinct, bordered, small, polygonal surfaces—the front surfaces of the zooids with the orifice near the middle part. The longitudinal axis of the zooids is at a right angle to the surface of the zoarium. The zooids are small and closely adjoin each other; with their lateral sides, they form the surface layer of the zooids with a thickness of 0.75 mm under the surface of the zoarium. The polypides are distinguished by the presence of a strongly developed gizzard. The number of tentacles is 16, but Okada (1925) reported 20.

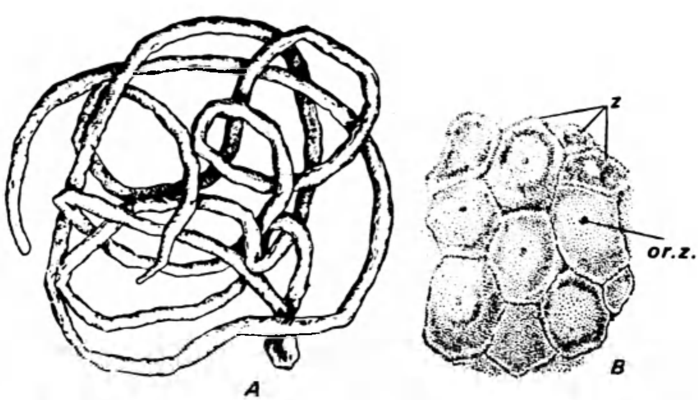


Figure 99. *Alcyonidium vermiculare* Okada. *A*—complete zoarium (natural size); *B*—part of the surface of the zoarium. Bering Strait.

The internal space of the zoarium is filled with polygonal alveoli, in which the residues of incompletely dissolved polypides are found.

The species lives on shells and stones at a depth of 54 to 119 m, on a bed of silt, sand, and shells.

Distribution. The species was found by me in the Bering Strait near Ratmanov Island, near the southern end of Cape Kruzenstern, and toward the south of the Diomede Islands. *Reports in literature:* Sea of Japan (Okada, 1925).

4. **Alcyonidium excavatum** Hincks, 1880

Alcyonidium excavatum Hincks, 1880b : 284, pl. XV, f. 8.

The zoaria are free-growing, small (up to 1.5 cm in height), unbranched, and clavate. The zooids located only on the convex side; the opposite, concave side looks as if it were excavated in the middle from the upper end, almost up to the base of the zoarium; it is surrounded by a thin margin and devoid of zooids. The zooids have an irregular form, their structural details are slightly noticeable at the surface, and they are devoid of papillae. They live on the tubes of annelids at a depth of 288 m.

Distribution. Reports in literature: Barents Sea, 75°16′6″ n. lat., 45°19′5″ e. long. (Urban, 1880).

5. **Alcyonidium hirsutum** (Fleming, 1828) (Figure 100)

Alcyonidium hirsutum Hincks, 1880a : 493, pl. 70, f. 4-7; *A. papillosum* Smitt, 1867 : 499, 516, t. XII, f. 20-21; non *A. hirsutum* Smitt, 1867 : 496.

The zoaria are prostrate, overgrowing in the form of a fairly dense crust of yellowish-brown color, or free-growing, flattened, ramosely lobate, and grayish in color, attaining up to 10 to 12 cm in height. The surface is covered with a more or less thin, chitinous membrane, consisting of oval surfaces (0.38 × 0.25 mm). The fertile surface of the zooids has an orifice located in the middle, and is surrounded on the margin by chitinous, conical papillae (up to 0.25 mm in height). The zoarium is surrounded along its margin by a number of more or less uniform, rectangular primordia of the future zooids. The one-layered, prostrate surface in the young zoaria is covered with more minute, colorless chitinous papillae; septa, or the margins of the zooids, are clearly distinguishable, and the yellow-brownish polypides (0.48 mm in length) are visible through the translucent, surface, chitinous layer. The polypides are located in an almost horizontal position. With the growth of the zoarium, the zooids occupy a more and more perpendicular position with regard to the surface of the zoarium; the conical papillae become pale yellow, increase in size, and are more or less rounded on the ends. As a result, the surface of the zoarium in the adult prostrate form, acquires a more or less uniform yellow color, and is densely covered with papillae, between which the surfaces of the zooids are less noticeable. The free-growing zoaria present a different picture. Although they also start with overgrowing on one or the other substrate in the form of one layer (remember the structure is prostrate at this time), in the adult stage their surface consists of the rounder, oval surfaces of the gray-white zooids, which are often surrounded by less large, but sharply pointed, strongly chitinized, and yellower conical papillae. The white polypides are located under the frontal wall of the zooids. Since the branches of the free-growing zoarium are flattened, in the cross section they consist of 2 layers of zooids, usually closely adjoining each other by their basal sides. Sometimes the branches in certain places, are thicker, and then the cross section in these places presents a picture reminiscent of the structure of *Alcyonidium gelatinosum*, where more or less large alveoli appear between the surface layers; the former are devoid of polypides. The number of tentacles is 15, rarely 16, but Hincks (1880a) reported 17 to 18.

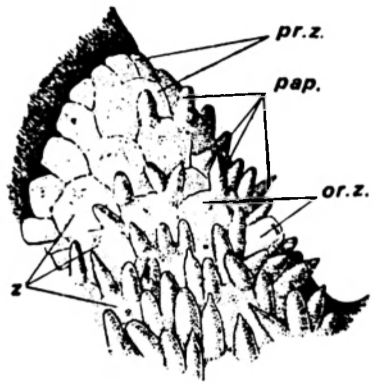


Figure 100. *Alcyonidium hirsutum* (Fleming). A part of a prostrate zoarium. Barents Sea.

The prostrate form usually overgrows fuci (*Fucus serratus* and *F. vesiculosus*) mixed, generally, with *Flustrella hispida*, and lives almost exclusively in the belt of ebb and flow. The free-growing form, starting with the overgrowth on underwater plants, settles down in the sublittoral to quite significant depths, up to 292 m, often up to 75 m, on a bed of algae, silt, and stones, at temperatures ranging from −0.83 to −1.5 °C.

Distribution. The species was found by me in the Barents Sea, Isfjorden in Spitsbergen, and in the southern part of the sea from western Murmansk to Yugorski Shar. *Reports in literature:* Barents Sea (M. Sars, 1851; Smitt, 1867, 1879b; Vigelius, 1881-82; Bidenkap, 1900a, 1900b; Abrikossov, 1932; Kluge, 1906; Grieg, 1925), White Sea (Kluge, 1908a; Gostilovskaya, 1957), coastal waters off western Norway (M. Sars, 1851; Nordgaard, 1912a, 1918), Skagerrack and Kattegat (Smitt, 1867; Levinsen, 1894), Great Britain (Hincks, 1880a) and northern France (Joliet, 1877).

This is an Arctic-boreal, Atlantic species.

6. **Alcyonidium mytili** Dalyell, 1847 (Figure 101)

Alcyonidium mytili Dalyell, 1847 : 36, pl. XI, f. 1-14; Smitt, 1867 : 496, 507, t. XII, f. 1-2; Hincks, 1880a : 498, pl. 70, f. 2-3; Silbermann, 1906 : 265; *A. polyoum* Borg, 1930a : 98, f. 121.

The zoarium is prostrate, overgrowing at a young stage in the form of a thin, transparent layer, which is clearly divided by the interzooidal septa into hexagonal (from 0.50×0.25 to 0.75×0.38 mm), pentagonal, or rectangular surfaces that are the slightly convex surfaces of individual zooids. The small, round or transversely oval orifice of the zooid is located near the distal end of the surface; the former is slightly raised above the surface. The row of large, uniform, rectangular primordia of the future zooids is located along the margin of the zoarium. With aging, the zoarium becomes thicker (reaching up to 1.25 mm), the zooids more clustered together (acquiring a position more perpendicular to the surface of the zoarium), the surface duller, the color more dirty-white or yellowish or, sometimes, darker, and the boundaries between the zooids become less noticeable. Recalling that the zoarium grows out in a single layer, nevertheless on one zoarium which had strongly overgrown the laminaria, I observed the formation of a free-growing, flattened, two layered hood (length 7 mm, width 3 mm). Up to 10 or more eggs develop in the zooids and by the time they reach the larval stage, the polypides have degenerated. The number of tentacles is 17 and 20, but according to Hassall (1841a, 1841b)—20, to Hincks (1880b)—15 to 18, to Silbermann (1906)—16 to 20, to Harmer (1915)—12, to Silen (1942)—20, and to Osburn, 15 to 17.

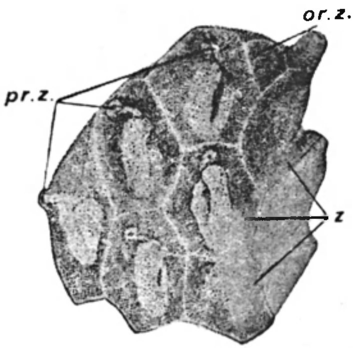


Figure 101. ***Alcyonidium mytili*** **Dalyell. Part of a zoarium. Barents Sea.**

This species lives on algae, shells, and stones, at depths from 5 to 315 m, more often from 10 to 50 m, on a bed of stone, shell, and silt, under temperatures ranging from −1.52 to 2.7°C, in a salt concentration of 32.25‰, although it is also found in more saline waters.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering and Okhotsk seas. *Reports in literature:* Barents Sea (M. Sars, 1851; Smitt, 1867; Bidenkap, 1900a; Andersson, 1902; Nordgaard, 1912a, 1923), White Sea (Gostilovskaya, 1957), Laptev Sea (Kluge, 1929), waters of the Archipelago of the Canadian Islands (Verrill, 1879a; Nordgaard, 1906a; Osburn, 1932), western Greenland (Verrill, 1879), eastern Greenland (Levinsen, 1914, 1916), Yan-Maien Island (Lorenz, 1886), western coast of Norway (M. Sars, 1851; Nordgaard, 1912a, 1918), Boguslen (Smitt, 1867), Denmark (Levinsen, 1894; Marcus, 1940), southwestern part of the Baltic Sea (Silbermann, 1906), North Sea (Borg, 1930a), Great Britain (Hincks, 1880a), Mediterranean Sea (Calvet, 1902), Bay of Man and the vicinity of Woods Hole along the eastern coast of North America (Osburn, 1912, 1933), and along the western coast of North America from Alaska to the Queen Charlotte Islands (Robertson, 1900; O'Donoghue, 1923, 1926).

This is an Arctic-boreal, circumpolar species.

7. **Alcyonidium irregulare** Kluge sp. n. (Figure 102)

The zoarium is white in color, partly prostrate, and partly free-growing in bundles consisting of zooids arranged in a quite irregular manner. Some zooids are located as if on a plane and are procumbent with their orifices, near the distal end; others are semi-erect and their distal ends are more or less free with an orifice on the end; and lastly, a third type appears to be erect. The orifice of the zooid is in the form of a small transverse slit. The zooids are of medium size (average length 0.75 mm, width in the proximal part 0.33 mm, and near the distal end 0.20 mm), oblong in form, and have an almost uniform width in the proximal half, while gradually tapering toward the distal, usually freely raised, end. In the prostrate and semi-erect zooids, the surface is convex; the erect zooids appear oval in the cross section. The zooidal wall is covered with a smooth, compact, translucent, chitinous layer; therefore the margins of the zooids are sharply pointed. The surface of the distal, raised section in the semi-erect and erect zooids has a thin, transversely annular pattern. The collar is more or less short. The "intertentacular organ" is present. The number of tentacles is usually 20, rarely 19.

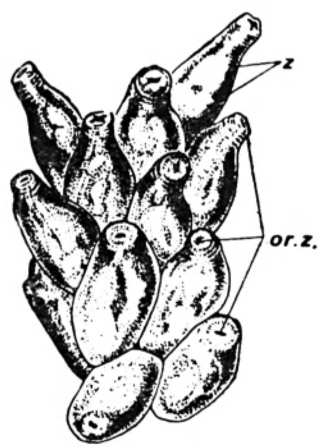


Figure 102. *Alcyonidium irregulare* Kluge. Zoarium; polypide visible through the frontal wall of the zooids. Barents Sea.

The species lives on hydroids (*Sertularia*) and shells, at a depth of 95.4 m, on a bed of shells.

Distribution. The species was found by me in the Barents Sea, in eastern Murmansk. Thus far it is endemic to the Barents Sea.

8. **Alcyonidium mamillatum** Alder, 1857 (Figure 103)

Alcyonidium mamillatum Alder, 1857a: 25, pl. XIII, f. 3-4; Hincks, 1880a: 495, pl. LXIX, f. 7-8; *A. hirsutum* forma *membranacea* Smitt, 1867 : 497 (part.), t. XII, f. 3-8.

The zoarium is prostrate, overgrowing sometimes in the form of a thicker, sometimes thinner, fleshy layer that is white or yellowish-brown in color; it consists of large zooids (length 0.88 to 1.13, width 0.50 to 0.60 mm), which have an oblong hexagonal or oval form. The surface of the zoarium is smooth and translucent, and clearly divided by interzooidal walls into the slightly convex, frontal surfaces of the zooids. Near the distal margin of the zooid where the surface forms a large (0.20 mm in diameter) cylindrical hood, is the nipple (about 0.30 mm long) which has the orifice of the zooid on the upper end. The papilla has a transversely annular surface and is directed almost perpendicular to the surface of the zooid; the papilla is more or less forwardly inclined in the longer zooids. The number of tentacles is 16 to 18 according to Hincks; the number varies according to Andersson, but never exceeds 23.

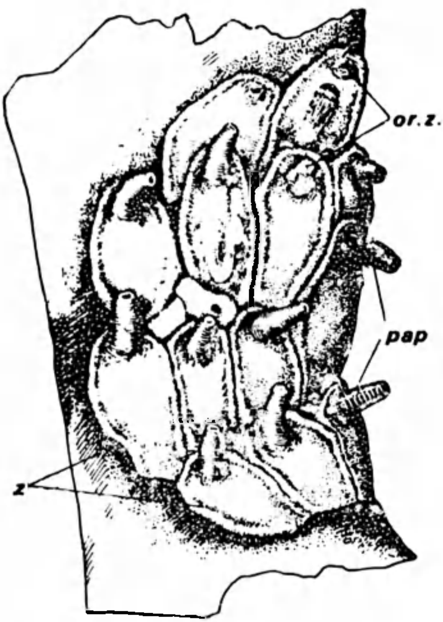


Figure 103. *Alcyonidium mamillatum* Alder. Zoarium. Barents Sea.

Usually the zoarium of this species is a continuous layer of close irregular rows of adjoining zooids. In the material from the expedition "Rusanov" of 1931 at station 21 (70°23′ n. lat., 64°00′ e. long., depth 158 m, brown silt) I came across a zoarium on the chitinous cover of a bivalved mollusk (most probably *Modiolus*) which was ramose, and the branches consisted of 1, 2, 3, or even 4, rows of zooids; often 3 daughter zooids originated from 1 zooid. The zoarium was in the form of a thin layer. The zooids were large (length 1.00 to 1.25 mm), oblong-oval in form, and had an almost completely transparent, frontal surface. The oral papillae were 0.30 mm long 0.20 mm in diameter, transversely annular, and could contract.

The species lives on hydroids, ascidia, peduncles of *Pantopoda* and shells, at a depth of 4 to 220 m, often from 10 to 50 m, on a bed of stone, shell, and silt, under temperatures ranging from —1.04 to 3.7°C.

Distribution. The species was found by me in the Barents, Kara, and Chukotsk seas. *Reports in literature:* Barents Sea (Smitt, 1867; Andersson, 1902; Nordgaard, 1907, 1923; Kluge in Deryugin, 1915), White Sea (Kluge, 1908a; Gostilovskaya, 1957), Kara Sea (Levinsen, 1887; Nordgaard, 1923), Laptev Sea (Kluge, 1929), waters of the Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1932), western Greenland (Smitt, 1868; Vanhöffen, 1897; Osburn, 1919), eastern Greenland (Kirchenpauer, 1874; Andersson, 1902; Levinsen, 1914, 1916), Yan-Maien Island (Lorenz, 1886), in the boreal region of the waters off western Norway (Nordgaard, 1918), Boguslen (Smitt, 1867), Great Britain (Hincks, 1880a), and near Desert Island (eastern coast of North America) (Osburn, 1933).

The species is Arctic-boreal.

8a. **Alcyonidium mamillatum** var. **erectum** Andersson, 1902 (Figure 104)

Alcyonidium mamillatum var. *erectum* Andersson, 1902 : 553, pl. 30, f. 6.

The zoarium is free-growing, branched, white or yellowish in color, and reaches up to 6 cm in height. Branching is dichotomous; in certain instances branching is so close that it gives the impression of a bush. The cylindrical branches (from 0.60 to 0.90 mm in diameter) consist of 4 to 5 zooids around the central longitudinal axis. The zooids have a somewhat oblong form (length 1.25 mm, width 0.35 mm) and slightly taper toward the proximal end. The walls of the zooids are more chitinized, due to which the zoarium is stronger. The frontal surface of the zooids is more or less convex, lower on the sides and the proximal end, and forms a cylindrical protuberance or papilla at the distal end (length 0.25 mm, thickness 0.18 mm) with the orifice of the zooid at the tip; the papilla is somewhat broader at the base and pointed obliquely toward the front in an upward direction. The number of tentacles is 23 to 25; according to Andersson (1902) 25.

The species lives on hydroids, tubes of worms, shells of bivalved and gastropod mollusks, and peduncles of marine spiders, at a depth of 1.5 to 560 m, more frequently from 30 to 200 m, on a bed of silt and stone, or silt and sand, under temperatures ranging from —1.7 to 2.22°C, in a salt concentration of 31.15 to 34.94‰.

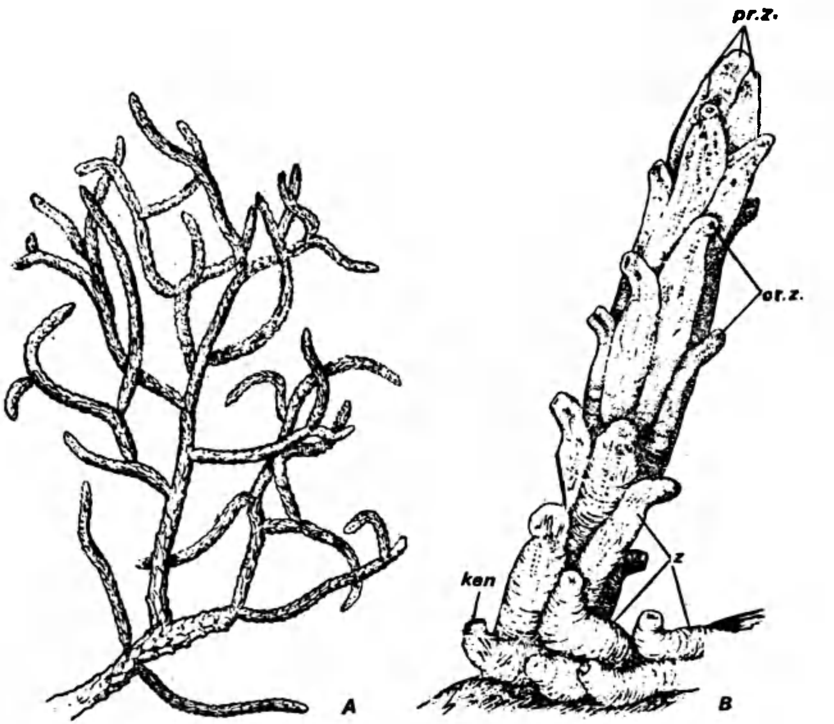


Figure 104. *Alcyonidium mamillatum* var. *erectum* Andersson. *A*—distal part of a branched zoarium; *B*—complete unbranched zoarium; polypide visible through the frontal wall of the individual zooids. Barents Sea.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, and Bering seas. *Reports in literature:* Barents Sea (Kluge in Deryugin, 1915), White Sea (Kluge in Deryugin, 1928; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Levinsen, 1887; Nordgaard, 1912b; Kluge, 1929), Laptev Sea (Kluge, 1929), East Siberian Sea (Nordgaard, 1929), northern coast of North America (Osburn, 1923, 1932), western Greenland (Vanhöffen, 1897), and eastern Greenland (Andersson, 1902).

This is a high Arctic, circumpolar species.

9. **Alcyonidium proboscideum** Kluge sp. n. (Figure 105)

The zoarium is prostrate and consists of closely adjoining roundish-hexagonal zooids of medium size (length 0.63 to 0.75 mm, width 0.35 to 0.45 mm). Near the distal end of the zooids, a strongly developed, more or less long, straight, and round proboscis is raised with an orifice at the tip (length 0.45 to 0.63 mm, width near the base 0.20, at the end 0.15 mm), which is sometimes pointed almost vertically upward, but mostly at a small or large angle. The walls of the zooids are transparent and rather strongly chitinized; therefore the zooids are clearly demarcated by sharp contours. Because of a strong chitinization, the proboscis is straight or slightly bent, and the transverse annulation is not present on its surface, a typical feature of *A. mamillatum*. The orifice of the zooids is round; the corners sometimes appear triangular. The tentacles are long, occupying a major portion of the cavity of the zooid in a retracted condition. The number of tentacles is 19. The esophagus, stomach, blind sac, and hind gut are short and thick; the parieto-vaginal and parietal muscles are strongly developed.

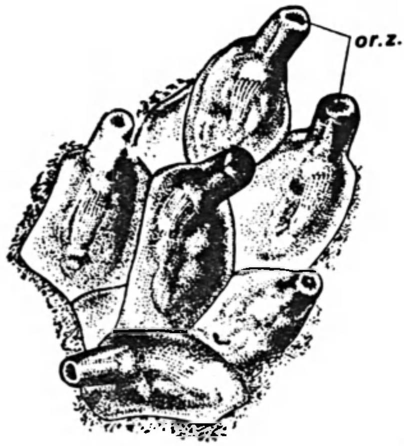


Figure 105. *Alcyonidium proboscideum* Kluge. Zoarium; polypide visible through the frontal wall of the zooids. Barents Sea.

The species lives on shells, at a depth of 75 m, on a stony substrate.

Distribution. The species was found by me in the southeastern part of the Barents Sea, toward the northwest and south of Kolguyev Island. Thus far the species is endemic to the Barents Sea.

10. **Alcyonidium albidum** Alder, 1857 (Figure 106)

Alcyonidium albidum Alder, 1857a : 25, pl. XIII, f. 5-6; Levinsen, 1894 : 80, t. VIII, f. 1; Marcus, 1940 : 307, f. 160.

The zoarium is prostrate, overgrowing, translucent, yellowish-white in color, and consists of irregularly arranged zooids. The zooids are located sometimes on one plane, and sometimes, depending upon the underlying substrate (branched hydroids), they form raised bundles; the neighboring zooids are directed sometimes to one side, sometimes in different angles, or even to the opposite side. The zooids are minute (total length 0.50 mm, length of the procumbent part 0.35 mm, width 0.20 mm, length of the raised, distal part 0.15 mm); their prostrate part is oblong, bent at a right angle, oval in shape, and more or less convex, while the distal end uprises in the form of a gradually tapering free tube with an orifice at the tip, often assuming a lagena-like shape. The zooids are covered with a more or less compact chitinous coating, because of which the transversely annular folds are not noticeable at the surface. The "intertentacular organ" is present. The number of tentacles is 20, but Alder (1857a) reported 18. Since 2 median tentacles participate in the formation of the "intertentacular organ," the free tentacles are always 18 and if Alder counted only these, then our data agree.

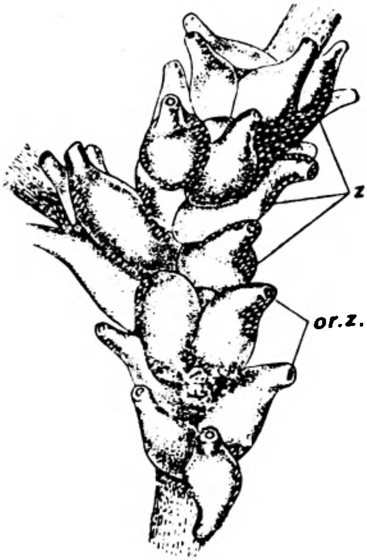


Figure 106. *Alcyonidium albidum* Alder. A zoarium. Barents Sea.

The species lives on algae, hydroids, and shells, at a depth of 25 to 135 m, on a bed of silt, sand, and stones.

Distribution. Reports in literature: Barents Sea in the region of Isfjorden (Smitt, 1867), Kola Bay (Kluge in Deryugin, 1915), Kara Sea (Levinsen, 1887), waters off Denmark (Levinsen, 1894; Marcus, 1940), and Great Britain (Alder, 1857b; Hincks, 1880a).

The species is Arctic-boreal.

11. **Alcyonidium disciforme** Smitt, 1872 (Figure 107)

Alcyonidium mamillatum var. *disciforme* Smitt, 1872a : 1122, t. 20, f. 9; *A. disciforme* Smitt, 1879a : 11; *et auctt.; A. Brucei* Calvet, 1903 : 33, f. 1-4.

The zoaria are free-growing, prostrate, not attached, round, flat like a cake or annulate, yellowish-gray in color, and attain 65 mm in diameter. The consistency of the zoaria is more or less dense and gelatinous. The zoaria are single-layered and either more or less convex or flat. Their convex or upper flat side forms the frontal surface, and the lower or concave side forms the basal surface. The zooids are located in regular, bent, crossing rows that widen gradually from the center toward the periphery, simultaneously exhibiting the branching of the rows. The frontal surface of the zoarium consists of a rhombic or hexagonal surface which forms the frontal surface of the individual zooids; in the center of the latter is located a round, raised part with the orifice of the zooid situated in the middle. The lower or basal surface of the zoarium consists of barely noticeable oblong-hexagonal, almost rhombic surfaces, usually covered with 2 longitudinal rows of more or less short, radicular tubes, which in totality give the impression that the basal side is covered with continuous one- or two-rowed radial lines of radicular fibers (threads) from the center of the zoarium toward the periphery. The periphery is surrounded by a relatively narrow, annular layer of uniform, rectangular buds (primordia) or the future zooids. Initially, the zoarium has the appearance of a more or less convex circle, in which the zooids closely adjoin each other, but together with the growth in the center of the zoarium, a round orifice emerges giving the zoarium a ring-like appearance. As the zoarium continues to develop, this orifice increases still further because the older zooids located nearer to its center die off. The formation of the central orifice takes place at different times in different zoaria; sometimes the zoaria attain a diameter up to 10 mm and do not have an orifice, but instances are frequent in which zoaria with a diameter of 5 to 6 mm have an orifice of 1 mm; one zoarium of 3.5 mm had an orifice of 0.5 mm; in any case the orifices were formed very early in the majority of samples, i.e., in the first year of their growth. With further development, the dying off of old zooids sets in with whole rings of several generations at one time, i.e., a periodical separation of the annular layers takes place. The annular rings are very noticeable on large zoaria, as on the largest one shown here which, at one time, had a diameter of 62 mm with an orifice of 22 mm and 3 prominently raised, annular rings; since at least 2 of these rings could have been included inside the orifice, this zoarium was at least 5 to 6 years old. An interesting phenomenon

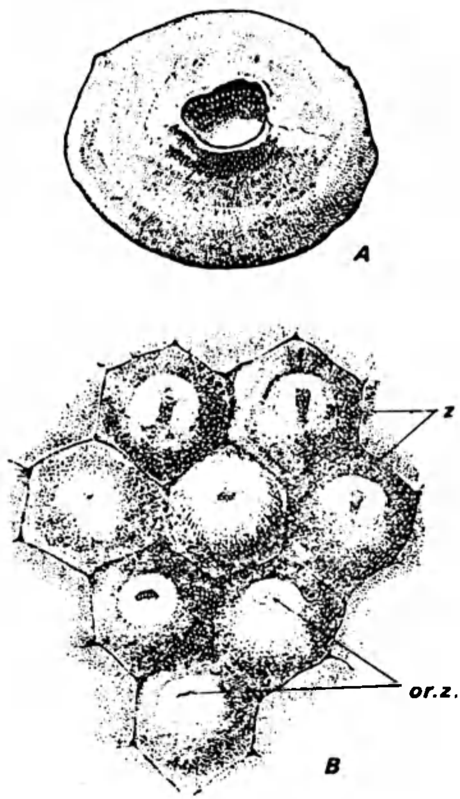


Figure 107. *Alcyonidium disciforme* Smitt. *A*—general view of a zoarium from the frontal side; *B*—part of the surface of a zoarium from the same side. Laptev Sea.

is observed in the East Siberian and Chukotsk seas, which is not found in the more southern seas, i.e., the incomplete rings are more or less divided into lobes of different sizes; the latter are not simply broken pieces, but lobes with smooth and intact edges that broaden toward the periphery. Often a small lobe develops on the margin near the broadened periphery. The polypides in *A. disciforme* differ from those in other species by a relatively long esophagus and a large stomach, as well as by the presence of peculiar tubes 0.40 mm and 0.08 mm long, located near the base of the tentacles, whose function could not be determined. The number of tentacles is 14 to 16, but Andersson (1902) reported 19 to 22, Calvet (1903) 16 to 18, and Osburn (1953) 16.

The species lives on a bed of silt and sand, settling with their radicular fibers (threads) between the particles of silt or sand, at a depth of 1 to 570 m, often from 10 to 150 m, under temperatures ranging from -1.75 to 4.5°C, in a salt concentration of 31.44 to 34.94‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, and Bering seas, and in the Devisov Strait. *Reports in literature:* Barents Sea (Smitt, 1872a; Bidenkap, 1897; Nordgaard, 1900, 1912a, 1912b; Calvet, 1903; Kluge in Deryugin, 1915; Zenkevich, 1927), Kara Sea (Smitt, 1879a; Levinsen, 1887; Nordgaard, 1912b; Kluge, 1929), Laptev Sea (Kluge, 1929; Abrikossov, 1932), East Siberian Sea (Kluge, 1929), waters of the Archipelago of the Canadian Islands (Osburn, 1932, 1936), western Greenland (Levinsen, 1914), eastern Greenland (Andersson, 1902; Levinsen, 1914), northern Norway (Nordgaard, 1905).

This is an Arctic, circumpolar species.

*12. **Alcyonidium parasiticum** (Fleming, 1828) (Figure 108)

Alcyonidium parasiticum Smitt, 1867 : 498, 514, t. XII, f. 14-19; Hincks, 1880a : 502, pl. LXIX, f. 4-6; Levinsen, 1894 : 80, t. VII, f. 27-32.

The zoarium is prostrate, overgrowing, and saturated with silty particles which provide a layer of greenish-gray mud. The zoarium initially consists of individual, minute (length 0.45 mm, width 0.22 mm), oval zooids connected by a common stem; the surface is covered with minute, spiny papillae. Simultaneous with the overgrowth of the zoarium, the zooids come closer, forming bundles and giving rise to a continuous and fairly thick, soft layer, in which the oval zooids are still noticeable near the margin, divided by the interzooidal walls, and covered with minute papillae; in the older parts of the zoarium the polygonal surfaces can be marked out (0.25 to 0.30 mm in the cross section), surrounded along the margin by longer papillae making the margin opaque, with surfaces covered by a thin, transparent, frontal membrane which has the round orifice of the zooid in its center; the tentacular crown protrudes through this orifice. The number of tentacles is 15 to 16 according to Hincks.

The species primarily lives on hydroids, particularly on different species of *Sertularia*, but it is not a parasite in the true sense of the term. It dwells at a depth from a few meters to 133 m.

Distribution. Reports in literature: Although it was once reported that this species exists in the Barents Sea (Bidenkap, 1900a: 531), on verification, the identification was proved wrong (Kluge, 1906). Keeping in mind that the species is widely distributed in the neighboring western seas—the waters off Iceland (Nordgaard, 1924), Great Britain (Hincks, 1880a), North Sea (Borg, 1930a), Skagerrack (Smitt, 1867), Kattegat (Levinsen, 1894; Marcus, 1940), and the southwestern part of the Baltic Sea (Borg, 1930a)—the possibility of its existence in our waters cannot be excluded.

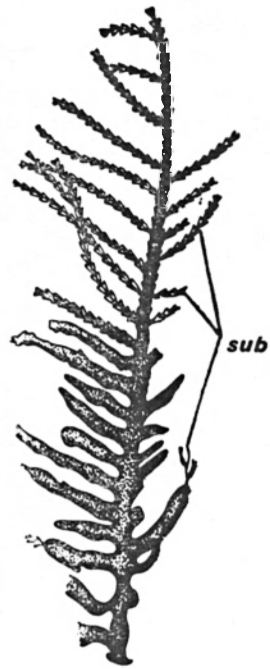


Figure 108. *Alcyonidium parasiticum* (Fleming) (from Hincks, 1880b).

II. Family **Flustrellidae** Hincks, 1880

Flustrellidae Hincks, 1880a : 504; *Halcyonellea* Smitt, 1867 : 496 (part.).

The zoaria are prostrate, overgrowing or free-growing, and soft. The zooids are arranged either in regular and straight, oblique, or irregular rows. The zooids are roundish-hexagonal or oval in shape. The orifice is located near the distal end of the zooid in the form of a transverse slit, formed by 2 thick labia, the margins of which are more chitinized; the lower or proximal labium is larger, more mobile, and more strongly chitinized, because of which its body closes the orifice like a lid or operculum in *Cheilostomata*. In *Alcyonidiidae*, this orifice is formed from a simple circular fold, which closes the orifice. In addition to the zooids or autozooids, there are kenozooids in the zoarium of different sizes and various forms, located either from the distal side or around the zooids, which have more or less strongly chitinized, hollow spines. The spines may be simple or branched. The larvae have a bivalved, chitinous shell.

Genus **Flustrella** Gray, 1848

Flustrella Gray, 1848 : 108, 146; Hincks, 1880a : 504; *Flustra* (part.) Fabricius, 1780 : 438; *Alcyonidium* (part.) Smitt, 1867 : 499.

This is the only genus and it has the same characteristics as the family. Genus type: *Flustra hispida* Fabricius, 1780.

1 (4). Zoaria prostrate, single-layered.

2 (3). Spines simple, unbranched, and located along the distal and lateral margins of the zooid............1. *F. hispida* (Fabricius).

3 (2). Spines branched and consist of a flattened pivot (flagellum) from which small, pointed spinules originate. Spines located either near one or both distal corners of the zooid...2. *F. corniculata* (Smitt).

4 (1). Zoaria free-growing, branched.

5 (6). Spines usually simple, unbranched, located around the zooid; rarely, small spines develop near the base......5. *F. vegae* Silen.

6 (5). Spines branched.

7 (8). Spines consist of a short stem that soon divides into 3 or 4 short branches on the free end. Zooids small..................................3. *F. cervicornis* (Robertson) (part.).

8 (7). Spines compoundly branched, consist of a short round flagellum that soon divides into 2 or 3 branches, after which the latter are dichotomously branched, mostly one after the other. Zooids large................................4. *F. gigantea* Silen.

1. **Flustrella hispida** (Fabricius, 1780) (Figure 109)

Alcyonidium hispidum Smitt, 1867 : 499, 517, t. XII, f. 22-27; *Flustrella hispida* Hincks, 1880a : 506, pl. 72, f. 1-5.

The zoaria are prostrate and barely affixed to the substrate in the form of a thick (1.25 mm), soft, yellow-gray layer which is irregular in form. The zooids are either located in regular rows in a checkered pattern, or sometimes irregularly. They are large (length 0.90 to 1.13 mm, width 0.50 to 0.65 mm) and broad, have an oblong, roundish-rectangular or oval form, and are covered with a translucent, yellow, chitinous layer with a flat and smooth surface. In the distal part of the zooid is located a slightly raised, bilabiate, transverse orifice, which closes with a mobile lower labium that is a little more chitinized and darker in color along the margin. Often during the examination of the preserved preparations, many fairly long projections could be seen through the orifice, which were transversely bilabiate in form and white in color—the base of the tentacular sheath—remaining because of the incompletely retracted polypide. The young zooids are surrounded by a few small slightly chitinized spines along the margin of the distal half of the zooid, and the older zooids are surrounded on the distal and lateral sides, by large and thick spines of a dark brown color, pointed at the distal ends, broad near the very base, and frequently slanted toward each other. Their development and number vary: in some zoaria they are relatively shorter and fewer in number, and surround only the orifice of the zooids from the distal end; in others, on the contrary, they are long (up to 1 mm), thick and numerous (up to 10 to 16), and arranged from the distal side of the orifice and along the lateral margins of the zooids. The number of tentacles is 35 according to Dalyell (1847)—the maximum among the members of *Ctenostomata.*

The species lives on algae, mostly on fuci, in the belt of ebb and flow, on a stony bed.

Distribution. The species was found by me in the Barents Sea (in

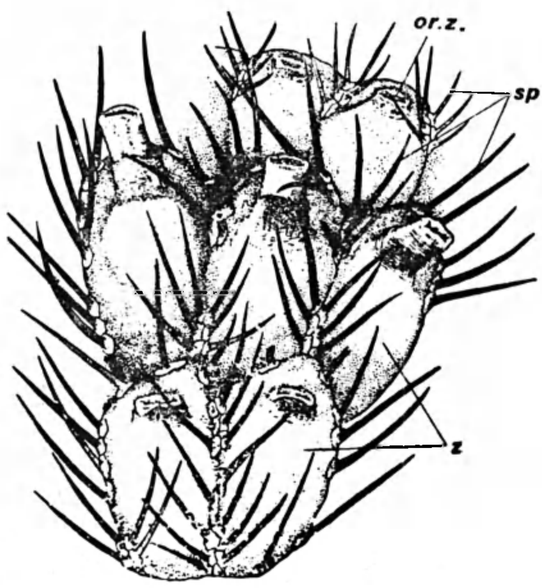


Figure 109. *Flustrella hispida* (Fabricius).
A part of a zoarium. Barents Sea.

Kola Bay and the Dalne-Zelenetskaya Inlet). *Reports in literature:* Barents Sea (M. Sars, 1851; Nordgaard, 1905, 1912a; Gur'yanova, Zaks and Ushakov, 1928; Kuznetsov, 1941), White Sea (Kluge, 1908; Gostilovskaya, 1957), coastal waters off western Greenland (Levinsen, 1914), Norway (M. Sars, 1851; Nordgaard, 1918), Skagerrack and Kattegat (Smitt, 1867; Levinsen, 1894), southwestern parts of the Baltic Sea (Borg, 1930a), North Sea (Borg, 1930a), Great Britain (Hincks, 1880a), western coast of France (Fischer, 1870; Joliet, 1877), western coast of the Atlantic Ocean from the Gulf of St. Lawrence to Woods Hole (Whiteaves, 1901; Osburn, 1912, 1933) and lastly, in the Pacific Ocean from the southern part of Alaska to California (Robertson, 1900).

This is an Arctic-boreal species.

2. **Flustrella corniculata** (Smitt, 1872) (Figure 110)

Alcyonidium corniculatum Smitt, 1872a : 1123, t. XX, f. 10-16; *Flustrella corniculata* Nordgaard, 1905 : 173, pl. III, f. 37, 38; Silen, 1947 : 137, f. 5-6.

The zoaria are prostrate, overgrowing in the form of small, thick (up to 1 mm), soft, one-layered surfaces of yellowish color. The zooids are located in more or less regular, oblique rows. The zooids are medium

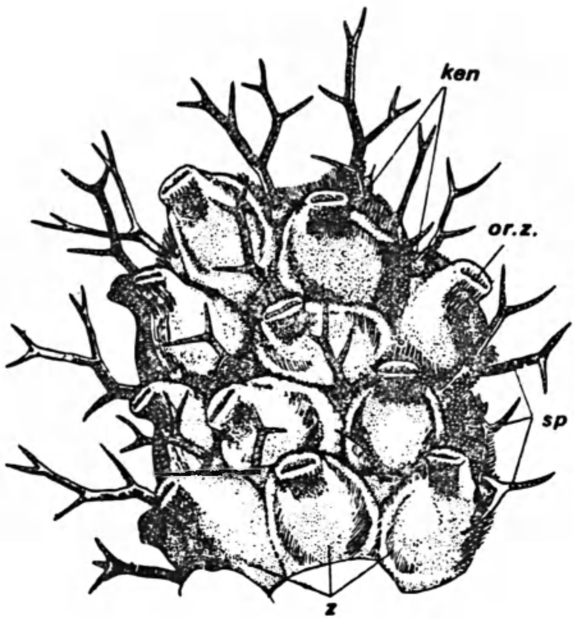


Figure 110. *Flustrella corniculata* (Smitt). Part of a zoarium. Novaya Zemlya (the Matochkin Shar Strait).

in size (length 0.75 to 1.00 mm, width 0.50 to 0.63 mm), broad, roundish-hexagonal or oval in form, covered with a translucent, pale yellow, chitinous layer, and have a smooth, flat surface. Located in the distal part of the zooid is a labial transverse orifice, which is covered with a more chitinized, mobile, lower labium. Usually in both distal corners, rarely near one of them, small kenozooids are located in the form of a triangular surface, each of which has a large (length up to 1.38 mm and width 0.12 mm) flat, spiniform flagellum, forming small, pointed, spine-like protuberances on both sides; the flagellum bifurcates only at the very end, and usually all the branches thus formed are on one level, corresponding to the plane of flattening of the flagellum, but it is not rare to find that the primary fork, or the secondary forks at the ends of the branches of the primary one, become situated on a plane perpendicular to the plane of the flagellum's flattening. There are 18 tentacles according to Smitt.

The species lives on algae, from the littoral to 52 m, often up to 10 m, on a bed of stone, shells, and silt, under temperatures ranging from 1.5 to 5.6°C.

Distribution. The species was found by me in the Barents Sea in the Isfjorden in Spitsbergen, along the Murmansk coast, and the entrance to the Kara Sea in the Yugorsk Shar. *Reports in literature:* Barents Sea (Smitt, 1872a; Bidenkap, 1900a; Andersson, 1902; Norman, 1903a), waters of the Archipelago of the Canadian Islands (Osburn, 1936), western Greenland (Levinsen, 1914), Yan-Maien Island (Lorenz, 1886; Andersson, 1902), and northern Norway (Nordgaard, 1905, 1918).

This is an Arctic species.

3. **Flustrella cervicornis** (Robertson, 1900) (Figure 111)

Alcyonidium cervicornis Robertson, 1900 : 330, pl. XXI, f. 15-16.

The zoaria are free-growing, small, and yellowish-brown in color. The zooids are small, irregularly arranged, and surrounded by numerous individual surfaces of different sizes and forms—the kenozooids with branched spines. The spines are small, strongly chitinized, brown in color, and consist of a short, straight, thick, round flagellum which, at the end, divides almost simultaneously into 3 or

Figure 111. *Flustrella cervicornis* (Robertson). Part of a zoarium. Barents Sea.

4 nearly equal sized branches that point toward the tip. Very rarely the main flagellum divides at the end into only 2 branches, and still more rarely, one of these branches divides again into 2 branches at the tip, but a secondary ramification of the latter was not found to occur. The spines develop in such a quantity that the whole surface of the zoarium is almost continuously covered with them, and the zooids under them are observed with difficulty. The closed orifice can be noticed along the chitinized margin of the lower labellum.

The species lives on algae, Bryozoa, and shells.

Distribution. The species was found by me in the Bering Sea near Bering Island. *Reports in literature:* coastal waters of southern Alaska (Robertson, 1900).

This is a Pacific, boreal species.

4. **Flustrella gigantea** Silen, 1947 (Figure 112)

Flustrella gigantea Silen, 1947 : 134; Text f. 1-3, pl. I, f. 3-4; *Alcyonidium cervicornis* Robertson, 1900 : 330 (part.), pl. XXI, f. 17.

The zoaria are free-growing, ramose, soft, yellowish-gray in color, and reach up to 15 cm in height. The branching is close, as though dichotomous. The branches are very elastic, located on one plane, two-layered, and not very broad (from 6 to 10 mm in width), but they widen before the point of bifurcation, and look as though they had been cut at the ends. The zooids are large (length 1.25 to 1.40 mm, width 0.88 to 1.00 mm), roundish-hexagonal or oval in form, and covered with a translucent, yellowish, chitinous layer that has a flat, smooth surface. A slightly raised bilabiate, transverse orifice whose proximal labium is strongly chitinized, is located in the distal part of the zooid. The zooids rarely adjoin each other directly; usually 3- to 4-sided or multifaceted surfaces are located around the distal ends, which are devoid of orifices; these are the kenozooids which have branched, chitinous spines on their bodies. These spines start as more or less thick, round stems, which soon divide into either 2 to 3 branches after which the latter are dichotomously branched from 2 to 4 times, ending with thin, pointed spinules. The secondary branches originate as if on a plane parallel to the surface of the zoarium, because of which the latter looks as though it were covered by a net of thin, intertwined spines.

This species lives on shells, at a depth from 37 to 47 m, under temperatures ranging from −0.6 to 2.22°C, in a salt concentration of 31.94 to 32.74‰.

Distribution. The species was found by me in the Bering Strait and the

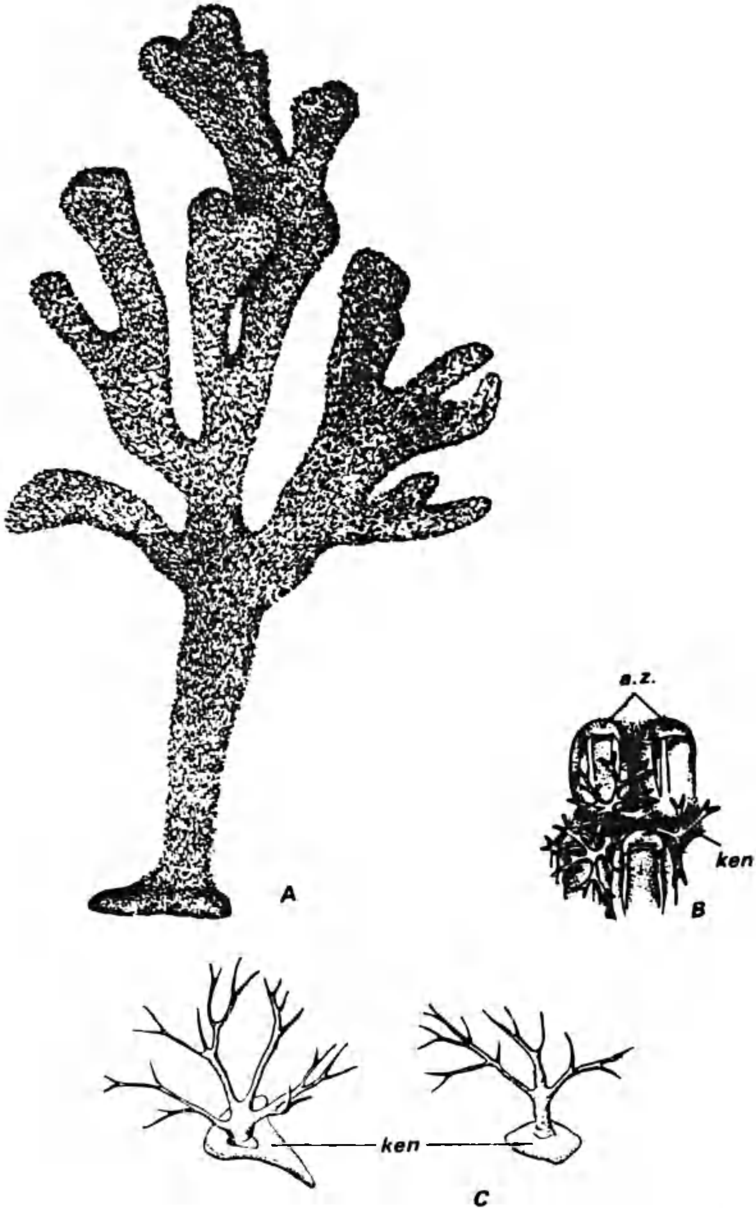


Figure 112. *Flustrella gigantea* Silen. *A*—a young zoarium; *B*—view of zooids from the frontal side; *C*—spines with different types of branching.

Bering Sea, as well as along the southern coast of Alaska. *Reports in literature:* Bering Sea (Silen, 1947), and the Pacific coast of southern Alaska (Robertson, 1900).

This is a Pacific, boreal species.

5. **Flustrella vegae** Silen, 1947 (Figure 113)

Flustrella vegae Silen, 1947 : 136, Text. f. 4, pl. I, f. 1-2.

The zoarium is free-growing, strongly branched, brown in color, and attains up to 5 to 6 cm in height. The branching is dense and irregular, starts near the base of the zoarium, and proceeds tightly, almost simultaneously, one after the other. The branches lie nearly on one plane; they are relatively narrow, attain 4 to 5 mm in width and 2 to 2.5 mm in thickness while tapering at the tips. The zooids, located irregularly, are comparatively small in size (length 0.50 to 0.63 mm, width 0.35 mm), roundish-hexagonal or oval in form, and covered with a translucent, pale yellow, chitinous layer which has a smooth, flat surface. The barely raised, bilabiate orifice is located in the distal part of the zoarium, and covered with a slightly chitinized, lower labium. The zooids never adjoin each other directly, as they are surrounded by relatively larger kenozooids, which sometimes equal the zooid in size. Each kenozooid has a strong, simple, long, and chitinous spine, sharpened at the end and brown in color. Occasionally spines are found among these spines which are bifurcated near the base, but they are always smaller in size.

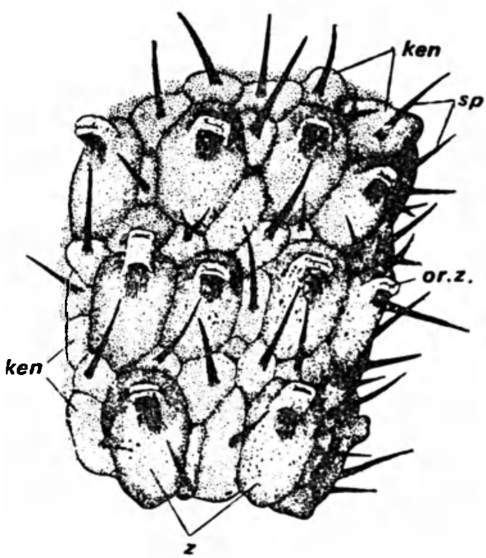


Figure 113. *Flustrella vegae* Silen. Part of the surface of a zoarium. Bering Sea.

This species lives on stones and shells, at the same depth as *F. gigantea;* the two are frequently found together.

Distribution. The species was found by me in the Bering Sea near Bering Island, and near Unalaska Island. *Reports in literature:* Bering Sea (Silen, 1947).

This is a Pacific, boreal species.

II. Subroder **Paludicellea** Allman, 1856

Paludicellea Allman, 1856 : 10, 76; Harmer, 1915 : 43; Silen, 1942a : 22.

The zoaria are prostrate. The zooids consist of a tapering proximal part which, in certain forms, may be stretched out in the form of a more or less long, thin tube, and a wider, distal part, which includes the polypide with an orifice near the distal end. This orifice may be located at the tip of the significantly raised papilla, and the distal part, together with the polypide, may be markedly stretched out and raised above the surface of the zoarium as though it were a free-growing zooid separated from the widening of the prostrate, tubular, proximal part of the zooid. The gizzard is absent.

Key for Identification of the Families of the Suborder Paludicellea

1 (2). Zooids prostrate on the substrate by their proximal as well as their distal part.. ....I. *Arachnidiidae* Hincks (see below).
2 (1). Zooids prostrate on the substrate by their proximal part; their distal part and the polypide are raised above the surface........ ....II. *Nolellidae* Harmer (see p. 251).

I. Family **Arachnidiidae** Hincks, 1880

Arachnidiidae Hincks, 1880a : 508; Harmer, 1915 : 48; *Hislopiidae* Annandale, 1911 : 197.

The zoaria are prostrate, membranous, and reticulately branched. The zooids consist of either a narrow, tubular, proximal part, sometimes fairly oblong, and a more or less widened distal part, or they are devoid of the oblong, tubular, proximal part, and consist merely of a widened part surrounded by protuberances on the margins. There is a round orifice near the distal end of the zooid.

Key for Identification of the Genera of Arachnidiidae

1 (2). Widened prostrate part of the zooid is not marginally surrounded by different protuberances. Orifice near the distal end of the zooid located on the small, raised, round papilla...........

....1. *Arachnidium* Hincks.

2 (1). Widened prostrate part of the zooid marginally surrounded by variable protuberances. Orifice situated at the end in the form of a long, raised, distal, tubular part of the zooid.............
.....................................2. *Arachnoidea* J. Moore.

1. Genus **Arachnidium** Hincks, 1859

Arachnidia Hincks, 1859 : 128; *Arachnidium* Hincks, 1880a : 508; Harmer, 1915 : 48.

The zoaria are either in the form of irregular, reticulately arranged zooids, or the zooids are arranged in one row. The daughter zooids start from the maternal zooid either from its distal end, or from the distal sides; in the latter case, the branches often start at a right angle. The branches anastomose with each other, but generally the zooids are more or less separated. The zooids are oblong and narrow in the beginning with a tubular form, and then grow out into a widened part which considerably varies in form. The orifice is near the distal end of the zooid, situated on a small, raised, round papilla.

Genus type: *Arachnidium hippothoides* Hincks.

1 (4). Zoarium branched, with a reticulate structure.

2 (3). Zooids large, oblong, widened in the distal part, and gradually tapering toward the proximal end......................
.....................................1. *A. clavatum* Hincks.

3 (2). Zooids oblong, consist of a wider oval, distal half, and a tapering, thin, tube-like, proximal half........................
.....................................2. *A. hippothoides* Hincks.

4 (1). Zooids arranged in one unbranched row................
....3. *A. Simplex* Hincks.

1. **Arachnidium clavatum** Hincks, 1877 (Figure 114)

Arachnidium clavatum Hincks, 1877b : 216; 1880a : 510, pl. LXXI, f. 3-5; *Arachnidia hippothoides* Norman, 1869 : 311.

The zoarium is prostrate, and consists of irregular, reticulately located zooids. The zooids are large (length 0.95 to 1.25 mm, maximum width 0.28, width of the proximal part 0.05 mm), oblong, widened in the distal part, and gradually tapering toward the proximal end. A small, round papilla is located near the distal end with an orifice at the tip. The formation of the daughter zooids takes place from the distal end, as well as from the lateral sides of the distal half at different angles, due to which the zoarium acquires an irregularly reticulate structures. Sometimes the lateral sides of 2 to 3 zooids fuse directly.

The species lives on ascidia, at a depth of 11 to 108 m, on a bed of silt, sand, and shells; at temperature of 3.7°C.

Distribution. The species was found by me in the Barents Sea in Kola Bay, and in Isfjorden in Spitsbergen. *Reports in literature:* Shetland Islands (Norman, 1869; Hincks, 1880a).

This is an Atlantic-boreal species.

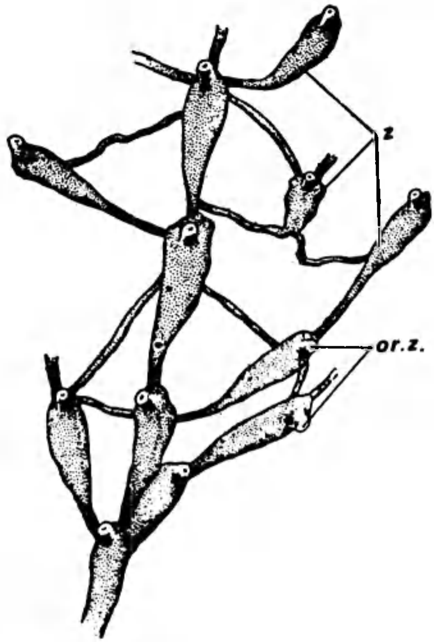


Figure 114. *Arachnidium clavatum* Hincks. Part of a zoarium. Barents Sea (Kola Bay).

2. **Arachnidium hippothoides** Hincks, 1862 (Figure 115)

Arachnidia hippothoides Hincks, 1862 : 471, pl. XVI, f. 2; *Arachnidium hippothoides* Hincks, 1880a : 509, pl. LXXI, f. 1-2; Andersson, 1902 : 509.

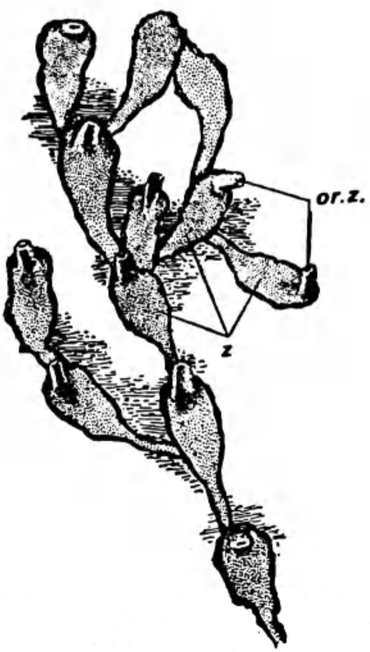


Figure 115. *Arachnidium hippothoides* Hincks. Part of a zoarium. Barents Sea.

The zoarium is prostrate, and consists of irregularly located one-rowed zooids which anastomose with each other. The zooids are light brown in color, oblong, and consist of 2 more or less definitely distinct parts: the broad, oval, distal half, and the proximal half which tapers in the form of a thin tube. Depending upon the length of the latter, the zooids are either located close together or separated. Frequently, the lateral branches start at right angles from the maternal zooid. The orifice is located on the small, round papilla near the distal end of the zooid.

The species lives on ascidia and and shells, at a depth of 10 to 80 m, on a bed of shells and stones.

Distribution. Reports in literature: Barents Sea in Isfjorden in Spitsbergen (Andersson, 1902), and the Irish Sea (Hincks, 1880a).

This is an Arctic-boreal, Atlantic species.

3. **Arachnidium simplex** Hincks, 1880 (Figure 116)

Arachnidium simplex Hincks, 1880b : 284, pl. XV, f. 10-11.

The zoarium is prostrate and consists of one unbranched row of zooids. The zooids are oblong, wider in the distal half, and gradually tapering toward the proximal end, which transforms into a thin, tubular part that connects them. The orifice near the distal end of the zooid is located on the raised, round papilla.

The species lives on the stems and branches of Bryozoa *Menipea,* at a depth of 111.6 m.

Distribution. Reports in literature: Barents Sea, in the southeastern part of the open sea (Hincks, 1880b).

Thus far this species is endemic to the Barents Sea.

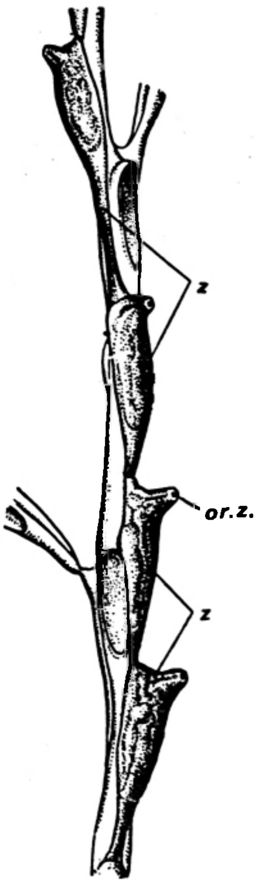


Figure 116. *Arachnidium simplex* Hincks. Part of a zoarium on a branchlet of the Bryozoa *Eucratea.* Kara Sea.

2. Genus **Arachnoidea** J. Moore, 1903

Arachnoidea J. Moore, 1903 : 297; Harmer, 1915 : 50.

The zoarium consists of relatively large, more or less separated zooids. The zooids consist of either a prostrate, proximal part in the form of a long, narrow tube, widened at the end, and a significantly raised, distal part which has an orifice on its free end, or they are devoid of the narrow tube and consist of a wide proximal part and a fairly raised, distal, tubular part which has the orifice at the end. In both instances, the prostrate, widened part is surrounded by different protuberances at the margins. The branching is often cruciate. The collar is more or less long.

Arachnoidea barentsia Kluge sp. n. (Figure 117)

The zoarium is prostrate and consists of more or less separated zooids, often located cruciately. The zooids are relatively large (length of the prostrate part 0.63 to 0.75 mm, width 0.45 mm, length of the raised tubular part 0.75 mm), and consist of a prostrate wider part and a long, raised, tubular part with an orifice at the free end. The wide, procumbent part is surrounded by different protuberances (hoods) on the margins, which are sometimes long and broad, sometimes short and narrow. These protuberances connect the zooids. The orifice of the zooids is rectangular. Unfortunately, the number of tentacles could not be counted.

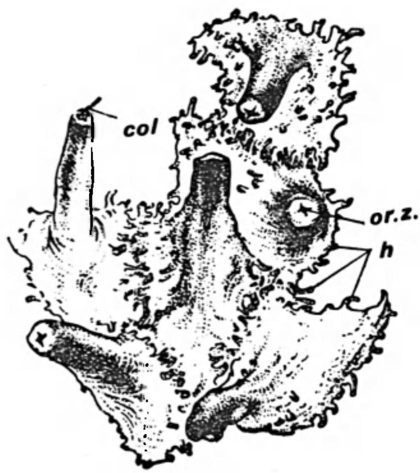


Figure 117. *Arachnoidea barentsia* Kluge. Part of a zoarium. Barents Sea.

This species was discovered on a fine grained, sandy bed, at a depth of 44 m, under a temperature of 2.3°C, in a salt concentration of 32.94‰.

Distribution. The species was found by me in the Barents Sea, toward the south of Kolguyev Island.

II. Family **Nolellidae** Harmer, 1915

Cylindroeciidae Hincks, 1880a : 534; *Nolellidae* Harmer, 1915 : 52.

The zoarium consists of oblong, cylindrical zooids raised freely above the surface; the base is formed by the widening of the thin, tubular stems which are procumbent on the substrate and anastomose with each other with the help of the branches originating from the widened bases of the zooids. The alimentary canal is devoid of a gizzard. The zooidal walls may be covered with a layer of fine, clay-like, calcareous, or sandy particles.

Genus **Nolella** Gosse, 1855

Nolella Gosse, 1855 : 35; Harmer, 1915 : 52; *Cylindroecium* Hincks, 1880a : 535.

This is the only genus, and its characteristics are the same as those of the family.

Genus type: *Nolella stipata* Gosse.

Nolella dilatata (Hincks, 1860) (Figure 118)

Cylindroecium dilatatum Hincks, 1880a : 536, pl. 77, f. 1-2; Prouho, 1892 : 626, pl. 24, f. 14-17; Marcus, 1940 : 327, f. 171; *Vesicularia fusca* forma *simplex* Smitt, 1867 : 503; t. XVIII, f. 38.

The zoarium consists of thin, tubular stems, procumbent on the substrate, which widen at definite intervals to form surfaces that make the base of the zooids, from which the cylindrical part of the zooid uprises vertically or diagonally. The outgrowths start from the base, usually from one or both sides, and are connected with the stem or the base of neighboring zooids, out of which the base of the zooids is formed and lies prostrate on the substrate. The zooids are large in size (length 1.25 to 1.75 mm, width 0.23 mm); they have a uniform width throughout their length, and thin, transparent, chitinous walls, which are sometimes encrusted with very minute grains of sand. The orifice is at the apex of the zooid. The gizzard is absent. The number of tentacles is 18 to 20.

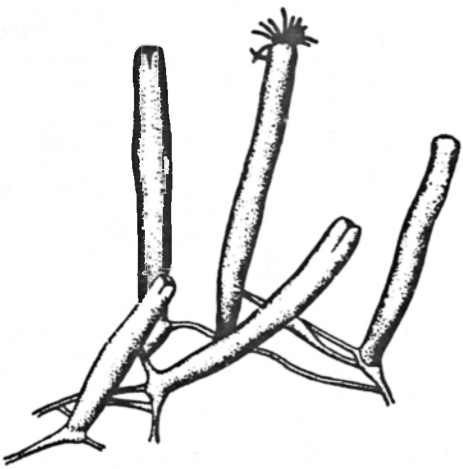


Figure 118. *Nolella dilatata* (Hincks). Part of a zoarium (from Hincks, 1880a).

The species lives on algae, hydroids, Bryozoa, and shells at a depth of 15 to 235 m, on a bed of pebbles, under a temperature of -1.2°C, in a salt concentration of 34.53‰.

Distribution. The species was found by me in the Barents and Bering seas. *Reports in literature:* Barents Sea (Norman, 1903a; Waters, 1904; Nordgaard, 1918), northern coastal waters of North America (Osburn, 1923), western Greenland (Osburn, 1919), Yan-Maien (Lorenz, 1886), Norway (Norman, 1903a), Boguslen (Smitt, 1867), northwest France (Joliet, 1877), and the Mediterranean Sea (Calvet, 1902).

This is an Arctic-boreal species.

III. Suborder **Stolonifera** Ehlers, 1876

Stolonifera Ehlers, 1876 : 126 (part.); Hincks, 1880a : 512; Harmer, 1915: 72 (part.); Borg, 1930a : 100; Silen, 1942a : 23; *Vesicularieae* Smitt, 1867 : 500.

More or less long tubes are formed by lateral budding from the ancestrula; they are devoid of polypides and orifices, and are filled with an unspecialized tissue, or kenozooids.

During successive budding, the kenozooids at the distal end give rise to new kenozooids; thus long tubes or stolons are formed which are divided by transverse walls—the boundaries of the kenozooids—into separate parts known as internodes. The stolons may be procumbent on the substrate or free-growing, simple, or branched. The lateral or surface budding of the stolon forms autozooids or zooids. Since these zooids do not produce buds for the development of their own types from themselves, the zooids in *Stolonifera* consequently have no direct connection with each other. They are arranged either in the internode or singly, separated from each other, or in pairs, bundles, or a mixture of all three; they are white in color. In addition to the bundles, single zooids are also found in one or the other place. They are either oval or cylindrical; their body wall, in the majority of cases, is continuously chitinized, smooth, and only in some species is it equipped with spiny hoods. The orifice is situated on the distal end. The gizzard is sometimes present, sometimes absent.

Key for Identification of the Families of the Suborder Stolonifera

1 (2). Zooids pedunculate, consist of 2 mobile, articulated parts: the upper, wider one includes the polypide, and the lower one is in the form of a hard stalk or peduncle...III. *Triticellidae* G. O. Sars (see p. 263).

2 (1). Zooids not pedunculate.

3 (4). Small oval zooids; the extended, free fore ends lie by their flat lower side toward the procumbent side...IV. *Buskiidae* Hincks (see p. 265).

4 (3). Zooids vertically stand on the prostrate or free-growing stolon.

5 (6). Zooids attached directly to the more or less thick stolon along its entire length. Gizzard present...I. *Vesiculariidae* Johnston (see p. 254).

6 (5). Zooids usually attached to the lateral branches of a relatively thin stolon, singly, or in groups. The branches start proximally from the diaphragm (septum) by which they are divided into

short internodes. Gizzard absent.............................
............................II. *Valkeriidae* Hincks (see p. 261).

I. Family **Vesiculariidae** Johnston, 1838

Vesiculariidae Johnston, 1838 : 247 (part.); Gray. 1848 : 94 (part.); *Vesiculariidae* Hincks, 1880a : 512; Harmer, 1915 : 60.

The zoarium consists of a prostrate or free-growing stolon and the zooids originate from it. The stolon is of uniform thickness throughout its length, or it branches and narrows toward the ends; the branching is dichotomous, pinnate, or irregular. The zooids start from the stolon either singly or in pairs, or in paired bundles, or in a fruticulose manner. The zooids are thin-walled, and oval or cylindrical; they taper on the proximal end, and drooping, do not fuse with the stolon compactly. The gizzard is present.

Genus **Bowerbankia** Farre, 1837

Bowerbankia Farre, 1837 : 391; Hincks, 1880a : 518; Harmer, 1915 : 70; Borg, 1930a : 100; Marcus, 1940 : 312; *Vesicularia* Smitt, 1867 : 500 (part.).

The zoarium is prostrate or free-growing. The stolon is of uniform thickness throughout its length; branching is irregular. Cylindrical or oval zooids originate from the stolon either in groups or singly. The zooids are thin-walled, transparent, and have a gizzard.

Genus type: *Sertularia pustulosa* Ellis and Solander.

1 (8). Stolons simple or branched, not fused in bundles.
2 (3). Zoarium free-growing, dependent. Zooids arranged in groups, consist of 2 rows and form a half-spiral around the stolon.......
............................1. *B. pustulosa* (Ellis and Solander).
3 (2). Zoarium prostrate, sometimes with free terminal branches. Zooids arranged singly or in groups, but not spirally.
4 (5). Diameter of stolon less than half of the maximum width of the zooid. Zooids frequently arranged in pairs. Proximal ends of zooids narrow abruptly and produce a narrow, pointed hood from below or on the sides.............4. *B. caudata* Hincks.
5 (4). Diameter of stolon either more, or less, than half the maximum width of the zooid. Proximal ends of the zooids rounded.
6 (7). Diameter of stolon more than half the maximum thickness of the zooid. Zooids mostly arranged in dense groups, between which single zooids are spread. Zooids of medium size..........

.................................2. *B. imbricata* (Adams).

7 (6). Diameter of stolon less than half the maximum thickness of the zooid. Zooids primarily arranged singly, sometimes in sparse groups. Zooids large......................3. *B. arctica* Busk.

8 (1). Stolons fuse into more or less branched bundles which gradually narrow toward the ends of the branches...5. *B. composita* Kluge.

1. **Bowerbankia pustulosa** (Ellis and Solander, 1786) (Figure 119)

Bowerbankia pustulosa Hincks, 1880a : 522, pl. LXXVI, f. 1-5; Borg, 1930a : 102, f. 131-132; Marcus, 1940 : 312, f. 162.

The zoarium is in the form of a free-growing, dichotomously branched stolon, attaining a length up to 7.5 cm. The stolon is thick (diameter 0.25 to 0.38 mm), strong, divided by transverse septa into internodes, and light brown in color. In each internode the zooids are located in groups; each group consists of 2 rows of zooids forming a half-spiral around the stolon. The spiral arrangement of the rows of zooids can be easily observed in the young groups of zooids near the end of the branch. The zooids are small and oblong-oval shaped. The gizzard is present. The number of tentacles is 8 according to Hincks (1880a).

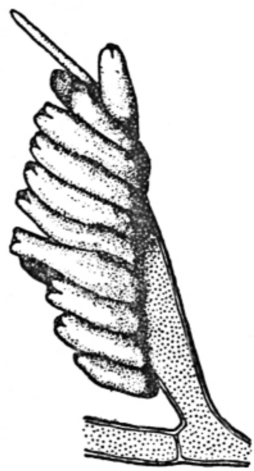


Figure 119. *Bowerbankia pustulosa* (Ellis and Solander). A group of zooids (from Hincks, 1880a).

The species lives mainly on laminaria and red algae, at a depth up to 20 m, on a bed of stone, under a temperature of 1.5°C.

Distribution. The species was found by me in the Barents Sea, in the region of Medvezhi Osa Island. *Reports in literature:* coastal waters of Helgoland Island in the North Sea (Borg, 1930a), British Isles (Hincks, 1880a), northwest France in the region of Roskov (Joliet, 1877), and the Mediterranean Sea (Calvet, 1902).

This is an Atlantic-boreal species.

2. **Bowerbankia imbricata** (Adams, 1800) (Figure 120)

Bowerbankia imbricata Johnston, 1847: 377, pl. LXXII, f. 5-6; Hincks, 1880a : 519, pl. LXXIII, f. 1-2; Borg, 1930a : 101, f. 127; *B. densa* Farre, 1837 : 391, pl. XX, XXI; *Vesicularia uva* Smitt, 1867 : 500, 519 (part.), t. XIII, f. 29-31.

The zoaria are in the form of prostrate and free-growing stolons, which are usually covered with small, spaced groups of zooids. The stolon is thick, usually more than half the largest width of the zooid (diameter

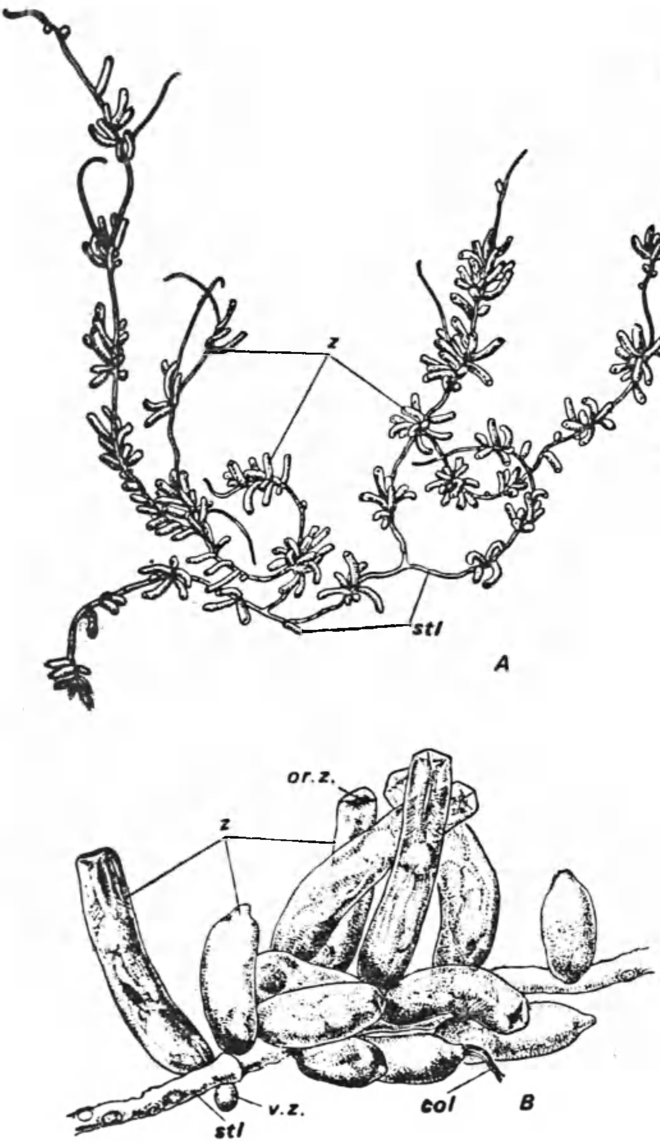


Figure 120. *Bowerbankia imbricata* (Adams). *A*—part of a zoarium with free-growing stolons; *B*—part of a stolon with a group of zooids; polypide visible through its walls. Barents Sea.

0.13 to 0.23 mm), branched, and divided by transverse walls located at varying distances in the internode. The zooids are transparent, cylindrical, medium sized (length 1.00 to 1.50 mm, width 0.25 to 0.30 mm), and usually located in paired groups before the diaphragm—8 to 12 in each place; but sometimes the zooids are found in the internodes in less specific groups and, rarely, are present singly. The orifice on the distal end of the zooid is rectangular. The gizzard is in the form of a spherical structure (diameter 0.10 mm), and continuously lined with very keratinized cells at the distal end. The number of tentacles is 14, but Hincks (1880a) reported 10.

The species lives on fuci, hydroids, Bryozoa, and stones, in the belt of ebb and flow and the upper sublittoral zone, at a depth of 0 to 53 m, on a bed of stone and sand, under temperatures ranging from 4.1 to 5.2°C, in a salt concentration of 32.27 to 33.22‰.

Distribution. The species was found by me in the Barents Sea, in the coastal waters of western Murmansk, Kolguyev Island, and in the Czeck Inlet. *Reports in literature:* Barents Sea in the waters of Finmark (Nordgaard, 1905, 1918), White Sea (Gostilovskaya, 1957), in the coastal waters of western Norway (Nordgaard, 1912a, 1918), Skagerrack and Kattegat (Smitt, 1876; Levinsen, 1894), North Sea (Borg, 1930a), Great Britain (Hincks, 1880a), northern France (Joliet, 1877), and the Mediterranean Sea (Calvet, 1902).

This is an Arctic-boreal species.

3. **Bowerbankia arctica** Busk, 1880 (Figure 121)

Farella—? sp. n. or *Bowerbankia arctica* Busk, 1880 : 240, pl. 13, f. 9; *B. arctica* Kluge, 1908b : 554; Nordgaard, 1912b : 29; *Vesicularia uva* Smitt, 1867 : 500, t. XIII, f. 32, 33.

The zoarium is in the form of a prostrate stolon. The stolon is not thick, usually less than half the maximum width of the zooid (diameter 0.08 to 0.10 mm), and rarely branched; its internodes are divided by transverse walls of

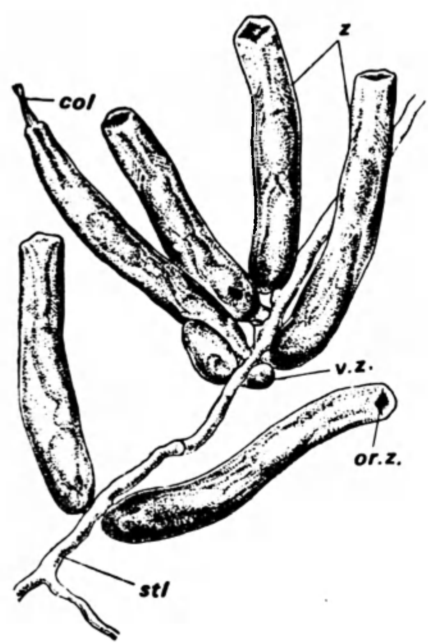


Figure 121. *Bowerbankia arctica* Busk. Part of a stolon with zooids, through whose walls the polypide is visible. Polar Basin (north of Franz Josef Land).

varying length. The zooids are transparent, cylindrical, more or less long (length 1.25 to 2.25 mm, width 0.20 to 0.30 mm), and located in the internode either singly or in separated (split) rows. The orifice on the distal end is rectangular. The gizzard is in the form of a lengthwise, oblong structure, and only its lower half is lined with keratinized and denticulated cells at the distal end. The number of tentacles is 16 to 17.

This species lives on hydroids, Bryozoa, shells, and stones, at a depth varying from 4 to 400 m, often from 50 to 200 m, on a bed of silt, stone, and shell, under temperatures ranging from −1.9 to 2.56°C, in a salt concentration of 33.25 to 34.96‰.

Distribution. The species was found by me in the Barents, White, Kara, Laptev, and East Siberian seas. *Reports in literature:* Barents Sea (Smitt, 1867, 1879b; Bidenkap, 1900a; Andersson, 1902; Nordgaard, 1907a, 1918; Kluge in Deryugin, 1915), White Sea (Kluge, 1908a; Gostilovskaya, 1957), Kara Sea (Smitt, 1897a; Levinsen, 1887; Nordgaard, 1912b; Kluge, 1929), Laptev Sea (Kluge, 1929), Archipelago of the Canadian Islands (Nordgaard, 1906a), western Greenland (Vanhöffen, 1897; Kluge, 1908b; Levinsen, 1914) eastern Greenland (Nordgaard, 1907a).

This is an Arctic species.

4. **Bowerbankia caudata** (Hincks, 1877) (Figure 122)

Valkeria caudata Hincks, 1877b : 215; *Bowerbankia caudata* Hincks, 1880a: 521, pl. LXXV, f. 7-8; Borg, 1930a : 101, f. 128, 129; Marcus, 1940 : 315, f. 164; *B. gracilis* var. *caudata* Osburn, 1912 : 254, pl. XXVIII, f. 79.

The zoarium is in the form of a prostrate stolon, sometimes with free terminal branches. The stolon is thin, less than half the maximum thickness of the zooid (diameter 0.08 mm), and has cylindrical zooids which, in the majority of cases, are located in pairs and originate on the sides (length from 1.25 to 2 mm, width 0.20 mm). The zooids are transparent; their distal end looks as though it had been cut and the orifice located on it is often rectangular in form. The proximal end, near the point of attachment of the stolon, narrows abruptly, and from the lower or outer sides, a pointed hood forms; besides this protuberance, one or several small, lobate protuberances are frequently formed near the base of the zooid. The gizzard is developed. The number of tentacles is 14, but Hincks (1880a) reported 8.

The species lives on algae, hydroids, Bryozoa, ascidia, shells, and stones at a depth of 20 to 86.5 m, on a bed of silt and stone, under a temperature of 5°C, in a salt concentration of 34.23‰.

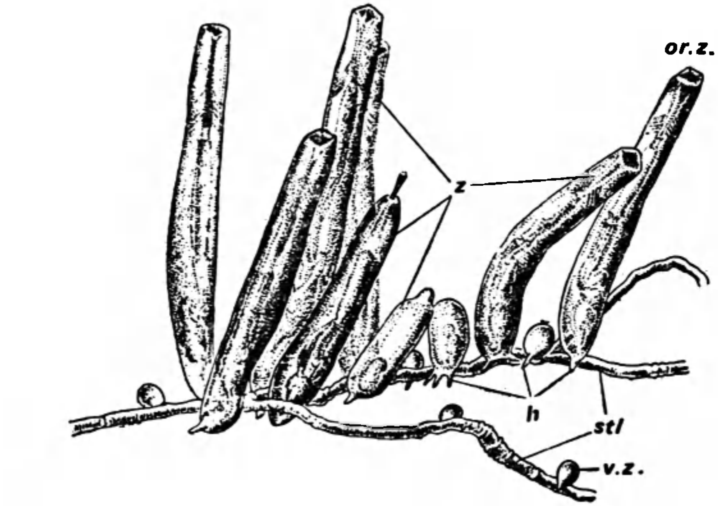


Figure 122. *Bowerbankia caudata* (Hincks). Part of a stolon with the zooids and their primordia.

Distribution. The species was found by me in the Barents Sea in the coastal waters of Murmansk and the Kolguyev Islands, as well as in western Greenland and the Devisov Strait. *Reports in literature:* Barents Sea, Matochkin Shar (Nordgaard, 1923), White Sea (Gostilovskaya, 1957) coastal waters of eastern Greenland (Levinsen, 1916), western Greenland (Osburn, 1919), Labrador (Osburn, 1913), region of Woods Hole (Osburn, 1912), Skagerrack and Kattegat (Levinsen, 1914; Marcus, 1940), Bristol Canal (Hincks, 1880a), and Vancouver Island on the western coast of North America (O'Donoghue, 1923).

This is an Arctic-boreal species.

5. **Bowerbankia composita** Kluge, 1955 (Figure 123)

Bowerbankia composita Kluge, 1955a: 98, fig. 44; *B. imbricata* Nordgaard, 1905: 174, pl. III, f. 36.

The zoarium is free-growing. From the broad base, fixed to the substrate and consisting of a dense intertwining of strongly branched stolons, thick bundles of stolons arise which soon branch out, sometimes sequentially, sometimes in bundles, giving rise to pieces reaching upto 5 cm or more in height. The branches gradually become thinner toward the distal end. The stems near the base of the zoarium consist of approximately 30 closely adjoining stolons; the branches in the middle of the zoarium consist of 12 to 14; and those near the distal end consist of 5, 4,

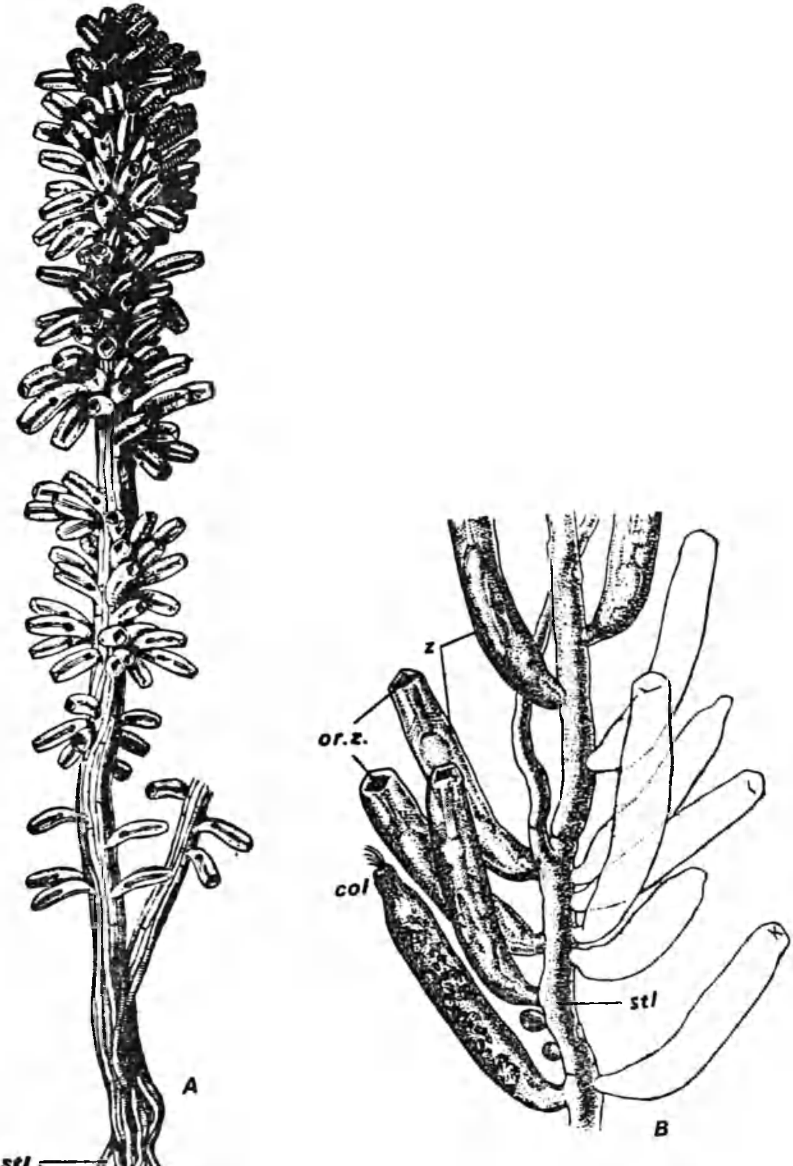


Figure 123. *Bowerbankia composita* Kluge. *A*—a bundle of stolons; *B*—part of a stolon with zoids. Chukotsk Sea.

3, and 1. The stolons are relatively thick, with an average diameter of 0.18 mm. The stolons are divided along their length by transverse septa—the diaphragms—into a series of internodes. In the distal half of each internode, 4 to 6 pairs of zooids usually originate on the sides of the stolon and closely adjoin each other; in the proximal half, 2 to 4 zooids are produced singly, sometimes on one side, sometimes on the other side of the stolon. Often a branch rises from the distal end of the internode that is separated from the stolon by a diaphragm. The zooids have a cylindrical form, are slightly bent in the proximal half, and taper in the place of their origin from the stolon toward a short, connecting pore plate that has a round orifice in the middle. The orifice of the zooid, usually rectangular in form, is located on the distal end. The zooids vary in length, but the fully developed ones are from 1.05 to 1.36 mm, rarely, even 1.60 mm long; their thickness varies from 0.20 to 0.25 mm in diameter. The proventricle and gizzard are round structures of almost uniform size (the gizzard is usually slightly wider, but sometimes the proventricle is larger); they are divided by a more or less deep girdle.

The number of tentacles is 12.

The species lives on stones, at a depth of 43 to 100 m, on a bed of stone, sand, and silt, under temperatures ranging from −1.14 to 1.12°C, in a salt concentration of 33.08 to 33.64‰.

Distribution. The species was found by me in the Chukotsk Sea, the Bering Strait, and in the Bering Sea. *Reports in literature:* Barents Sea in the region of the lower part of the Spitsbergen, depth 1,359 m, temperature 1.2°C (Nordgaard, 1905).

II. Family **Valkeriidae** Hincks, 1877

Valkeriidae Hincks, 1877b : 532; 1880a : 551; Harmer, 1915 : 73.

The zoarium consists of a thin, prostrate, sometimes free-growing stolon, divided into internodes. The latter slightly bulge at the distal ends, i.e., proximal to the diaphragm. From these places, 2 branches usually originate at a right angle; they are short and simple, or longer and ramose, and divided into short internodes. The transparent zooids are located either singly or in groups on the latter, which are devoid of a gizzard. The zooids are oval, with stems (genus *Farella*), or without stems (genus *Valkeria*), or they are urceolate and flattened (genus *Hypophorella*).

Genus **Valkeria** Fleming, 1823

Valkeria Fleming, 1823 : 490; 1828 : 550 (part.); Farre, 1837 : 402; Hincks, 1880a : 551; Harmer, 1915 : 73.

The zoarium is either prostrate or free-growing. Two branches start at a right angle near the diaphragm, which are short or long and branched. Oval and acaulose (stemless) zooids with a round base are located on the branches with a more or less rectangular orifice. The number of tentacles is 8.

Genus type: *Sertularia uva* Linnaeus.

Valkeria uva (Linnaeus, 1767) (Figure 124)

Sertularia uva and *S. cuscuta* Linnaeus, 1767 : 1311; *Valkeria uva* Fleming, 1828 : 551; Hincks, 1880a : 551, pl. LXXV, f. 1-5 and Text f. 33.

The zoarium is in the form of a prostrate, free-growing, thin, chitinized, branched stolon (diameter 0.05 mm), divided by transverse septa or

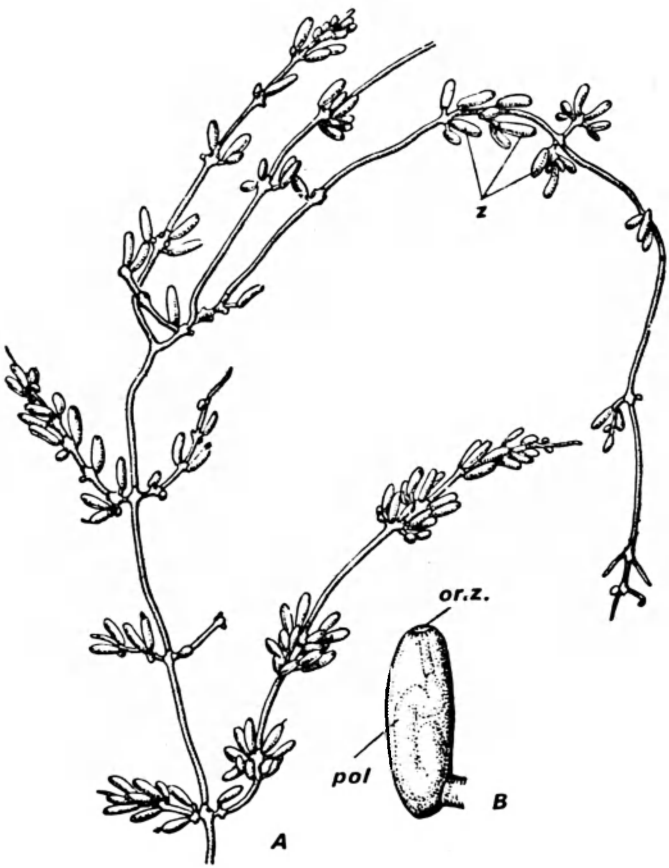


Figure 124. *Valkeria uva* (L.). *A*—part of a free-growing stolon; *B*—zooid, through whose wall the polypide is visible. Barents Sea.

diaphragms into internodes. At the end of an internode or before the diaphragm, which separates the latter from the daughter internode, more or less short, lateral branches usually originate at a right angle on both sides of the stolon. Very small zooids (length 0.45 mm, thickness 0.11 mm) are located in groups on these (and on the stolon itself); these zooids are transparent, oval, and tapered on the proximal end. The orifice of the zooid, more or less rectangular in form, is situated on the opposite distal end. The alimentary canal is devoid of a gizzard, a feature which distinguishes this form from *Bowerbankia imbricata,* a species with which this one is often confused. The number of tentacles is 8, of which 2 are outwardly bent during the projection of the crown. The zooids are deciduous.

The species lives on algae and hydroids, at a depth ranging from the belt of ebb and flow up to 69 m.

Distribution. The species was found by me in the Barents Sea in Kola Bay. *Reports in literature:* Barents Sea, North Finmark (M. Sars, 1851), White Sea (Gostilovskaya, 1957), Norway (M. Sars, 1851; Nordgaard, 1918), Skagerrack and Kattegat (Smitt, 1867; Levinsen, 1894; Marcus, 1940), southwestern part of the Baltic Sea (Borg, 1930a), British Isles (Hincks, 1880a), northwest France (Joliet, 1877), and Casco Bay on the eastern coast of North America (Osburn, 1912).

This is an Atlantic-boreal species.

III. Family **Triticellidae** G. O. Sars, 1874

Triticellidae G. O. Sars, 1874 : 397; Hincks, 1880a : 541; *Vesiculariadae* Alder 1857a : 24; *Hippurariadae* Busk, 1874 : 30.

The zoarium is in the form of a prostrate, thin stolon, from which thin, transparent, chitinous zooids rise up sometimes singly, sometimes in bundles. The latter consist of the upper, widened part, which is movable and connected to the lower stem or peduncle. The upper part contains the polypide; almost the entire frontal surface is occupied by the aperture covered with a thin and flat membrane, and the orifice of the zooids is located on its distal end. Its dorsal side is more or less convex, and 2 semi-circular, lateral, chitinous stripes or rebra stretch out on it, in certain species, toward the orifice, and taper, possibly, to strengthen the walls of the zooid. The gizzard is absent.

Genus **Triticella** Dalyell, 1847

Triticella Dalyell, 1847 : 66; G. O. Sars, 1874 : 397; Hincks, 1880a : 542; *Hippuraria* Busk, 1874 : 29.

This is the only genus and its characteristics are similar to those of the family.

Genus type: *Triticella flava* Dalyell.

Triticella pedicellata (Alder, 1857) (Figure 125)

Farella pedicellata Alder, 1857a : 24, pl. XIV, f. 1-3; *Triticella pedicellata* Hincks, 1880a : 547, pl. LXXX, f. 3-5; Marcus, 1940 : 324, f. 170.

The zoarium is in the form of a thin, prostrate, and branched stolon, from which long, thin, transparent, chitinous zooids uprise singly at varying distances. The zooids consist of 2 parts: the lower or proximal originating from the stolon in the form of a strong, thin, round stem or stalk, and the upper which is situated on the stem and includes the polypide. The 2 parts are joined and movable because of the presence of 2 muscles connected to the stalk on one side, and the distal half on the other, which permit the upper part to bend downward and stretch out. The zooids are long (total length 4.5 to 5 mm, length of upper part 0.70 to 1.00 mm, width 0.20 mm, length of peduncle 4.0 to 4.5 mm, thickness or diameter of stalk 0.04 mm); the upper part, including the polypide, is shorter than the lower and has an oblong-oval form. Its flat or slightly convex, frontal (ventral according to other authors) side is almost completely covered with an aperture overlaid with a transparent membrane, while the dorsal or basal side is more or less convex and smooth. The orifice of the zooid is located on the distal end of the upper part. Twelve tentacles stretch out of this orifice. The gizzard is absent. The upper part with the polypide falls away.

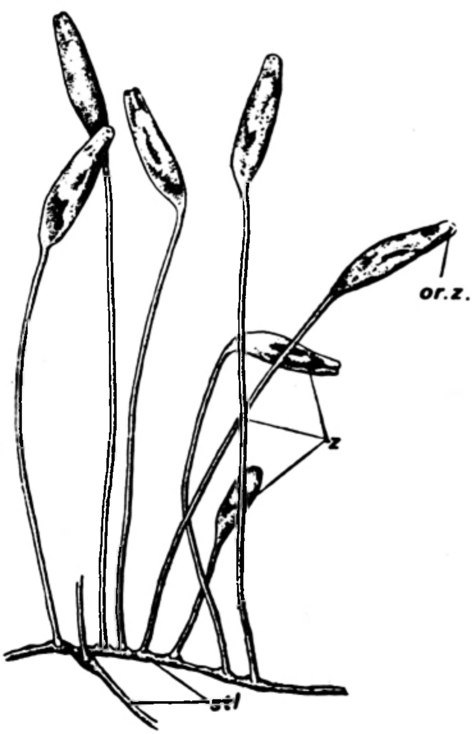


Figure 125. *Triticella pedicellata* (Alder). Part of the zoarium with a group of zooids. Barents Sea.

The species lives on

gastropod shells (*Buccinum undatum,* etc.), at a depth of up to 200 m, under temperature ranging from 1 to 7.6°C.

Distribution. The species was found by me in the Barents Sea in Kola Bay. *Reports in literature:* Barents Sea, Norsanger-fiord (Nordgaard, 1918), coastal waters of Norway (Nordgaard, 1918), Skagerrack and Kattegat (Smitt, 1867; Levinsen, 1894; Silen, 1944a), southwestern part of the Baltic Sea (Marcus, 1940), North Sea (Nordgaard, 1907b), British Isles (Hincks, 1880a), northwest France (Joliet, 1877), Mediterranean Sea (Calvet, 1902), and the eastern coast of the Pacific Ocean in the region of Vancouver Island (O'Donoghue, 1913).

This is an amphiboreal species.

IV. Family **Buskiidae** Hincks, 1880

Buskiidae Hincks, 1880a : 531; Harmer, 1915 : 85; *Vesiculariadae* Alder, 1857b : 156 (part.).

The zoarium is prostrate in the form of a branched, thin stolon, on which oval zooids with a free, stretched out, distal end with an orifice, are arranged sometimes densely (in groups), sometimes sparsely (singly). The zooids are either provided with, or devoid of, spiny protuberances on the sides or spines on the surface. A small gizzard is present.

Genus **Buskia** Alder, 1857

Buskia Alder, 1857a : 24; 1857b : 156; Hincks, 1880a : 531; Harmer, 1915 : 85.

This is the only genus and the characteristics are the same as those of the family.

Genus type: *Buskia nitens* Alder.

Buskia nitens Alder, 1857 (Figure 126)

Buskia nitens Alder, 1857a : 24, pl. XIII, f. 1-2; 1857b : 156, pl. VIII, f. 1-2; Hincks, 1880a : 532, pl. LXXII, f. 6-7a; Levinsen, 1894 : 83, pl. VIII, f. 12-13; Marcus, 1940 : 316, f. 165.

The zoarium is prostrate in the form of a thin, branched, and anastomosing stolon, on which very small zooids are located at certain intervals. The stolon is branched, usually in the interstices between the zooids, and divided into internodes by a few transverse septa. The zooids are very small (length 0.42, width 0.20 mm), have a wide, oval form with denticulated, lateral margins, and the denticles are highly variable in their development, sometimes short and numerous, sometimes long and smaller in numbers, and sometimes absent. The frontal surface of the zooids is more or less convex, smooth, and glassy; its proximal end is clearly separated from the stolon, and not a mere continuation of the latter. The fore end of the zooid is free and raised upward and frontward, tapering toward the distally located orifice which is almost square in shape. The alimentary canal has a gizzard. The number of tentacles is 8.

Figure 126. *Buskia nitens* Alder. Part of a zoarium. Barents Sea.

The species lives on hydroids, more often on *Lafoea,* and Bryozoa, but preferably on *Cellularina,* and rarely on stones, at a depth varying from the belt of ebb and flow up to 235 m, on a bed of silt and shell, under temperatures ranging from above zero to $-1.24°C$, in a salt concentration of 34.83‰.

Distribution. The species was found by me in the Barents, Kara, and East Siberian seas. *Reports in literature:* Barents Sea (Urban, 1880; Waters, 1904; Nordgaard, 1918), White Sea (Hincks, 1880a; Gostilovskaya, 1957), East Siberian Sea (Kluge, 1929), Devisov Strait (Hincks, 1877a), Kattegat (Levinsen, 1894; Marcus, 1940), British Isles (Hincks, 1880a), northern France (Joliet, 1877), and along the eastern coast of the Pacific Ocean near Queen Charlotte Islands (Hincks, 1884).

The species is Arctic-boreal.

III. Order **Cheilostomata** Busk, 1852

Cheilostomata Busk, 1852a : 346.

The zoaria are more or less calcified, prostrate, overgrowing or free-growing, simple, or branched, and consist of zooids located in 1, 2, or more layers. The main distinguishing feature of this order is the presence of labiate lid, or the so-called *operculum,* which covers the orifice of the zooid; from it the present order got the name of cheilostomates (in the old literature it was "labiate mouthed", which led to confusion). The simple operculum is a distally located fold of the frontal membrane in the form of a valve, surrounded by a chitinous arch on the margins; the attachment of the operculum is directly converted into the covering membrane of the frontal surface of the zooid. In the compound operculum the opercular valve, and the membranous part lining the valve, combine to form a chitinous plate which is distinguished by color and hardness from the membrane overlaying the calcified part of the frontal membrane. Since in forms with a compensatory sac the latter opens directly behind the operculum, the proximal margin of the latter does not continue to form the covering membrane of the zooid, as in the simple operculum, but continues into the lower wall of the compensatory sac. Such an operculum appears to consist of 2 parts: the frontal valved one or the "anter", and the hind one or "poster", and the suspended line of the operculum forms the boundary between these 2 parts (Figure 127, B). When the frontal valved part (anter) opens during the projection of the tentacular crown, the poster simultaneously drops down and marine water enters the compensatory sac. On both ends of the suspended line, the operculum is tightly fixed with the corresponding margin of the orifice in such a manner that the denticulated protuberances near the ends of the proximal margin of the orifice or the condyle, corresponded to the chitinous ridges located at the margin of the operculum on the inner side.

The cavity under the operculum is known as the *vestibule;* the membranous part of the body wall enclosing the latter is known as the vestibular membrane (Figure 127, A). The bottom of the vestibule consists of many cell layers; in its center is located the orifice which opens into the atrial cavity enclosed by the tentacular sheath. This thickening with the orifice in the middle is known as the *diaphragm;* the polypide passes through this orifice during its projection and invagination (extension and retraction). The opening and closing of the orifice is brought about with the help of the circular muscle, the sphincter, which consists of many muscle fibers. From the lower side of the diaphragm a bundle of parietal-diaphragmatic muscles (*mm. parieto-diaphragmatici*) originates on each side toward the basal and lateral walls of the zooid. The closing of the orifice of the operculum is brought about by a highly developed pair of muscular bundles, the opercular (occlusor) muscles (*mm. occlusores operculi*), originating on each lateral side of the proximal part of the operculum toward the basal and distal walls. The opening of the orifice takes place by a simple pressing of the operculum during the projection of the polypide.

In many *Cheilostomata*, paired oral glands are found near the diaphragm, either consisting of a simple, round sac on each side which opens through a narrow, tubular duct into the vestibular cavity (Figure 127, C), or of dual sacs; the first is oblong in shape but has no definite structure; however traces of roundish structures and large cells are visible; the second

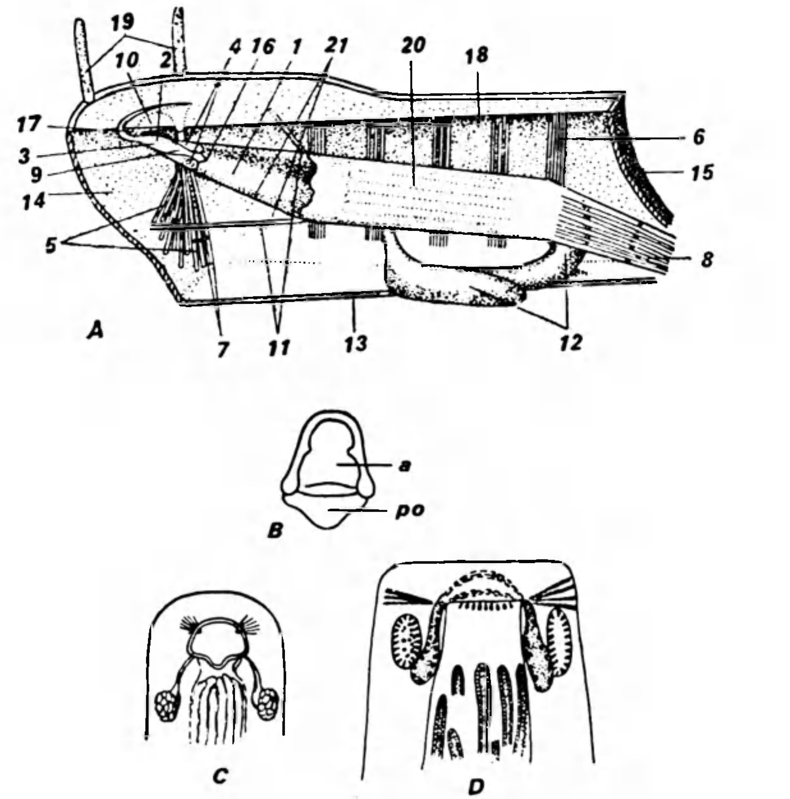


Figure 127. *A*—schematic picture showing the structure of the autozooid of *Flustra foliacea* (L.); *B*—operculum of *Ascophora* anter (*a*) and poster (*po*) (from Marcus, 1926a); *C*—oral glands of the zooid of *Cheilostomata*—simple (from Marcus, 1926a);
D—same as *C*—double (from Waters, 1900):
1—*atrium;* 2—*vestibule;* 3—*vestibular membrane;* 4—*diaphragm;* 5—*opercular (occlusor) muscles;* 6—*parietal muscles;* 7—*parietal-diaphragmatic muscles;* 8—*retractor muscles;* 9—*orifice of diaphragm;* 10—*operculum;* 11—*parieto-vaginal ligaments;* 12—*alimentary canal;* 13—*basal wall;* 14—*distal wall;* 15—*proximal wall;* 16—*sphincter;* 17—*thickened margin of operculum;* 18—*frontal membrane;* 19—*spines;* 20—*tentacles;* 21—*tentacular sheath* (*from Silen,* 1938).

sac is round or oval in shape, attached to the proximal end of the former, and has a definite cellular structure with nucleoli (Figure 127, D). The contents of the glands consist of a homogeneous, non-colored substance which contains many vacuoles. These glands are found in the members of several families, particularly in *Rhamphostomellidae.* The significance of these glands is not yet understood. In many representatives of *Smittinidae,* and particularly in *Reteporidae,* similar avicularian glands develop which are sometimes very large.

Of the 6 walls that usually border the zoid, the one on which the orifice of the zooid is located, is known as the frontal wall, and its opposite side is the basal wall; the remaining 4 comprise 2 lateral walls and 2 transverse (distal and proximal). In the majority of the species found in our waters, the lateral walls are independent since, after treatment of the zoarium with a solution of Javel water, these disintegrate into longitudinal rows of zooids adjoined by their lateral sides, as each has its own lateral wall. In some, e.g., *Myriozoidae, Sclerodomidae,* the lateral wall is common to 2 zooids adjoined by their lateral sides. The transverse walls, located between 2 successive zooids in the longitudinal row, are common, as a rule, but in the genus *Onychocella* and some species of the genus *Retepora* are exceptions in that the transverse walls are double and independent for each of the adjoining zooids.

Of all the walls of the zooid the frontal one shows maximum variability in its structure, and therefore it is the most important for taxonomic purposes. It may be completely membranous or completely calcified, or partly membranous and partly calcified. On the basis of the structure of the frontal wall, Levinsen (1909) divided the order *Cheilostomata* into 2 groups. In one group the frontal wall is membranous with much or little calcification, or it is covered with more or less fused marginal spines surrounding the membranous wall; this group is devoid of the compensatory sac and forms the suborder *Anasca* Levinsen (Figure 128, A). In the second group the frontal wall is calcareous throughout and the compensatory sac is located under it; this is the suborder *Ascophora* Levinsen (Figure 128, B).

The primary frontal wall in all members of the simple *Cheilostomata,* included by Levinsen in the suborder *Anasca,* is membranous, and consists of an ectodermal layer covered by a thin chitinous layer on the outer side, and a mesodermal layer on the inner side. This covering membrane may be more or less calcified, but when its chitinous layer is saturated with calcium, it is known as a gymnocyst. But, in addition to the gymnocyst, another calcified wall exists, the so-called cryptocyst, which is located under the uncalcified covering membrane and originates sometimes from it, and sometimes from the lateral and transverse walls of the zooid. Between the covering membrane and the cryptocyst there is a space which, as was demonstrated by Calvet (1900), is filled with leucocytes and mesenchymatous tissue and forms a part of the zooidal body cavity. This hypostegial cavity communicates with the remaining body cavity (containing the polypide) with the help of a pore of varying size known as the opesium. This opesium may sometimes coincide with the so-called aperture, or the orifice on the frontal surface, covered with the primary uncalcified membrane, as hapens in zooids devoid of a cryptocyst (*Membranipora membranacea, Flustra membranaceo-truncata, F. securifrons*), or it may occupy a larger or smaller part of the aperture

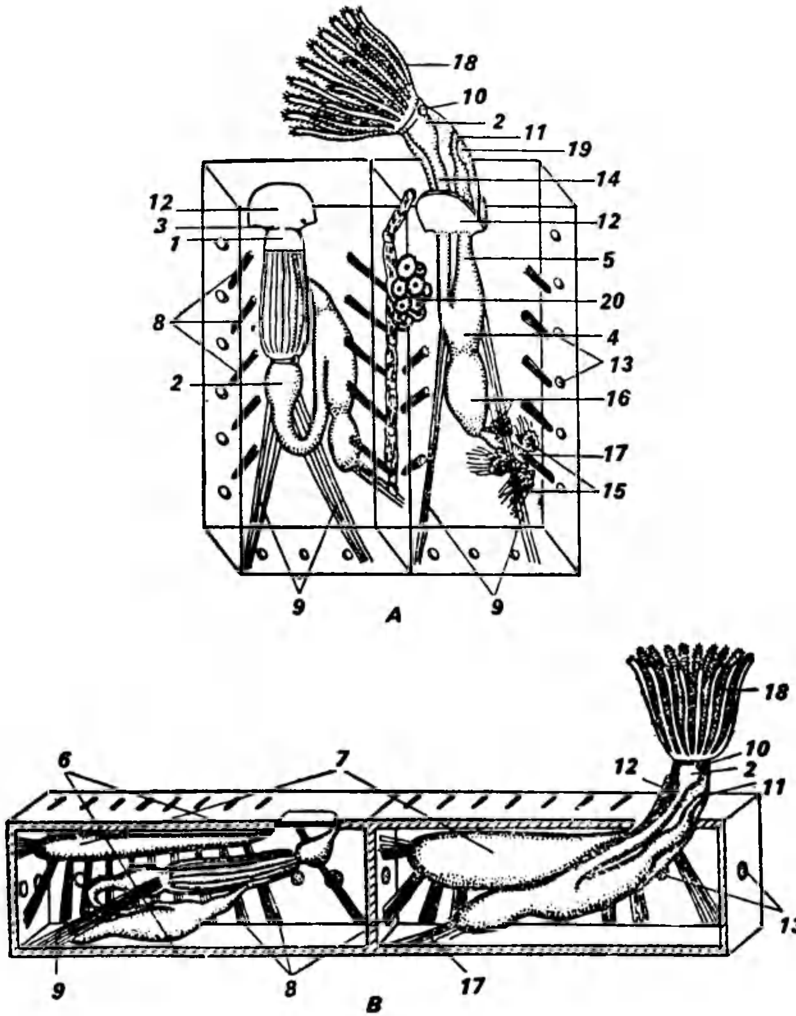


Figure 128. Sketch of the structure of the simplest representative of *Anasca* (*A*) and *Ascophora* (*B*) with retracted and evaginated polypide:
1—*atrial cavity*; 2—*pharynx*; 3—*diaphragm*; 4—*stomach*; 5—*hind gut*; 6—*calcified body wall*; 7—*compensatory sac*; 8—*parietal muscles*; 9—*retractor muscles*; 10—*nerve ganglion*; 11—*anal orifice*; 12—*operculum*; 13—*pore plates*; 14—*esophagus*; 15—*testis*; 16—*blind sac*; 17—*funicle*; 18—*tentacles*; 19—*tentacular sheath*; 20—*ovary*.

depending upon the degree of cryptocyst development.

Among representatives of *Anasca*, it is possible to find transitions from the totally membranous, frontal wall to an almost completely calcified one, and this calcareous part may be either a gymnocyst, a cryptocyst, or both together.

While the gymnocyst is absent in all species of the family *Flustridae*, which are found in our waters, except *F. nordenskjoldi* Kluge, the cryptocyst is present in many (*F. carbasea, F. nordenskjoldi, F. serrulata*, the procumbent part of *F. foliacea*) in the form of a poorly developed brim along the sides, and a slightly more strongly developed proximal part of the zooid. It is interesting that in *F. foliacea* the cryptocyst is strongly developed in the procumbent part of the zoarium, but absent from the frontal wall of the zooid, in the free-growing part of the zoarium. In the family *Bicellariidae* the gymnocyst is developed to a variable degree in members of the genera *Bugula* and *Dendrobeania*, where a larger part of the frontal surface is developed; on the other hand, it is quite strongly developed in the genus

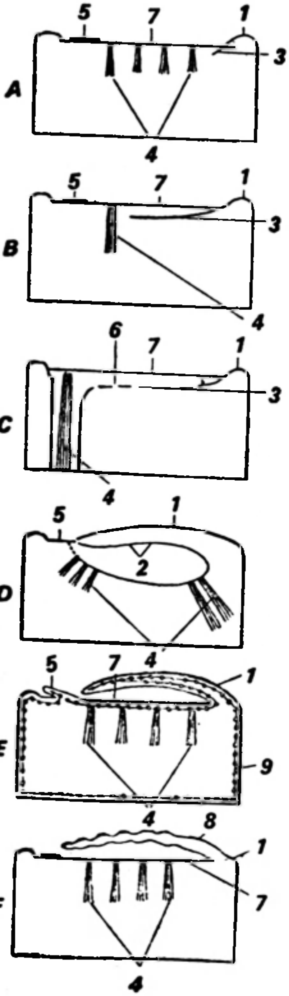


Figure 129. Schematic drawings of the frontal surface of the main types of *Cheilostomata* in the median-sagittal section. Calcified parts have been shown by thick lines; lines marked with thin lines are membranous (7). *A—Membraniporida* of the usual type (*Callopora*, etc.); *B—Membraniporida* with a well-developed cryptocyst (3) in the median-sagittal section; the structure of *Pseudostega* is mainly the same; *C—Coelostega* in the sagittal section (from the side of the operculum, a well-developed cryptocyst is visible; *D—Ascophora*): location of the compensatory sac (2) and parietal muscles (4); *E*—formation of the compensatory sac due to the strong development of the gymnocyst; this stage of development closely corresponds to the situation in *Pseudolepralia*; *F*—formation of the compensatory sac by fusion of the spines (formation of the frontal bristles) in the species of the group *Cribrimorpha* (from Silen, 1942b): 1—*gymnocyst*; 2—*compensatory sac*; 3—*cryptocyst*; 4—*parietal muscles*; 5—*operculum*; 6—*pore of cryptocyst*; 7—*frontal membrane*; 8—*frontal bristle*; 9—*epitheca*.

Bicellarina. In this family the cryptocyst is rarely present. In the family *Scrupocellariidae* a large part of the frontal surface is occupied by the gymnocyst, and only in the genus *Caberea* is the cryptocyst rather strongly developed. The frontal wall in the family *Membraniporidae* has a fairly variable structure. It is totally membranous in *Membranipora membranaceae*, and becomes calcified to a larger or smaller degree in other species, either in the form of a gymnocyst (*Electra pilosa* L.) (Figure 129) or in the form of a cryptocyst (*Reussina impressa* Reuss) (Figure 129); but more often it is partly a gymnocyst and partly a cryptocyst with one or the other predominating. Thus, in the genera *Tegella, Callopora,* and *Cauloramphus* where the aperture occupies a larger part of the frontal surface, the cryptocyst is developed poorly in the form of a more or less narrow brim, surrounding a large opesium (Figure 129, A), while in the genera *Amphiblestrum* and *Rhamphonotus*, the cryptocyst is more or less strongly developed and surrounds a relatively small opesium (Figure 129, B). In the family *Cribrilinidae* the frontal, calcareous wall is the gymnocyst (Figure 129, F) and the cryptocyst is slightly developed only in *Membraniporella*, in the form of a narrow brim along the margin of the aperture.

In the family *Microporidae*, similar to the majority of other families of the group of *Coelostega*, the whole concave, calcareous, frontal wall, covered with an overlying membrane, forms the cryptocyst (Figure 129, C). In these forms the projection of the polypide takes place with the help of contractions of the parietal muscles (Figure 130, A), which are located in pairs in a row on both sides of the median line in the distal half of the zooid. The proximal ends of these muscles are fixed to the lower parts of the hard calcified, lateral walls or toward the basal wall, and the distal ends, and passing through the lateral orifices in the cryptocyst (opesiules) are fixed to the frontal membrane. During the contraction of these muscles, the distal ends come closer to the proximal ends, thus pulling the frontal membrane down, due to which the volume of the body cavity of the zooid is reduced, and the reduced pressure of the fluid contained in the cavity projects the polypide through the orifice of the zooid. Thus, the reduction of the body cavity serves as a cause of projection of the polypide; this cause should be similar for all Bryozoa. In *Anasca* this takes place owing to the presence of a soft, membranous, frontal surface, but it cannot happen in this manner in those forms where all the walls, and consequently also the frontal one, are hard and incapable of bending. In all these forms the so-called compensatory sac is present (Figure 129, D; 130, B); it is long and located in the body cavity under the frontal wall, and opens out through an orifice situated either near the proximal margin of the zooidal orifice or slightly below it; the latter is the so-called ascopore. The compensatory sac communicates with the outer water through this orifice. Muscles also originate in pairs in 2 rows from the bottom of the

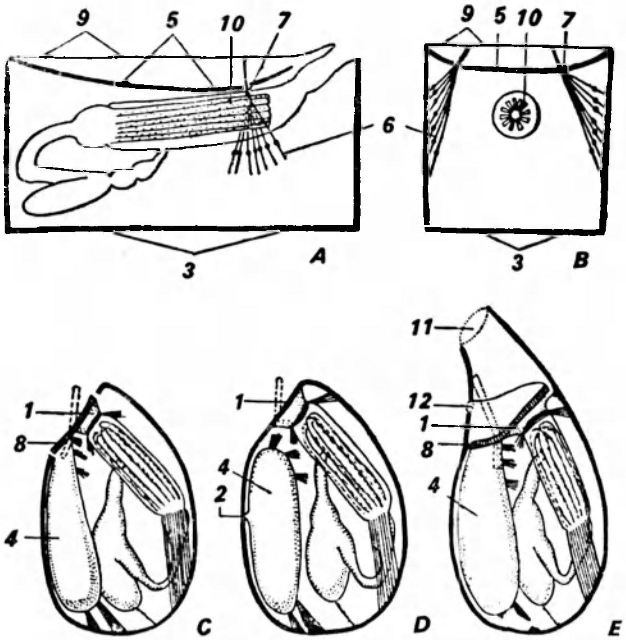


Figure 130. *A*—schematic representation of the projection and retraction of the polypide in *Micropora* (*Anasca, Cheilostomata*) in the median-sagittal section; *B*—the same, in cross section; *C*—diagram of the mechanism of projection and retraction of the polypide in *Ascophora* (*Cheilostomata*) with the primary orifice; *D*—the same, with the primary orifice and the ascopore (2); *E*—the same, with the secondary orifice (11) and spiramen (12): 1—*anter;* 2—*ascopore;* 3—*basal wall* (*calcified*)*;* 4—*compensatory sac;* 5—*cryptocyst;* 6—*parietal muscle;* 7—*opesium;* 8—*poster;* 9—*frontal membrane;* 10—*tentacles;* 11—*secondary orifice;* 12—*spiramen.* (*A*—*from Cori,* 1941) (*B*—*from Marcus,* 1926a).

compensatory sac toward the lower parts of the lateral walls. Their contraction causes a widening and a reduction of pressure in the sac, and the suction of marine water into it. Because of this, the pressure increases on the fluid contained in the body cavity, which pushes out the polypide. As can be seen, the process of projection of the polypide in *Ascophora* takes place according to the same principle as in *Anasca,* and the structure of the muscular system resembles that of the parietal muscles in *Anasca.*

The formation of the hard, calcareous, frontal wall in *Ascophora* should be undisputedly considered a primary phenomenon, while the development of the compensatory sac can only be considered secondary. The problem of the nature of the calcareous part of the frontal wall in members of *Anasca* is as simple and clear, as the solution to the problem of the nature of a continuous, calcareous, frontal wall in the compensatory sac representatives of *Ascophora* is complicated. The solution to this problem is closely related to the question of the origin of *Ascophora*. It will be seen below that different authors have given different explanations for this problem, sometimes arriving at opposite conclusions about the nature of the frontal wall. This has happened because of the fact that up to the presens time, sufficient material has not been accumulated, particularly material with regard to the initial stages of development of the zoarium from the ancestrula, which could provide a complete basis for one or the other explanation; consequently, one or the other author puts forward his "solution" on the basis of only a few facts, which necessarily leads to lop-sided conclusions. Therefore, I do not consider it superfluous to review the various approaches to the solution of the given problem, so that the researcher, while analyzing his own material, will not overlook the significance of one or the other fact which he comes across, in the light of earlier observations and proposed hypotheses.

Smitt (1868, 1873) and, later, Hincks (1880a) proposed that *Ascophora* could have originated from representatives of the genus *Membraniporella* among *Anasca,* because they possess an almost continuous, convex, calcareous, frontal wall that is also devoid of a raised margin which, in their opinion, is the main difference between representatives of *Ascophora*. They could have put forward such a hypothesis not knowing about the presence of the compensatory sac in *Ascophora*. Harmer (1903) was also initially inclined to consider *Cribrilinidae* as the connecting link between *Anasca* and *Ascophora,* but later on he rejected the opinion, accepting it as possible only for an individual case, namely with regard to the origin of the species of the genus *Umbonula*. Since the frontal wall of *Cribrilinidae* consists of fused marginal ribs in which, according to Harmer, the latter develop as folds of the margin of the gymnocyst, the frontal wall itself is the gymnocyst. Levinsen (1909) demonstrated the incorrectness of Harmer's opinion about the development of the wall in the genus *Umbonula;* based on his own observations, he established that this wall develops under the covering membrane and consequently forms the cryptocyst.

Even Calvet in 1900 showed through cross sections that in many members of *Ascophora,* the convex, calcareous, frontal wall is situated under the covering membrane and forms the cryptocyst. The correctness of this opinion was recognized by Levinsen (1909) who found the calcareous wall located under the covering membrane in the majority of the forms studied by him, and only in a few forms such as *Hippothoidae,* partly *Escharellidae,* and others, was he unable to locate the covering membrane, and hence considered their wall as a gymnocyst.

The data cited about the calcareous wall in the majority of *Ascophora* being a cryptocyst, are also supported by findings with regard to the ontogenetic and phylogenetic development of *Cheilostomata,* and particularly of

Ascophora, by Smitt (1868a, 1868b, 1872a). He was the first to describe and provide drawings of a primary individual, or the ancestrula, of a few species of *Cheilostomata,* which he called the "Tata" form; its main peculiarity is the presence of the frontal membrane which, in the majority of cases, is surrounded by spines (Figure 131). Since this "Tata" form is found among *Anasca* as well as *Ascophora* Smitt (1896), Harmer (1903), and Levinsen (1909) considered it the progenitor of *Anasca* and of *Ascophora,* which developed from the forms of the *Malacostega* group, and is characterized by the presence of a frontal membrane and marginal spines. Although in a few species (*Cribrilina annulata, Smittina reticulata, Retepora beaniana,* etc.) the ancestrula has a structure similar to the adult form, in most species its structure is like a modified "Tata" form, reflecting an earlier initial form. Levinsen (1909) observed that all the ancestrulas of a modified "Tata" form belonging to the families of *Ascophora* which have a frontal wall in the form of a cryptocyst, have a more or less developed and deep cryptocyst. On the basis of this he concluded that these families originated from representatives of the *Coelostega* group, which are characterized by a developed, continuous, and deep calcareous wall, i.e., the cryptocyst, under the frontal, covering membrane. Such a transition from *Coelostega* to *Ascophora* makes it mandatory that the depressed cryptocyst of *Coelostega* changed into a convex one and, according to Levinsen, this in its turn, becomes an essential condition for the formation of the compensatory sac in *Ascophora,* which would not find enough space for its development under the depressed cryptocyst; therefore he considered it quite possible that the development of the compensatory sac in *Ascophora* could have taken place only after the conversion of the depressed cryptocyst into a convex one. In this case, the compensatory sac should have formed as an invagination of the primary, frontal membrane near the orifice of the zooid into the body cavity, and between the bottom of this sac and the side walls of the zooid, a new muscular system should have developed which could have played the same role as that played by the parietal muscles in representatives of the *Anasca* group. Thus, the compensatory sac developing under the calcareous wall should have been a new formation—which does not allow one to draw a homologue between this and the structure of *Anasca.*

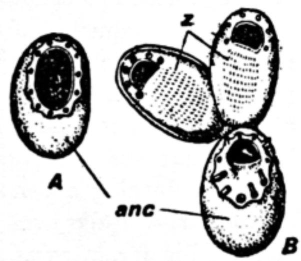


Figure 131. Ancestrula (anc), "Tata" form. *A*—single; *B*—with 2 zooids (*z*) originating from it (from Smitt, 1868b).

The explanations of some authors such as Cori (1941), also led to a similar conclusion, i.e., that the hard, frontal wall of *Ascophora* could have originated by a direct calcification of the frontal membranous wall itself, in the presence of which the compensatory sac should have developed also through invagination of the frontal wall into the body cavity.

On the basis of the opinion expressed about a sequential development of the *Cheilostomata* group, a closer relationship between representatives of the *Anasca* and *Ascophora* groups, and the appearance of the compensatory sac in *Ascophora* as an abrupt new formation and an unnatural one, Silen (1942b) found it more logical to consider the origin of the compensatory sac as a consequence of the structure found in members of *Anasca*. A gradual complication in the structure of the frontal surface, among various groups of the latter, was observed in the direction of a greater protection of the initial frontal membrane. Thus among members of *Membraniporidae*, the aperture was surrounded with spines which were more bent toward the aperture, forming a dense layer of flattened spines above the aperture, e.g., in *Cauloramphus costatus* Silen; in *Scrupocellariidae* where only one spine (scutum or fornix) was strongly developed, in certain forms such as *Scrupocellaria scabra* var. *paenulata* Norman (Figure 240), it fully covered the aperture, reaching right up to the margins of the latter.

On the basis of these and other similar facts, Silen concludes that the hard frontal wall in the species having a compensatory sac, must have developed as a shield above the initial, frontal membrane. These lateral margins of the aperture gradually overgrew above the latter. The calcareous layer, secreted by the underlying epithelium, suggests that there was a fold which had overgrown above the aperture from its margins. The upper layer of this fold is the frontal, calcareous layer, and the lower layer, along with the aperture located under the fold, makes the sac structure which opens near the proximal margin of the orifice, i.e., the compensatory sac (Figure 129, E). In this case the parietal muscles attached to the frontal membrane in *Anasca* are fixed to the lower wall of the compensatory sac in *Ascophora* and hence these structures are homologous. In the *Cribrimorpha* group the intermediate stage of development of the frontal shield can be seen; the shield is attached to the frontal aperture: in simple representatives of the genera *Membraniporella* and *Cribrilina,* it is in the form of more or less fused spinal margins, forming a space between the rebral shield and the aperture which opens upward near the zooidal orifice, as well as between the spines (Figure 129, F); in more complex forms (representatives of the genus *Figularia*), it is in the form of a continuous layer of fused spines which restrict the space underneath so that it opens only near the proximal margin of the operculum; in other words, it is almost a real compensatory sac.

Harmer (1926) later expressed a view about the possibility of the hard frontal wall originating by the fusion of the spines, on the basis of the fact that in some members of the genus *Figularia* the plane of the frontal surface, occupied by rebra, is reduced because of the overgrowing, continuous wall under which the actual compensatory sac is located, formed by the invagination of the small frontal membrane situated under the rebral membrane.

Voigt (1939), considering the pores and depressions along the margin of the frontal wall found in many *Ascophora* from the families *Escharellidae, Smittinidae,* and others, as residues of the inter-rebral slits in ancestors, was inclined to believe that the latter originated through the fusion of the rebra.

Lastly, Silen (1942), considering the possibility of the origin of a few species of *Ascophora* from cribrimorphic forms, believed that the hard frontal wall in many *Ascophora* had a simpler and more natural origin in the form of an overgrowing fold in the gymnocyst from the margins of the aperture, the outer layer of the gymnocyst being calcareous, while the inner one formed a ceiling (roof) for the compensatory sac, the bottom of which formed the initial frontal membrane with the parietal muscles attached to it (Figure 129, D, E). As an example, he has cited the strong development of the gymnocyst in *Pseudoleprali̇a ellisinae* Silen.

Since the marginal spines, according to Harmer (1903), develop as folds of the margin of the gymnocyst, the shield, formed by the fusion of the spines, is also a gymnocyst.

As a result of the complete fusion of the spines and their cavities, 2 layers are formed: the outer becomes hard and calcareous, and the inner becomes soft and membranous to form the ceiling of the compensatory sac; the bottom of the latter becomes a frontal membranous wall. As the final stage in a similar process of development of the hard frontal wall, one can presume the formation of a common fold of the gymnocyst around the aperture—about which Silen has written; ontogenetically it is a short repetition of the phylogenetic development.

Thus a majority of the authors quoted here, in contrast to the opinion expressed by Levinsen, came to the conclusion that the calcareous, frontal wall in many, if not in the majority of *Ascophora,* is the gymnocyst. Of course, this does not exclude the possibility of the origin of *Ascophora* by different ways, i.e., polyphyletically, and the task for future researchers is to accurately explain in what way the different groups of *Ascophora* originated.

While in *Cyclostomata* the cavities of the neighboring, adjoining, zooidal tubes in a zoarium communicate between themselves with the help of simple pores, in *Cheilostomata* and *Ctenostomata* the cavities of the neighboring, adjoining zooids fuse with each other with the help of the so-called pore plates or the pore chambers. The pore plates, widely distributed in *Cheilostomata,* were first described by Smitt (1867) in *Flustrata foliacea* and were called "communication pores" by him, but he understood the whole pore plate by this name without mentioning the existence of individual pores in it. Reichert (1870), studying *Zoobothryon pellucidum* Ehrenberg, noticed individual pores in the plates and called the latter "rosette-like plates"; Levinsen, 1894, sketched them for several Danish species, and in 1909 provided detailed descriptions of each along with the pore chambers in different members of *Cheilostomata*. In 1944 the fairly detailed work of Silen appeared in which he introduced corrections and additions to the data of Levinsen, and raised the question about the nature and origin of these structures in *Cheilostomata*. Even Waters (1896), who described the structure of the rosette-like plates in different species of the genus *Flustra*, showed that these formations can have great taxonomic importance in identifying different species. Having studied these formations in detail in representatives of the genus *Flustra* found in our waters, I became convinced that sometimes it is difficult to make an assertive distinction between closely related species only on the basis of the external structure of the zooid, in the absence of avicularia and ovicells; in that case the study of the pore plates provides a key to identification. On this basis, I have prepared an identification key for all our species of the genus *Flustra*. Because of this, while studying almost all the other species, I paid attention to the investigation of the pore plates and pore chambers, and provided these data in the descriptions of most of the species. True, this is very tedious work, and therefore few authors have paid any attention to this problem, but like Levinsen (1909), I assume that in the future the structure of pore plates and chambers may serve as a good criterion not only for identifying species, but also for classifying other larger, taxonomic groups.

The pore plates occurring in the majority of the members of *Cheilostomata* appear to be simpler structures compared to the pore chambers. For example, when analyzing a zoarium of any species of the genus *Flustra* with Javel water, it disintegrates into longitudinal, single rows of zooids. This happens because, as we have seen earlier, zooids of most species of *Cheilostomata* have their own lateral and transverse walls. Therefore, the closely adjoining and sticking lateral walls of 2 neighboring rows of zooids, which give the impression of a single, common wall, separate when treated with Javel water and the zoarium divides into individual, longitudinal rows. The pore plates are located in the lateral walls of the adjoining zooids. The latter consist of 2 parts: one part, located on the wall of one of the adjoining zooids, is a thin-walled depression, similar to a watch crystal perforated with one large, or several smaller pores, and surrounded on the margins by a chitinous border—the so-called pore ring, which rather strongly varies in its development (Figure 132). The other part, located opposite to the first one in the lateral wall of the neighboring, adjoining zooid, is a simple round or oval orifice. Levinsen presumed that the pore

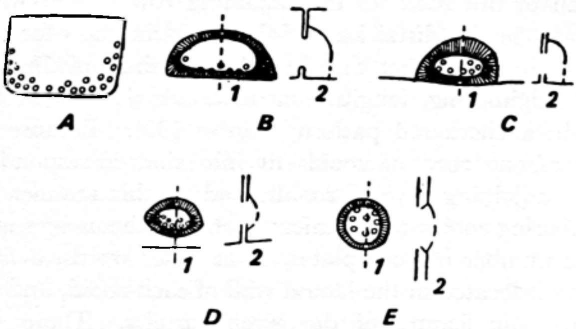


Figure 132. *Electra pilosa* (L.) *A*—transverse wall of the ordinary type; *B*—"pore chamber" often visible at the distal end or on the free lateral walls of the zooid; one is identical with the proximal end of the new zooid (1—view from the outer side; the wall surrounding the orifice from outside is grooved; the pores belong to its internal wall; 2—the same, in transverse section); *C*—pore chamber of the ordinary type, communicating with the lateral wall of the neighboring zooid; structure is the same as in Figure *B; D*—intermediate structure between *C* and *E;* structure as in Figure *B; E*—ordinary pore plate; structure as in Figure *B* (from Silen, 1944c).

ring does not belong to the wall with the porous plate, but to its adjoining wall in which the orifice is located. But this is not correct. The pore plates may have a single pore (in the side walls of *Flustra securifrons, F. serrulata, F. membranaceo-truncata,* etc.), or several pores (*F. foliacea, F. carbasea,* and most representatives of *Cheilostomata*). A sharp boundary between the single-pored and multi-pored plates cannot be drawn because the main feature characterizing a multi-pored plate is the common pore ring, which surrounds individual, single-pored plates, and varies in its development; often a few closely lying single-pored plates can be seen along with the typical multi-pored plates, the single-pored plates being devoid of a common pore ring. Besides the lateral, single-pored plates in some species of *Flustra* (*F. securifrons, F. serrulata, F. papyrea*), as well as in a few species of the genus *Retepora,* only one orifice exists in the transverse wall; it is devoid of the pore ring and, like many simple, minute pores located in the transverse wall in some of the near *Flustra* species (*F. foliacea, F. carbasea*) and *Membraniporidae* (*M. monostachys, M. catenularia*), it is a larger, simple pore. The basis for this is given below.

Even a single look at the lateral walls of *F. carbasea* (Figure 133, A), *F. foliacea* (Figure 133, D, E) and most of the other species of *Cheilostomata,* makes it clear that the pore plates are usually located in the distal half of the zooid, while simple orifices are located in the proximal half. If after treating the zooids with Javel water, the 2 adjoining rows of zooids are placed in the position they had before treatment with the bleach, then it would appear that the same number of orifices in the proximal half of the zooid of the adjoining row of zooids, would face the pore plates in the distal half of the zooid in the other row. This happens because of the fact that in most members of *Cheilostomata,* the zooids in 2 neighboring, longitudinal rows are situated in an alternate order, i.e., in a checkered pattern (Figure 133). Because of this, the pore plates of one row of zooids fit into the corresponding orifices of the other adjoining row of zooids, and in this manner the cavities of the neighboring zooids communicate between themselves with the help of a definite number of pore plates, or in other words, a fixed number of pore plates is located in the lateral wall of each zooid, and this number is a characteristic feature of the given species. There are species (*Membranipora membranacea, Electra pilosa, E. crustulenta, Schizoporella linearis,*

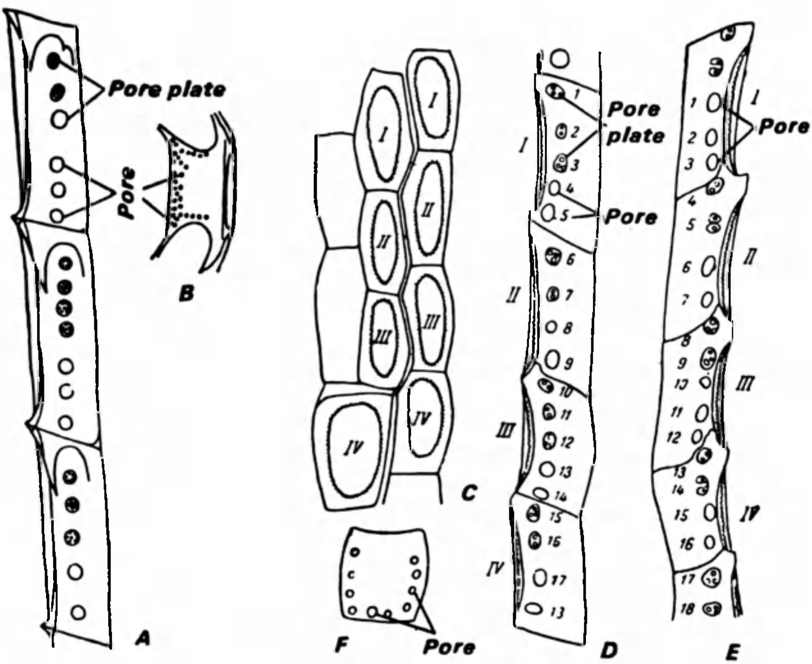


Figure 133. *A—Flustra carbasea* (Ellis and Solander), view from the lateral wall of the row of zooids with the arrangement of the pore plates (pore plate) in it, and simple pores (pore); *B*—the same, transverse wall of the zooid with the arrangement of simple pores in it; *C—Flustra foliacea* (L.), a sketch of the arrangement of zooids in the zoarium (view from the frontal side); *D* and *E*—the same, lateral walls of the zooids of 2 separated rows with the arrangement of pore plates and simple pores in them; *F*—transverse wall of the zooid with the arrangement of pores in it. *I* to *IV*—serial numbers of the zooids in a row; 1 to 18—serial numbers written near the pore plates, and the pores of the side walls of the zooids, indicate their arrangement in the 2 adjoining rows within a zoarium (the pore plates of each zooid from the zooids of the left row correspond to the simple pores of the right row, and vice versa).

etc.) in which the zooids are located in the zoarium in a manner very different from the checkered design; frequently they form regular transverse rows; in this situation we find that in the lateral wall of a zooid, or a few zooids placed in a continuous row, only pore plates are located, while in the corresponding side walls of the other adjoining row, only orifices are found. With regard to the number of pore plates in the lateral wall of the zooid, some authors, including Levinsen, have reported the number of pore plates only in the distal half of the lateral wall of the zooid; I myself, and some other authors, have indicated the complete number of pore plates in the lateral wall of the zooid irrespective of whether they are all situated on the lateral wall of one row of zooids, or partly located on the side wall of the zooid of one row, and partly on the side wall of the corresponding zooid of the other adjoining row. When the number of pore plates in the lateral wall of the zooid appears to fluctuate or seems unspecific, the method followed by me makes it simple to count them and immediately gives a clear picture.

By the term "pore chambers", Levinsen understood the small cavities located in the corners between the basal wall and one of the vertical walls (lateral or transverse). They have the shape of a triangle in the cross section, in which it is possible to distinguish the basal wall corresponding to the basal wall of the zooid, the internal wall in which minute pores are located corresponding to the transverse wall of the zooid, and the outer one which is situated near the entrance to the cavity in the form of a simple orifice (Figure 132, B). The pore chamber has such a structure in the transverse wall of the zooid, and the internal wall is located in the maternal zooid, while the outer orifice opens into the cavity of the daughter zooid. If the pore chamber is located in the lateral wall of the zooid, opposite to the entrance orifice of the chamber located on the lateral wall of one of the 2 adjoining, longitudinal zooidal rows, a simple orifice will be located on the lateral wall of the corresponding zooid of the other adjoining row (Figure 132, C). The pore chambers in the lateral walls of the two adjoining rows of zooids are distributed in a manner similar to the pore plates: the pore chambers are located in the distal half, and in the proximal part these are simple orifices (Figure 134) or continuously placed pore chambers in the lateral wall of the zooid of one row; in the corresponding lateral walls of the

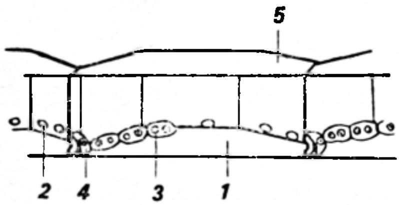


Figure 134. Diagram of the intrazoarial fusion of the zooids: pore chambers:
1—*basal wall;* 2—*orifice which corresponds to the lateral-basal pore chamber of the neighboring zooid;* 3—*lateral-basal pore chamber;* 4—*lateral-proximal pore chamber;* 5—*frontal wall* (*from Marcus,* 1926a).

adjoining row, they are simple orifices.

Until recently, researchers confined themselves only to the constancy and distribution of such structures, but the problem of their origin remained unclear until Silen (1944c) started work on their formation and origin. Silen started from the fact that in *Cheilostomata* 2 different types of body walls exist: the outer (lateral walls, frontal and basal) and the inner (transverse walls, distal and proximal). Although it appears that the longitudinal rows of zooids in the zoarium are fused with each other by simple walls similar to the transverse wall, and therefore internal, we have seen during their treatment with Javel water that they are actually double, and consequently outer walls as well. The sketch presented here (Figure 135) shows the formation of outer and inner walls in the zoarium. The primary individual, or the ancestrula, has only outer walls initially; when budding and the formation of daughter zooids starts

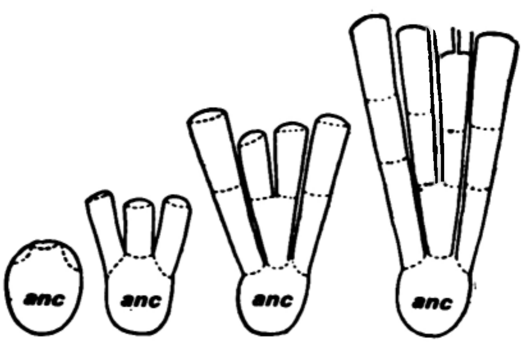


Figure 135. Diagram of the formation of outer (continuous lines) and inner (broken lines) walls in a zoarium (*anc.*—ancestrula). For clarity, the longitudinal walls are shown as separated from each other; in reality they very closely adjoin each other and look like simple walls (from Silen, 1944c).

in it, small areas begin to separate from its common cavity in the distal part, and from the sides of the distal half, due to the uprising of 3 folds from the frontal wall downward to the basal wall; these are the partitions which separate these areas from the common maternal cavity. During this, most probably because of the mesenchymatous cords stretching throughout the cavity, especially toward the newly formed buds, the dividing walls during their growth meet obstacles and, by bypassing them, cause the formation of small pores in each wall through which the cords pass. When the daughter zooids grow out, daughter buds are similarly formed near their distal membranous ends, again by outgrowths from the frontal wall toward the basal fold, separating the cavity of the new bud from the cavity of the daughter zooid. The fold growing toward the basal wall forms similar pores, like the former partition on meeting the mesenchymatous cords. The distal wall of the daughter zooids, outgrowing in length, forms a new zooid. Thus, one step after the other, the zoarium grows, and the side walls of the zooids are external while the transverse walls are internal. In speaking of this point, Silen has correctly pointed out that contrary to prevailing opinion, this transverse wall is not the distal wall of the maternal zooid, but the proximal wall of the daughter zooid.

We can now return to the question concerning the origin of the pore chambers and pore plates according to the opinion of Silen which, in my view, completely tallies with the observed facts. The development of the zoarium from the ancestrula in *Electra pilosa* (Figure 136) takes place in such a way that initially 2 lateral buds develop in the distal

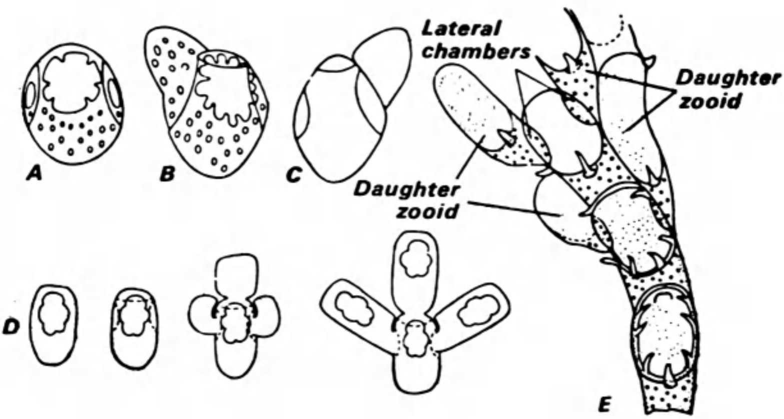


Figure 136. *Electra pilosa* (L.). Lateral budding of the ancestrula. *A*—ancestrula with 2 lateral parts separated from the common cavity, the oval surfaces of these parts still being membranous; *B* and *C*—the distal part has also separated in exactly the same way; formation of the new zooid has started from the lateral chamber; view from the frontal (*B*) and basal (*C*) side; *D*—diagrammatic representation of the new zooids forming from the ancestrula (from Silen, 1944c); *E*—the same, lateral budding in the free-growing zooids.

half as outgrowths of the 2 inner walls, from the frontal wall toward the basal one; in the lower part of these walls minute pores form because of the mesenchymatous cords. The distal bud is afterwards formed in the same way at the distal end. These buds develop into daughter zooids. Lateral budding in the adult zooids of *Electra pilosa* (similar to that in the ancestrula), originates from large, lateral chambers formed by separation from the common cavity of the zooid, due to outgrowths of the inner walls. In this case, the large oval space remains uncalcified and membranous at the distal part of the lateral wall in the calcified zooids, just as it does in the ancestrula. In the free-growing zooids, which are not restricted on the sides with the zooids of the neighboring rows, these membranes outgrow, as can be seen in Figure 136, E, giving rise to new daughter zooids. Thus these lateral chambers here are true buds. Their structure is exactly the same as the lateral pore chamber described above. How great the urge to form new zooids is in the newly-formed buds, when free space is available for this process, can be seen from the fact that as soon as 2 adjoining rows of zooids separate for one reason or another, the zooids of both rows start producing daughter zooids, and the arrangement of the lateral chambers in both rows becomes checkered. If the lateral wall of the young zooid near the distal margin of the zoarium is not free, but rather attached to the neighboring row of zooids, often 2 small or 1 large chamber (Figure 137) separate out from the cavity of this zooid. The size and form of these chambers vary. It can be seen from the figures that their internal walls reach up to the basal side and their structure totally coincides with that in the aforementioned pore chambers. The orifices do not exist when these chambers are formed in the lateral wall; only a roundish, membranous surface exists, and the remaining part of the lateral wall is already calcified. If the structure of these chambers is studied throughout their development, it would appear that instead of the membranous surface, a roundish orifice now exists in the lateral wall, and the lateral wall of the corresponding zooid of the neighboring row has a similar orifice. As can be seen, the strucuture of these chambers completely corresponds to the structure of the pore chamber.

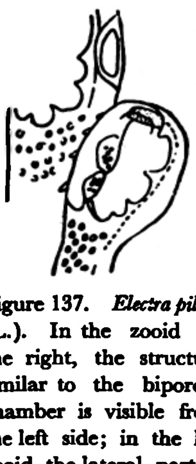


Figure 137. *Electra pilosa* (L.). In the zooid on the right, the structure similar to the biporous chamber is visible from the left side; in the left zooid, the lateral part of the body cavity is separated; its outer wall is partly membranous (Figure 136, D) (from Silen, 1944c).

Silen has stated that he was able to observe a few chambers which occupied the same position as the pore chambers, but were slightly smaller in size and located a little above the basal wall (Figure 132, D). He considered these chambers as the transitional stage toward the structures described below, which have a different appearance and location, are formed on the lateral wall of the zooids, and adjoin the zooids of the neighboring row (Figure 138). They develop on the inner side of the lateral wall above the basal wall, first appearing in the form of an annular fold that fuses in the middle due to overgrowth, and forms a convex cavity. In the wall thus formed, which itself is an internal wall, pores develop, probably in the same manner as that described for pore development in the internal (transverse) walls of the zooids. There was no orifice in the lateral wall in this place initially, but in the fully developed zooids we found that a larger part of the membranous surface had dissolved in this place, and only a more or less narrow margin remained around the orifice formed; a similar orifice had formed in the corresponding zooid of the neighboring row of zooids opposite to this place. It is clear that the internal wall of the chamber described, is full of pores and forms the pore plate while the margin surrounding it is the pore ring. Thus we found that in *E. pilosa* the cavities separated out from the zooidal cavity look like pore chambers and small cavities; their inner wall corresponds to the pore plate; these two types of cavities are homologous in their development, structure, and location, and the presence of transitional forms. Levinsen (1909), on the basis of his observations of *Lepralia pallasiana* in which the zooids have pore chambers on the lateral wall together with pore plates,

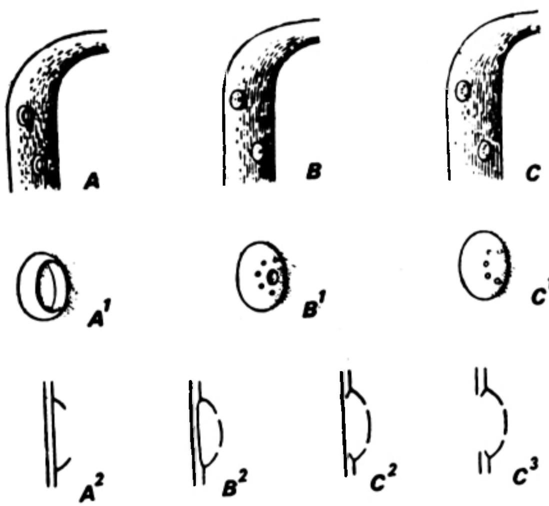


Figure 138. *Electra pilosa* (L.). Development of pore plates. *A* to *C*—distal half of the lateral wall with developing pore plates; the internal side is visible obliquely from the upper side; A^1 to C^1—individual pore plates, larger and, possibly, in a corresponding stage of development (A^1—young pore plate forming a round margin; B^1—pore plate closed with the exception of the center; pores appeared at a small distance from the center; C^1—pore plate completely closed); A^2 to C^3—diagrammatic cross sections of different stages of development of the pore plates; lateral wall of the neighboring zooid is on the left. Figure A^2 corresponds to Figure *A*; Figure B^2 corresponds to Figure *B*; a portion of the lateral wall is covered with the pore plate, which has been slightly enlarged in the drawing on the outer side; C^2—a part covered by the pore plate, which has dissolved in the center; the corresponding portion of the neighboring lateral wall has dissolved. The dissolution of the lateral walls which was shown in Figure C^3, possibly takes place simultaneously. (All figures from Silen, 1944c).

assumed that the pore plates were primary structures, while the pore chambers were secondary ones, i.e., originated from the pore plates by their overgrowth in all directions right up to the basal wall, simultaneous with a deepening of the zooidal cavity, because of which a cavity similar to the pore chamber was formed. Consequent to this analysis, the wall of the pore chamber would have to be double, as was shown by Borg (1930a), but this does not correspond to reality, as the cavity of the chamber is enclosed in simple walls. Since Silen followed the progressive development of the pore chambers and pore plates, his opinion should be considered as more authoritative—that the pore chambers are primary structures and the pore plates secondary ones originating from the pore chambers.

It becomes clear from the above description that initially these cavities were actually the buds of the zooids. If the buds form on the free wall of the maternal zooid, i.e., have sufficient space for their full development, they become adult zooids. If they form on the lateral wall situated opposite to the zooids of the neighboring row of zooids, small cavities (in the majority of cases) separate from the cavity of the maternal zooid, and their outer wall instead of developing into a zooid, dissolves and forms an orifice; a similar orifice appears in the corresponding zooid of the adjoining row, i.e., pore plates develop. *Electra pilosa* has the distinction of being the most convenient species for studying the aforementioned forms, because the structure of its zoaria occupies an intermediate place between the single-rowed zoaria with free zooids in which any kind of bud grows into a mature zooid, and the multi-layered zoaria in which buds being organically connected with the zooid rows, and not finding sufficient space to develop into mature zooids, become stunted in growth and directed in the pore chambers and pore plates, which serve to interconnect the adjoining zooids. As an example of a typical multi-layered zoaria in which, as in most zoaria of *Cheilostomata,* the zooids are regularly located in a checkered pattern, Silen mentions *Membranipora dumerilii* in which the zooids are interconnected only with the help of the pore chambers, and *Flustra foliacea* in which, as in most representatives, the zooids are interconnected only with the help of pore plates. Since in most *Cheilostomata* the zooid rows firmly touch each other, the secondary formation of zooids in them takes place chiefly on the distal ends of the zooids; when the zooidal rows branch in order to occupy a larger area, branching occurs either by the formation of 2, or rarely 3, buds on the distal margin, or frequently by the formation of buds in the distal, lateral chamber, or the lateral plate.

At present it is difficult to say anything positive about the causes for the dissolution and formation of the orifice in the zooidal wall, where the pore chamber or pore plate is located, and in the wall of the zooid of the adjoining row. In any case, the impulse for the formation of these orifices comes from the zooid in which the bud is located, which develops in the pore chamber or the pore plate. This was the reason Silen considered the pore chambers as special types of heterozooids which, to the same degree, also belong to the pore plate.

Of all the Bryozoa, the phenomenon of polymorphism is more pronounced among members of the order *Cheilostomata*. Besides the autozooids, engaged in feeding and reproduction, heterozooids and kenozooids are also found to occur frequently in the zoaria of *Cheilostomata*. Avicularia and vibracula belong to the heterozooids. On the basis of the works of Hincks (1880a), Calvet (1900), and others, 2 types of avicularia are presently distinguished: vicariating (independent or substituting) and adventitious (dependent). By the vicariating is understood those avicularia which occupy the place of a zooid, i.e., are located by the side of other zooids in the zoarium, and stretched from the frontal side of the zoarium to the basal side; although they are usually slightly smaller in size than the zooids, sometimes they are larger than the latter (Figure 174). Adventitious or dependent avicularia, usually small, but sometimes fairly large, are located on the zooids or fused with the latter (mobile or immobile) with the help of a thin stalk (Figure 181). The site of the adventitious avicularia varies; they may be situated on the frontal, lateral, or basal sides of the zooid and, according to the observations of Levinsen (1909) and Harmer (1923), even inside the zooid in some species of the genus *Menipea*. Both types of avicularia are independent in movement, but dependent for nutrition upon the zooids. The general organization of avicularia points toward the function of catching and holding; their mandible and rostrum somewhat perform the function of jaws. Initially their significance was considered to be that of an organ for catching prey, but later, according to the opinion of Hincks (1880a) and Harmer (1930-31), they were thought to be more an organ of defense that protected the zoarium from becoming mixed with sponges, Bryozoa, and other animals, because their larvae, settling down to the bottom, rest on the zoarium. But a more precise statement about the significance of the avicularia in the life of the zoarium has yet to be made.

The structure of vicariating avicularia was first studied by Vigelius (1884) in *Flustra membranaceo-truncata* Sm., later by Levinsen (1909) in different groups of *Anasca* and *Ascophora*, and lastly in greater detail by Silen (1938) in *Flustra foliacea* (L.). The structure of aventitious avicularia was studied by Busk (1849; 1854c) in *Notamia bursaria* (L.) and others, by Calvet (1900), Ladewig (1900), and Herwig (1915) in different species of the genus *Bugula*, and more recently by Silen (1938) in *Dendrobeania birostrata* (Yanagi and Okada). The vicariating avicularia are closest to the structure of an autozooid. As an example, we shall examine the structure of the avicularium of *Flustra foliacea* (L.), which was studied in greater detail by Silen (Figure 139). The frontal surface of the avicularium consists of 2 parts: the distal or the opercular, covered with the chitinized mandible, and the proximal or the sub-opercular one, covered with a membrane corresponding to the aperture of the autozooid of mem-

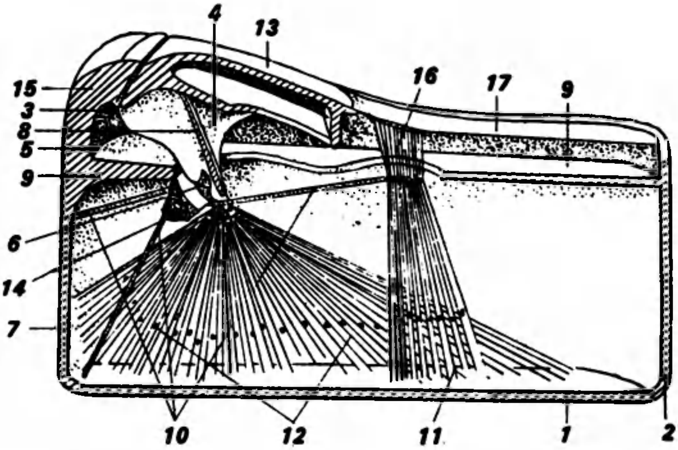
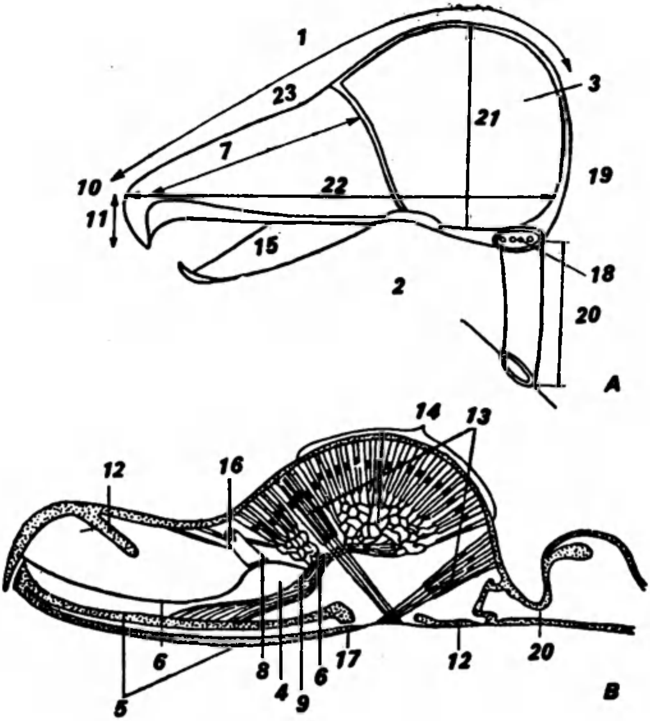


Figure 139. Diagram of the structure of a vicariating avicularium of *Flustra foliacea* (L.): 1—*basal wall;* 2—*lateral wall;* 3—*vestibule;* 4—*vestibular membrane of the mandible;* 5—*vestibular membrane of the rostrum;* 6—*diaphragm;* 7—*distal wall;* 8—*vein;* 9—*cryptocyst;* 10—*cellular cords of unknown significance, possibly residues of the funicular tissue;* 11—*abductor (opening) muscle;* 12—*adductor (closing) muscle;* 13—*mandible;* 14—*polypide (diaphragm);* 15—*rostrum;* 16—*epithelial threads;* 17—*frontal membrane (from Silen,* 1938).

bers of the family *Membraniporidae.* The boundary between them is formed by a suspended line bordering the proximal margin of the mandible. This suspended line in most *Anasca* consists of 2 denticles starting from the lateral walls of the zooid, and in most *Ascophora* consists of a transverse crossbeam, which is formed by the elongation and fusion of the aforementioned denticles. These denticles and the crossbeam play the role of an axis in the opening and closing of the mandible. The body wall of the avicularium corresponds to the cystid of the autozooid, but it has a more strongly developed mandible and adductor muscles or rostrum (Figure 139). Frequently the cryptocyst, absent in zooids, exists under the frontal wall of the avicularium. Located in the middle of this cryptocyst is an orifice that is sometimes roundish, sometimes more oblong, through which the abductor muscle passes. This cryptocyst may be present in the opercular as well as in the sub-opercular parts. In *F. foliacea* it is developed more in the sub-opercular part, in *Sarsiflustra abyssicola* in the opercular part (Figure 199), while in *Smittipora solida* it is developed in the greater part of the surface (Figure 200). While the basal and frontal walls of the vestibule in the zooid are fused by 2 lateral walls which, during the closing of the operculum, form folds, the latter are absent in the avicularia, and the vestibule in them is found to occur in the form of 2 separated plates, the basal one of which occupies the opercular surface, while the frontal one, proximally connected to the basal, stretches along the inner surface of the mandible and thus forms a sort of roof for the vestibule. In the majority of small avicularia, which have a semi-circular mandible, the frontal plate is attached to the margin of the mandible; in the large avicularia of *Sarsiflustra abyssicola* it is fixed to the middle, triangular, strongly chitinized part of the mandible, forming poorly chitinized, thin, lateral lobes on the sides. In *Smittipora solida* it is proximally attached to the small triangular surface, and further along (more than half) the length, it attaches to its chitinous axis (Figure 200) in the form of a thin membrane from both sides. The mandible is strongly developed in the avicularium; its frontal side is covered with a thick, chitinous layer, which gradually transforms into the thinner cuticle of the frontal membrane at the proximal end. The lower chitinous layer is located under the upper chitinous layer; the former lies between the roof of the vestibule and the frontal chitinous layer. Moreover, the transverse vertical wall is located at its proximal end; the lower end of the wall resting against the cryptocyst plays a part, together with the denticles, in the opening of the mandible. Due to the double-layered structure of the mandible, a flat cavity is located in it known as the mandibular cavity. Since the lower chitinous layer has a roundish orifice near the proximal margin, the frontal wall of the mandible is visible in this place in the form of a brighter, roundish surface, the so-called lucid.

As has already been mentioned, besides the adductor muscles of the operculum, and the parietal muscles starting from the frontal wall and serving the purpose of projecting the polypide, the autozooids also have retractor muscles for drawing the polypide back into the cystid, and parieto-diaphragmatic muscles for opening the orifice of the diaphragm at the time of the polypide's projection. In view of the poor development of the polypide in avicularia and the absence of an orifice in the diaphragm, the 2 latter muscular systems are absent in them, but the first 2 systems are strongly developed. The parietal muscles are used for opening the mandible and include a strongly developed muscle (*m. abductor mandibuli*), which is attached by its upper end near the proximal margin of the operculum to the more strongly chitinized part of the sub-opercular membrane, stretched down through the orifice in the cryptocyst, and fastened by a more or less broad base to the proximal half of the calcareous basal wall. The contraction of this muscle draws the sub-opercular membrane downward and backward, causing it to drag the proximal end of the mandible, resting with the transverse, proximal, chitinous septum, against the above-mentioned lateral denticles of the suspended line. As a result of this, the opening of the mandible takes place. The muscles closing the operculum in the autozooids (*mm. occlusores operculi*) are changed into the strongly developed pair of adductor muscles for the mandible in the avicularium (*mm. adductores mandibuli*). These muscles are attached to the basal wall by their lower ends, and occupying a broad space in its distal half, leave a narrow strip on each side which is not covered by them; in the proximal half, they gradually narrow to enclose the *m. abductor mandibuli* on each side and stretch up to the proximal, calcareous wall of the cystid. In addition to the basal wall, these muscles are also attached to the lower parts of the distal and lateral walls of the cystid. From the basal places of attachment, the fibers of each muscle stretch toward the frontal wall, combining simultaneously into a bundle. The strongly stretched ends of these bundles lie close to each other at a height slightly below the level of the cryptocyst and, in the middle, between the distal and proximal margins of the mandible. Two parallel, initially closely adjoining, thick cords of uniform supporting mass, start from the median line of the inner surface of the distal margin of the mandible near the corner which is formed by the horizontal part of the mandible and its bent distal part. These are transpierced by the thin hair (fibrils) of the changed epithelial cells. These cords together form a sort of vein, the proximal ends of which pass through the bottom of the vestibule, and from each of their ends, one bundle of threads with a nuclei originates, to which the distal ends of the fibers of the above-mentioned muscular bundles are attached. The normally developed polypide of the autozooids is represented in avicularia by the primordia of the tentacular sheath—the unperforated diaphragm and small groups of cells from which the tentacles and the intestine could have developed. Sex organs are absent in the avicularia.

The structure of the vicariating avicularium in *Flustra foliacea* described above, is repeated, with slight variations in individual parts, in all the other vicariating and sessile adventitious avicularia, and even in mobile, articulated, pedunculated avicularia which markedly differ from them in external appearance. Since among the order *Cellularina* we often come across similar avicularia, I shall first report here the terminology used in the literature for their individual parts. Since these structures (Figure 140) are similar to a bird's head (from whence the name avicularium), some parts even now are known by the corresponding names, particularly the wider and bulging proximal half which represents the head; its large cavity is called the avicularian chamber. The tapering distal half consists of 2 parts: the upper, immobile jaw, which terminates in a beak, is known as the rostrum; the lower, mobile part connected to it is known as the mandible. The surface consists of the opercular part covered with the mandible, and constitutes the frontal side; the sub-opercular part is



pigure 140. Pedunculated avicularium. *A*—general view with the main parts indicated; *B*—medial, longitudinal section of the avicularium of *Dendrobeania birostrata* (Yanagi and Okada):
1—*basal side;* 2—*frontal side;* 3—*avicularian chamber;* 4—*vestibule;* 5—*upper and lower layers of the mandible;* 6—*vestibular membrane;* 7—*upper jaw (rostrum);* 8—*diaphragm;* 9—*vein;* 10—*distal end;* 11—*beak;* 12—*cryptocyst;* 13—*abductor muscles;* 14—*adductor muscles;* 15—*mandible (lower jaw);* 16—*polypide;* 17—*pore into the cavity of the mandible;* 18—*pore plate;* 19—*proximal margin;* 20—*stem for attachment;* 21—*height;* 22—*length of the pore plate;* 23—*bend (from Silen,* 1938).

covered with the aperture membrane. The more or less convex opposite side is the basal side. The proximal end of the avicularium forms the point of the avicularian attachment to the stem, and the bent beak is the distal end. Under the sub-opercular membrane, along the inner margin, is located the cryptocyst in the form or a more or less broad semi-circular edge. Transverse plates originate, one on each of the 2 ends of the latter, from the lateral walls in the place of the transition of the opercular part into the sub-opercular one which, together with the widening proximal margins of the rostrum, form pointed axils in which the sharp ends of the proximal margin of the mandible are located. The cryptocyst is also located in the opercular half. The cryptocyst starts almost in the middle of the internal, lateral sides of the rostrum. The orifice formed by the inner margins of the cryptocyst is the opesium through which the muscles pass toward the mandible and the aperture membrane. It must be pointed out that the cryptocyst varies in its development in different species. Thus in *Dendrobeania birostrata* (Yanagi and Okada) described by Silen (1938), the cryptocyst is strongly developed in the proximal half in the form of a continuous semi-circular plate in which a narrow slit proceeds along the medial line, ending with a small round orifice in the middle of the plate.

The mandible is a more or less stretched, triangular, slightly convex plate with a blunt apex that is bent inwardly. This mandible consists of 2 chitinous plates connected by more thickened walls: the narrow vertical one on the sides and the transverse one on the proximal side. A small round orifice (pore) is located in the middle of the second one, through which the inner flat cavity of the mandible communicates with the outer environment. A membrane covered with a thin layer of cuticle starts from the inner surface of the mandible at a distance of one-third its length, and stretches first inwardly, then backwards at a distance of almost up to the proximal margin of the mandible. Further, this membrane turns and goes near the basal wall toward the beak, rising on the sides toward the lateral walls of the rostrum. This membrane forms the mandibular part of the vestibular membrane (Figure 140, B), which itself restricts the cavity of the vestibule.

As in other vicariating avicularia, the paired occlusor muscles or adductors are more developed in this species. They originate in the form of a large number of muscular fibers from both halves of the internal, basal and lateral walls of the avicularian chamber, leaving a narrow strip along the medial line uncovered by them. These fibers are collected by their distal ends in the avicularian chamber. A long, strong, fibrous cord starts from the middle of the internal surface of the mandible along the medial line, which is attached to it by a broad base. This cord, after piercing through the blind, proximal end of the vestibular membrane, develops into 2 branches; each branch proceeds in the basal, lateral direction, and at the end is divided into thin fibrils which connect the branch with the distal ends of the muscular fibers. Through the contraction of these muscular fibers, the distal end of the cord drags the open mandible behind itself, and as a result of the strong development of the adductor muscles, the mandible snaps shut quickly, catching whatever foreign body falls between it and the rostrum. Contrarily, the mandible opens slowly; the unpaired abductor muscle is relatively poorly developed in the form of 2 thin branches consisting of a few muscular fibers attached to the basal wall by their proximal ends, and to the connecting ones under the aperture membrane, near the proximal margin of the mandible, by their distal ends. Their action is similar to that described in the vicariating avicularia of *Flustra foliacea.*

In the deepest part of the vestibule, near the passage of the adductor cord through the vestibular membrane, is located a small deep sac, on the bottom of which is a cluster of cells surrounded by muscular fibers; the wall of the tube corresponds to the tentacular sheath, while the part of the vestibular membrane restricted by the boundaries of the tube and consisting of many cell layers, corresponds to the continuous, unperforated diaphragm. Silen has stated that he could not find cilia at the distal end of the polypide; Busk (1854b) was first to notice a polypide in the avicularium, and reproduced it as a roundish knob raised at the bottom of the vestibule, and covered with a bundle of cilia. The latter has also been reported by several other authors, and Calvet (1900) has given a description and a drawing of an avicularium with a bundle of cilia at the end of the polypide; his material has been presented in many textbooks and handbooks.

A round orifice, surrounded by a thickened annular border, and stretching through a very thin, calcareous plate in which 2 to 4 pores are located, is situated at the proximal end of the avicularium. Mesenchymatous fibers pass through the pores in the plate and help the avicularium to obtain its nutritional substances from the maternal zooid carrying it. This pore plate is the terminal part of the stem, which originates from the maternal zooid and carries the bud that eventually develops into the avicularium. Silen considered it strange that Calvet (1900) assumed that the stem belonged to the avicularium; this can be clearly seen in his Figure 137, in which the stem forms a part of the avicularium, resting on the base at the wall of the maternal zooid. Marcus (1926a), slightly changing Calvet's Figure 35, indicated that the pore plate connecting the zooid with the avicularium was the one belonging to the zooid, and like Calvet, Borg (1930a), Cori (1941), and others, he referred to the tapering, proximal part of the avicularium as the stem. Apparently a misunderstanding exists here in the fact that we are talking about 2 different parts: on the one hand about the stem on which the avicularium is located, and on the other hand about the proximal part of the avicularium itself. Silen, using *Dendrobeania* as his sample, is right in speaking of the avicularium being located on a longer stem, while Calvet and others, using *Bugula* for study, did not consider its short and wide protuberance on the zooidal wall as a stem.

But in this regard, the Antarctic species of the genus *Bugula* are particularly specific examples in which the avicularia are located on long stems, the length of which may be 2 to 4 times greater than the length of the zooid; they are connected by a simple orifice to the latter at the point of origin, while the avicularium is connected with the distal end of the stem by a pore plate that has just a few pores (Kluge, 1915).

Avicularia demonstrate considerable variability in individual structure within one zoarium (Kluge, 1915: 10-11), as well as variation in groups within the limits of a species, which serves as a basis for the formation of new forms and subspecies. Regardless of their considerable variability however, avicularia can serve as a good taxonomic parameter, particularly when discussing smaller taxonomic units. Thus, during my detailed investigation of the species *Dendrobeania* (*Bugula*) *murrayana* Johnston, in which only one form (subspecies) was recognized, *D. murrayana* var. *fruticosa* Packard, I had to divide it into 3 species and several subspecies: *D. murrayana* Johnston, *D. pseudomurrayana* Kluge with varieties *D. pseudomurrayana* var. *tenuis* Kluge and *D. pseudomurrayana* var. *fessa* Kluge, and *D. fruticosa* Packard with varieties *D. fruticosa* var. *quadridentata* Loven and *D. fruticosa* var. *frigida* Waters (see p. 391 and further).

Another form of heterozooids, i.e., vibracula, is close to the organization of the avicularium. Usually the vibracularium is located on the dorsal, or the basal side of the zooid (*Scrupocellaria scabra, Caberea ellisi*, etc.), but sometimes it is found to occur on the lateral (*Scrupocellaria scruposa*), or even on the frontal surface (*Cribrilina latomarginata*). Calvet (1900) considered both structures as 2 forms of one and the same individual species, differing only by a larger or smaller mandibular length, and a more or less reduced chamber. Waters (1904) indicated greater differences between them: while the avicularian chamber is a symmetrical structure, the chamber of the vibracularium is asymmetric and, furthermore, the articulated part of the mandible has different knobs to which muscles are attached, which allow the movement of the mandible in different directions. In many species the mandible of the vibracularium has the appearance of a long, flagellate structure, which is frequently denticulated along its entire margin on one or both sides (species of *Caberea*, Figure 244). The length of the flagellum varies in different forms. In some members of the genus *Scrupocellaria*, the mandible has the appearance of a small, oblong plate which tapers toward the end and alone closes the opercular part of the chamber or rostrum; this feature makes a vibracularium of this type resemble an avicularium (Figure 241). The proximal part of the mandible is usually thick, roundish, more or less free-moving in the opercular part of the chamber, or it has the appearance of an open iron ring or cartridge clip enclosing the hood in the cystid like an axis. The abductor and adductor muscles are attached to this proximal part (Figure 141). The chamber has the appearance of a slightly flattened structure of oval, triangular, or even oblong, navicular form. In addition to the muscles mentioned above, which almost fill the entire cavity of the chamber, one finds the polypide in the form of a small collection of cells carrying cilia, and covered with a sheath that is homologous to the tentacular sheath (Calvet, 1900). The pore plates are located on many chambers, from which the kenozooids start in the form of radicular tubes. Although the flagella move independently, Hincks (1880a) observed synchronous movements in *Caberea,* from the dorsal side to the frontal side, occurring at definite time intervals, which were sometimes slight and sometimes more pronounced.

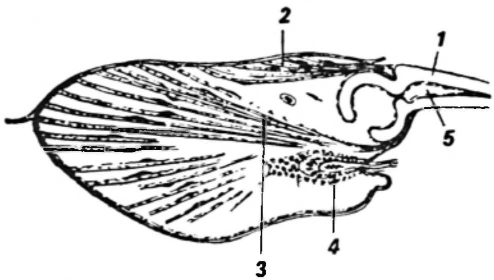


Figure 141. Longitudinal section of a vibracularium of *Caberea boryi* Audouin: 1—*mandible;* 2—*abductor muscles;* 3—*adductor muscles;* 4—*polypide* (*rudimentary*); 5—*mandibular cavity* (*from Calvet,* 1900).

The so-called kenozooids differ significantly from heterozooids. Their structure was described in the introductory part (see p. 11). Here we shall examine those forms in which they are found to occur in the order *Cheilostomata.* In *Membranipora membranacea,* vertical, cylindrical protuberances up to 3 mm in height are found at the margin of the zoarium on the frontal surface of the zooid (Figure 151). As yet, their significance is not clear. In many *Cellularina,* kenozooids are found in the form of more or less long, strongly chitinized tubes which frequently terminate in a widened, branched plate that is attached to the substrate; these are the so-called radicular tubes [genus *Scrupocellaria, Notoplites, Uschakovia* (*U. gorbunovi*): Figure 228]; or the kenozooids are in the form of slightly chitinized, soft tubes filled with a fluid, which terminate in a bundle of thin threads at their proximal end, and enter into the soft, silty or sandy ground—these are the so-called stems supporting the upper crown of the zooids [genus *Kinetoskias* (*K. beringi*); Figure 223]. The individuality of these structures is expressed in the fact that though they originate from the zooids, they are separated from them by septa which have pores (the pore plates). They usually originate from the lower or upper part of the lateral wall of the zooid, and rarely from the dorsal wall. However, these radicular tubes are not always individually expressed. Thus in the genus *Pseudoflustra* [(*P. solida*); Figure 292] of the group *Ascophora,* the radicular tubes start either from the proximal end, or from the middle of the frontal wall of the zooid, as a direct tubular continuation of the chitinized membrane which covers the calcareous, frontal wall of the zooid. These tubes are strongly chitinized throughout their length and frequently fuse with the other branches of the zoarium, thus ensuring its wholeness; strongly ramified toward the lower end, they form a dense intertwining of tubes fusing with the hard ground. In certain forms (genus *Uschakovia*), the kenozooids are in the form of changed, strongly chitinized zooids in the proximal part of the zoarium, and assist in the accumulation of the nutritive substances requisite for the growth of the distal part of the zoarium. Marcus (1925) cited a striking example of polymorphism in *Stirpariella mortenseni* Marcus, where the lower part of the zoarium consisted of calcareous kenozooids in the form of a jointed stem which was branched toward the upper side, while the joints of the lower part consisted of a pair of fused and changed zooids. Lastly, kenozooids are found in the form of continuous or hollow plates, which fill the free spaces between the zooids on the frontal surface of the zoarium (*Escharella ventricosa*) (Figure 255), or are situated on the dorsal side of the zooids, or in the sub-tentacular plate where they assist in the fixation of the zoarium. In spite of the large differences between kenozooids and heterozooids, a very close interdependence may exist between them.

Polymorphism is perhaps nowhere as strongly developed among members of *Cheilostomata,* as in representatives of the family *Reteporidae.* This development is so complex that even up to the present time, many details in their structure still remain unresolved. As a rule, in the species of the genus *Retepora,* the autozooids are arranged in one layer and their frontal surface is turned toward the inner side of the usually funnel-shaped zoarium; the dorsal side of the zooids is covered with calcareous plates of variable forms and without orifices, or with a similar type of plate which has an avicularium. Even Waters (1889) observed that these structures on the dorsal side, are not only on the surface layer directly adjoining the dorsal side of the autozooids, but on the terminal surface layer of a whole series of mutually adjoining structures which start from the dorsal side of the autozooids; numerous cavities are found in these layers (Figure 142). Levinsen (1909) believed that these structures were kenozooids which could vary considerably in appearance, and the cavity enclosed by them highly attenuated right down to its total disappearance under certain conditions. Many small pore channels fuse among themselves as well as with the autozooids and avicularia. Levinsen also determined that these kenozooids were closely associated with the process of thickening in the branches and, with continuous thickening, became covered with new and accumulative layers, which formed a whole series of layer depositions one over the other. The avicularia located on the kenozooids, under similar thickening, may also become covered with layers. Buchner (1924), while investigating *Retepora tumescena* Ortmann in detail, observed in sections from different parts of the zoarium, up to 9 layers of such structures in its lower parts.

On the basis of the existence of 2 species known so far (*Retepora bilaminata* Waters and *R. tesselata* Hincks), which consist of 2 layers of ordinary autozooids, Buchner believes that initially the dorsal side of the zooids was also covered with autozooids. Subsequently, a rudimentation of the autozooids of the dorsal side took place, the stimulus for which could have come from 2 sources: first, unfavorable conditions of nutrition on the dorsal side in the development of the funnel-shaped zoarium; and second, a necessity for a larger strength of the zoarium, which could be achieved through a stronger calcification and change in the form of the zooids, but which would hinder the development of the polypides. This may be observed in the proximal part of the zoarium of many *Retepora* species, where the frontally located autozooids become more and more broad, acquiring the form of plates, in which the polypides may still be

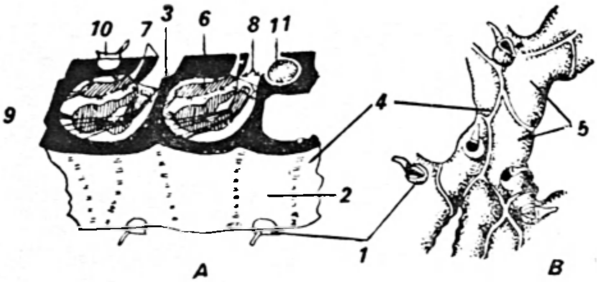


Figure 142. A part of the branch of a zoarium of *Retepora*. *A*—diagrammatic longitudinal section; *B*—view from the basal side:
1—*basal avicularium;* 2—*basal side of the branch consisting of many layers of kenozooids;* 3—*secondary orifice;* 4—*boundaries of kenozooids;* 5—*kenozooids;* 6—*compensatory sac;* 7—*primary orifice;* 8—*peristome;* 9—*spiramen;* 10—*frontal avicularia;* 11—*egg in the ovicell* (*from Marcus,* 1926a).

visible although in most cases they are absent. The cavities of the kenozooids formed on the dorsal side, were maintained to a variable degree; in those cases where they had completely disappeared, the individuals were converted into massive plates. According to Buchner, the formation of avicularia in these cases, could be explained possibly by either the phenomenon of atavism in which avicularia are situated on them like true buds (an opinion held by Levinsen), or by a totally new process not found anywhere else among avicularia.

In *Retepora terebrata* Buchner, the dorsal side consists partly of large kenozooids, and partly of similar structures equipped with the avicularian polypide and the musculature belonging to it. In the opinion of Buchner, this fact cannot be explained in any way other than the suppression of the budding process of the avicularia with a simultaneous transition of the primary (initial) kenozooid into an avicularian structure. Buchner has not contradicted the fact established by Levinsen that numerous kenozoids in some parts of the zoarium are deposited in layers one over the other, but he presumes that the whole process of the thickening of the branches and the basal or sub-tentacular plate takes place because of the development of avicularia, since "one can hardly doubt the fact that externally located avicularia originate by budding from the underlying, outgrowing avicularia." This, in the opinion of Buchner, explains the real reproduction of avicularia, i.e., the budding out of offspring similar to the parent—an observation which he was the first to make.

In contrast to the statement by Buchner about the impossibility of budding by highly developed, articulate, and staminate avicularia, I have demonstrated in the section on regeneration (see p. 30) that even such strongly specialized avicularia can produce offspring by budding.

It could seem that the facts cited here only confirm the correctness of Buchner's opinion about the possibility of budding in the formed avicularia. But a question is raised whether the avicularian polypides, with their musculature, are perhaps independent avicularia, and the kenozooids enclosing them, their cystids.

The existence of similar kenozooids devoid of avicularian polypides, along with reappearing avicularian structures, suggests that this process of the formation of avicularian structures is an individual instance, and that thought gives rise to the idea that these polypides are internal buds of the kenozooids; this is indicated by the fact that 2 to 3 avicularian polypides exist in 1 kenozooid.

There is hardly any necessity for a more specialized structure than the kenozooid, i.e., for the avicularium which has no avicularian polypide and its musculature, to produce a plate which would be several times larger than its own mass to act as its cystid. It is difficult to say what role is played by small avicularia in such a case, but they can hardly serve the purpose of zoarian attachment when the kenozooids with cavities, and still more, those without cavities, actually fulfill this function.

It seems more likely that the reduction of these avicularia, and the concommitant loss of their functioning capacity, leads to their rudimentation, the ultimate result of which would be their gradual degeneration and disappearance. On the other hand, a stronger development of the kenozooids is observed in many species, in the form of continuous, calcareous plates which cover large areas of the zooids as well as the supporting basal plate; this most probably explains the predominance of the process of development of kenozooids over the reverse transformation of kenozooids into avicularia.

Harmer (1934) has also expressed doubt about the correctness of the opinion held by Buchner—that the structures carrying avicularia are not kenozooids but avicularia, and that these avicularia produce other avicularia which lie above them by budding. From my understanding of Buchner, the conclusions are somewhat doubtful. When the kenozoecium has only one cavity, which itself belong to the avicularium, then there is no difficulty in calling the entire structure an avicularium. But this concept becomes less clear when the kenozoecium carries 2, or a larger number of avicularia. For the purpose of description at least, the only practical method seems to be to label the area as the kenozoecium, regardless of the existence or absence of the avicularium in it, and it is quite possible that this is the correct presentation, "which should be followed with regard to its morphology."

Spines. Spines are found to occur around the oral orifice and along the margins of the zooid in many members of *Cheilostomata.* A distinction is made between the oral and marginal spines according to their position. Both these types are found in the group *Anasca;* only oral spines exist in the group *Ascophora.* In form and structure, these spines are either hollow, cylindrical, and calcified (in most species), or short or long, sharpening toward the end, and chitinized (*Electra pilosa, Electra crustulenta,* etc.), jointed (in some species of the genus *Retepora*) or without joints and simple or ramified (*Callopora derjugini, Larnacicus corniger,* etc.). The number of spine varies in different species: 1 in the form of a lateral, broad spine, simple or branched scutum or fornix in some species of the genus *Scrupocellaria,* 2 in *Escharella dijmphnae,* 4 in *E. ventricosa,* 6 in *E. immersa,* etc.; their number also varies in different zooids of a single species: in *Electra pilosa* from 3 to 12, in *Callopora lineata* from 6 to 12, in *C. craticula* from 12 to 18, etc. In most species the spines are connected at their base with the cystid through a chitinous articulation. Many authors consider this articulation as an acquired adaptation which provides greater flexibility and capacity for resistance to unfavorable conditions for the spines; some authors also believe that these structures do not have an individuality of their own. In recent times Silen (1942b) has opted for the individuality of at least those hollow, articulated spines which have an orifice at their distal end, and are covered with a membrane—taken by Silen as the frontal wall, i.e., the aperture devoid of an orifice; he considered such spines to be undeveloped or, rather, degenerated zooids or kenozooids. His opinion is based on the uniform, initial development of the spine and the staminate avicularium, as well as on considerations of the phylogenetic nature of their origin from the zooids arranged around the aperture in a manner similar to the primitive form of *Labiostomella gisleni* Silen, described by him. However, this question requires further investigation.

Ovicells. The term ovicell was first introduced by Busk (1852a); Hincks (1861) called them oecia; both terms are now in general usage, although many authors use them to distinguish gonozooids from true heterozooids in *Cyclostomata*. The terms "ovicell" or "oecium" for cells which include eggs are correct to the same extent as the term "gonozooid", first used by Borg (1926), is for the zooid in which the egg develops. Huxley (1856) first expressed the correct opinion that the ovicells are saccate structures into which eggs enter from the body cavity in order to develop into embryos, although a researcher of Hinck's eminence (1861), and others, later stated that the eggs were formed in the ovicells themselves.

The ovicells found in *Cheilostomata* are often not formed in a similar manner; some of them are markedly raised above the surface of the zoarium and were observed by earlier researchers; others, however, are very slightly raised or not raised at all above the surface of the zoarium, and consequently were rarely recognized. Only because of the investigations carried out during the past 50 years, particularly by Calvet (1900), Harmer (1903, 1926), Levinsen (1902, 1909), and Silen (1944b, 1944d), has the structure of all the existing forms of ovicells become more or less familiar. Levinsen has made a distinction between hyperstomial, endozooecial, endotoichal, peristomial, and acantostegous ovicells. Among members of *Cheilostomata* occurring in our waters, the forms with hyperstomial ovicells are most widely distributed; forms with endozooecial ovicells are found rarely. Calvet (1900) was the first to describe, in relatively greater detail, the structure and formation of the hyperstomial ovicell in *Bugula sabatieri* Calvet. Although most of the authors have cited his description and figure, there exists a significant difference of opinion in their interpretations. According to his observations, the ovicell is formed from 2 hollow saccate protuberances, of which the lower spherical one presses the upper whose body partly covers the lower in the form of a semi-circular capsule (Figure 143). The upper sac originates from the proximal end of the distal (daughter) zooid, and is protected on the outer side by a chitinized coat. A narrow space, located between both its leaves, forms part of the body cavity of the daughter zooid. Since it is the body wall of the latter, it could have formed the above-mentioned, semi-circular, protective capsule. The lower sac constitutes the projection of the distal wall of the fertile zooid, and its cavity communicates with the body cavity of the fertile zooid. The upper wall of the lower sac, consisting of cylindrical cells (embryophore), is deep, and a cavity exists between the 2 sacs (the brood chamber) in which the incoming egg develops. This cavity is the outer cavity for the zooid and is not connected with the zooid's inner cavity.

The findings of the most recent authors such as Levinsen, Harmer, Cori (1941), and Silen, except those of Marcus (1926a), are contrary to the interpretation of the origin of the upper sac as a part of the distal or daughter zooid. Their data contradict the existence of the pore, and consequently, the communication between the daughter zooid and the cavity of the upper sac of the ovicell. While Levinsen and Harmer consider the upper sac as an independent structure in participation with the frontal wall of the daughter zooid, and independent of the distal wall of the fertile zooid, Cori and Silen consider the upper sac as an extension of the latter. According to Levinsen, who studied the formation of ovicells in a large number of different species of *Cheilostomata*, at a very early stage in many species, such as *Scrupocellaria scabra*, *Tegella unicornis*, *T. arctica*, *Callopora aurita*, and others, the ovicell develops from 2 primordia in the form of 2 calcified plates in the still membranous, frontal wall of the distal (daughter) zooid, starting from the frontal margin of the distal wall. Soon these primordia fuse and give rise to the medial suture, as a result of which a semicircular plate forms that is two-layered along its margin. This plate, by overgrowing, is equipped with a calcareous rim, which forms the outer border of the above-mentioned plate. This plate, being the common wall for the zooid and the ovicell, forms the basal wall of the ovicell; the frontal part of the latter is formed by a further circular overgrowth of the basal wall and the surrounding rim, resulting in the formation of a round, two-layered structure, the inner layer of which is the endooecium, and the outer the ectooecium.

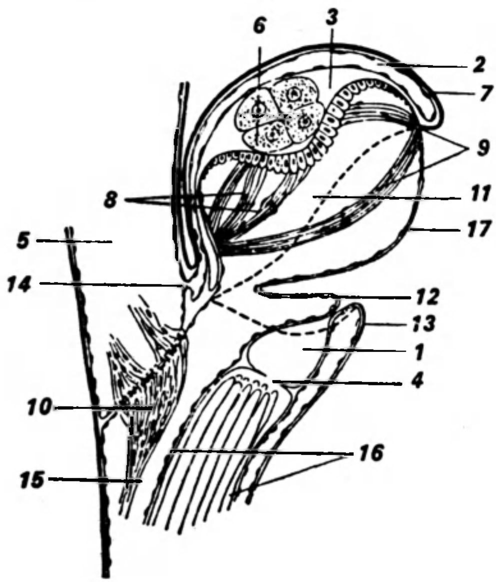


Figure 143. Structure of the ovicell (in *Bugula sabatieri* Calvet):
1—*vestibule;* 2—*upper sac;* 3—*brood chamber;* 4—*diaphragm;* 5—*distal zooid;* 6—*embryo;* 7—*cuticle;* 8—*muscles broadening the brood chamber;* 9—*retractor muscles;* 10—*mesenchymatous tissue;* 11—*lower sac;* 12—*orifice of the zooid;* 13—*operculum;* 14—*pore;* 15—*proximal zooid;* 16—*thin, cuticular layer of the tentacular sheath;* 17—*epitheca* (*from Calvet,* 1900).

In other species like *Dendrobeania murmanica*, *D. murrayana*, *Caberea ellisi*, and most of the *Ascophora* members, the primary primordium of the ovicell consists not of 2 distal, calcareous plates, but of one continuous, semi-circular plate.

Silen (1944a, 1944b), while studying the development of the same

Scrupocellaria scabra, and the close species of the above-mentioned group of *Membraniporidae*, i.e., *Callopora dumerili*, on sections of decalcified preparations, came to the wrong conclusion that Levinsen in observing the development of ovicells only on calcified preparations that were free of the tissue part, drew incorrect conclusions due to the alkali or Javel water treatment. Confirming the fact demonstrated by Levinsen about the initial formation of the upper sac from 2 originally independent primordia which soon fused into one unit, Silen demonstrated that these 2 primordia are not merely calcified plates, but flat, two-walled extensions of the lower part of the distal wall of the fertile zooid, whose hollow cavity is very narrow initially and has a slit-like appearance (Figure 144). These fused primordia form a semi-circular, two-layered plate which, by overgrowing inside and upward, forms a raised, round, hyperstomial structure which, contrary to previous authors, Silen called the ectooecium. This consists of 2 layers: the outer and inner, named the ectooecium and the endooecium by Calvet, Levinsen, and Harmer. In some species (many members of *Membraniporidae* and *Cellularidae*), the outer layer is calcified; in others (*Escharellidae*), the inner one is calcified; while both are calcified in a third group of species (*Smittinidae* and *Reteporidae*). Silen is inclined to confirm a proposal by Harmer (1903) on the inital formation of the 2 independent primordia, namely, the possibility of considering the ovicell as originating through the fusion of a strongly widened and fused pair of oral spines—a phenomenon which he had observed in *Alysidium* and *Euthyroides*.

We have examined the interpretation of the various authors about the origin of the upper sac consisting of 2 layers. With regard to the origin of the lower sac, which completes the formation of the brood chamber and forms a sort of depression for the development of the egg entering the brood chamber, all the authors, except Levinsen, agree that it is formed by the extension of the distal wall of the fertile zooid. Being initially small, it soon grows out in the form of a follicle-like structure which is completely enclosed by the ectooecium. A bundle of muscular fibers passes through its cavity, which are attached by one end to the inner side of the frontal wall opposite to the margin of the orifice of the ectooecium, and by the other end to the basal wall of the zooid. It opens the orifice of the ectooecium by its contraction for the entry of the egg and the release of the developed larvae. Since the lower sac is not calcified, it has been referred to in literature as the "lower sac of the ovicell" (Calvet) or the "membranous sac" (Harmer). Contrary to all the previous authors, Silen has called the upper sac the "ectooecium", and the membranous sac the "endooecium"; he has rightly pointed out that the "ectooecium", the "endooecium", and the "brood chamber" form the 3 important parts of the ovicell.

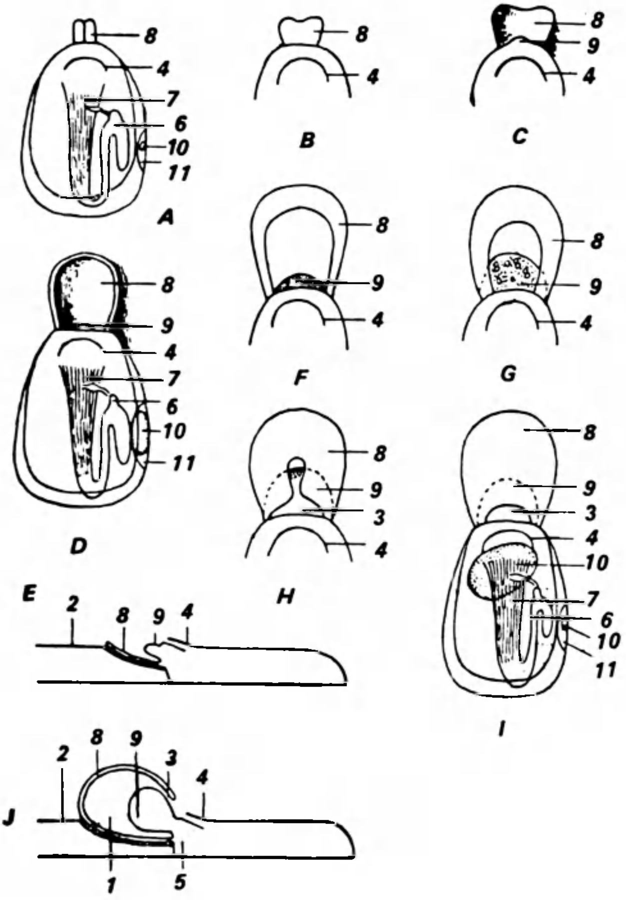


Figure 144. *Callopora dumerili* (Aud.) (× 65). Development of the egg and ovicell. Development of the egg in the body cavity and the hyperstomial oecium. *A*—dual origin of the ectooecium, appearance of the egg in the ovary; *B*—further development of the ectooecium; *C*—further development of the ectooecium; the development of the endooecium has begun; *D*–further development of the oecium; the first egg has attained a large size and lies in the distal part of the ovary; *E*—diagrammatic sagittal section of the same stage; *F* to *H*—development of ectooecia and endooecia; *I*—oecium has reached full development; the first egg is ready for replacement; the second egg appears in the ovary; *J*—diagrammatic sagittal section of the same stage. In Figures *E* and *J* the narrow striped interval between the basal part of the outer layer of the ectooecium and the wall of the distal zooid shows that these walls have virtually dissolved:

1—*brood chamber;* 2—*distal zooid;* 3—*outer orifice of the oecium;* 4—*operculum;* 5—*pore between the layer of ectooecium and the body cavity;* 6—*alimentary canal;* 7—*tentacles;* 8—*ectoderm;* 9—*endoderm;* 10—*egg,* 11—*ovary* (*from Silén,* 1944b).

In many species of the *Ascophora* group—*Schizoporella stylifera* Levinsen (Figure 335), *Smittina tuberosa* Kluge (Figure 287), *S. rigida* Lorenz (Figure 280), and others—the ovicells at the surface of the ectooecium are also covered with the so-called covering layer formed by the outgrowth of the gymnocyst of the frontal walls of the neighboring zooids.

With regard to endozooecial ovicells, Silen, after studying their development on the same species as used by Levinsen (*Flustra securifrons*), agreed with him that initially the ectooecium also develops from 2 different primordia, which later on fuse into 1 semi-circular primordium. However, Silen showed that these primordia are not plates as Levinsen thought, but extensions of the lower part of the distal wall. The ectooecium further develops in the same manner as in *Callopora dumerili*, gradually outgrowing into the cavities of the proximal part of the distal (daughter) zooid, forming a semi-circular ectooecium, covered on top with the frontal wall of the distal zooid (Figure 145). The endooecium also develops by an extension of the distal wall of the frontal zooid forming a follicle-like structure. In both cases, the hyperstomial and the endozooecial ovicells, a depression with a thickened wall (embryophore) develops in the upper part of the endooecium, in which the egg develops after entry. In *Flustra securifrons* and *F. membranaceo-truncata*, a semi-circular membrane with a chitinized distal margin, is located between the distal end of the zooid and the free, calcareous margin of the ectooecium (Figure 197), from the middle of which, on the inner side, starts the earlier mentioned muscular cord which is attached to the basal wall of the zooid by the other end. This membrane forms the so-called operculum of the ovicell, or in other words, the frontal part of the endooecium. In the above-mentioned and other species of Flustra, 2 more or less broad, flat cords, one on each side, are stretched from the lateral walls of the distal zooid between the frontal membrane and the ectooecium; the plate is usually fused in the middle of the frontal side either proximally or distally from the frontal margin of the ectooecium; this is the cryptocyst.

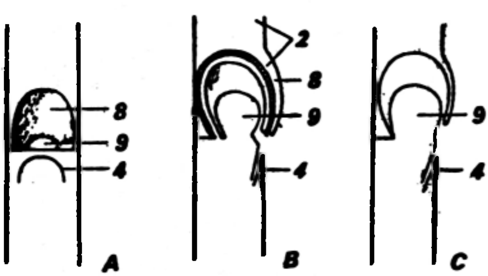


Figure 145. *Flustra securifrons* (Pallas). Diagrammatic representation of the oecium. *A*—the stage of development of the ectooecium and endooecium corresponds with that shown in Figure 144, *Callopora dumerili* (Aud.); *B*—completely developed oecium in the sagittal section; the narrow striped interval between the basal part of the ectooecium and the wall of the distal zooid shows that these walls have virtually dissolved; *C*—structure of the oecium according to previous authors: *Legend is the same as in Figure* 144 (*from Silen,* 1944b).

On the basis of the fact that the ovicells develop completely in the same manner in both types, Silen has included the endozooecial with hyperstomial, considering the latter, contrary to Levinsen, as simpler. Since the brood cavity of the ovicell is the outer cavity of the zooid, the egg must immediately come out of the cavity of the zooidal body, and only then enter the brood cavity. This process of egg transference from the body cavity to the brood chamber remained unexplained for a long time, and up to the present time only 2 authors, i.e., Gerwerzhagen (1913) and Silen (1944b), could follow it.[5] Gerwerzhagen studied this process in *Bugula avicularis* Linnaeus, and Silen studied it in *Callopora dumerili* (Audouin), *Escharella immersa* Fleming, and *Microporella malusii* (Audouin). The observations of Silen confirm the brief data of Gerwerzhagen, but since they are more complete and accurate, I shall describe his findings in short. In the beginning of summer one egg develops in the ovary and gradually increases in size. Under the pressure of the intestine, it changes its form from round to oval, and under the influence of the movement of the intestine, is moved into the distal part of the body cavity where it attains a larger size. By the completion of its growth, it is located between the orifice of the zooid, and the distal end of the crown of tentacles (Figure 146, A). When the polypide is projected, the egg drops down again (Figure 146, B), but under the influence of quick, sequential widenings and narrowings of the zooidal body wall, the upper end of the egg narrows down and stretches out; when the egg passes by the side of the hind gut, it rapidly enters the distal part of the polypide where it again assumes its original form, as a result of which the distal part of the polypide is markedly broadened (Figure 146, C). All this continues for 2 to 3 minutes, but sometimes the process takes up to 4 hours, and the polypide must be retracted and reversed a number of times until the egg again reaches the position near the orifice of the zooid. When the distal part of the zooid is broadened, under the pressure of the egg, the pore (coelopore) is clearly visible on the anal end of the intertentacular surface between two tentacles opening the body cavity outward. After this, the polypide slowly settles down to half of its extended size until its distal end reaches up to the level of the orifice of the ovicell. The tentacles loosen at this time and are either arranged in an irregular manner or turned backward. Now the transfer of the egg to the ovicell begins. The egg passes through the pore, in the form of a thin cord, into the orifice between the ectooecia and endooecia, reaching the brood chamber of the ovicell. As it enters the ovicell, it soon becomes

[5] The work of Paltschikova-Ostroumova (1926) which mentions the entry of the egg from the body cavity to the "ovicell" of *Membranipora zostericola,* cannot be included here because this "ovicell" is not of that type; it is a brood chamber formed in the daughter zooid by the fusion of spines arranged along the sides of the aperture.

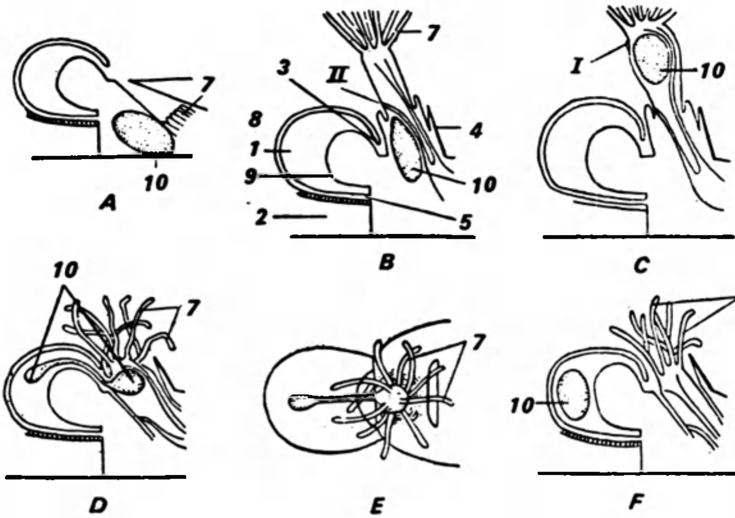


Figure 146. *Callopora dumerili* (Aud.). Transfer of the fertilized egg from the body cavity into the oecium (ovicell). *A*—location of the egg before transference; *B*—the egg halfway into the projected polypide; *C*—the egg at the end of the extended polypide; *D*—transfer of the egg from polypide to oecium; *E*—the same stage, frontal view; *F*—the egg located in the oecium. *A* to *D* and *F*—a narrow space remained between the basal part of the ectooecium and the wall of the distal zooid; a striped line indicates that the wall had virtually dissolved: I—*coelopore;* II—*anal orifice; the remaining legend is the same as in Figure* 144 (*from Silen,* 1944b).

round, even while the remaining portion continues penetration; when the whole egg has passed into the chamber, it quickly resumes its original round shape. This process lasts for about 15 seconds. After the transfer of the egg into the ovicell is completed, the polypide, along with the tentacles, remains in an immobile state for about 15 minutes, after which it is gradually invaginated into the cystid, and there remains immobilized for a long period of time.

According to the observations recorded by Silen, it takes 14 days from the detectable appearance of the egg in the ovary, for it to complete its growth and enter into the distal part of the polypide; the same period of time is required for the egg to develop into a larva in the ovicell, after which the larva leaves the ovicell. Silen made an interesting observation: when the first egg has developed into a larva and entered the body cavity, the second egg becomes noticeable in the ovary, but while the first egg is still in the body cavity, the second one remains small in size. When the first egg leaves the ovicell, the second egg reaches its full development and is situated in the distal part of the body cavity.

At this time, the third egg appears in the ovary. The development of the second and third egg proceeds in the same manner as that of the first; in this way at least 3 to 4 eggs develop sequentially in one and the same ovicell during the period of zooidal reproduction; earlier, it was assumed that only one egg developed in the ovicell at a time.

I. Suborder **Anasca** Levinsen, 1909

Anasca Levinsen, 1909 : 91.

The zoaria are prostrate and overgrow the substrate in the form of a crust, partly prostrate, partly free-growing, or even fully upright. The frontal wall of the zooids is either completely or partially uncalcified and (correspondingly) is occupied by an aperture (orifice), which is covered by the primary (initial) outer membrane, or it is calcified throughout its surface except for the orifice of the zooid, and has the appearance of a more or less fused, hollow, flattened rebra with hollow interstices or pores between them.

Avicularia and ovicells may be present or absent.

Key for Identification of the Divisions of the Suborder Anasca

1 (6). Aperture present, covered with a membrane, although occupying a small part of the frontal surface (genus *Doryporella*). Zoaria prostrate in the form of a crust or free-growing.

2 (5). Zoaria prostrate or free-growing. Avicularia adventitious or vicariating, or of both types; all avicularia sessile (petiolate only in *Cauloramphus*).

3 (4). Free-growing zoaria bushy, primarily leaf-shaped (foliate), consist of irregularly or dichotomously dividing, non-cylindrical branches. If avicularia present in free-growing zoaria, they are vicariating and not raised above the surface of the zoarium. In procumbent species, avicularia may be adventitious or vicariating, or of both types .... I. Section *Malacostega* (see p. 308).

4 (3). Free-growing zoaria consist of dichotomously divided, cylindrical branches, which are jointed with chitinous articulations into separate internodes. A strongly developed, deep cryptocyst is located under the frontal membrane, and covered with pores and orifices—opesiules—on the sides .... II. Section *Coelostega* (see p. 386).

5 (2). Zoaria always free-growing, single-layered, and one-, two-, or multi-rowed. Avicularia always adventitious, and clearly raised above the surface or the margins of the zoarium; in some genera they are petiolate (stalked). Vibracula either present or absent.................... III. Section *Cellularina* (see p. 388).

6 (1). Membrane covered aperture absent. Frontal wall, except for zooidal orifice, calcified with transverse slits, hollow spaces, or even pores arranged in transverse or radial rows. Zoaria prostrate in the form of a crust............................ .... IV. Section *Cribrimorpha* (see p. 465).

I. Section *MALACOSTEGA* Levinsen, 1902

Malacostega Levinsen, 1902 : 2; 1909 : 91; Harmer, 1926 : 177.

The zoaria are prostrate or free-growing. The aperture, covered with a membrane, occupies either the whole or part of the frontal surface. Avicularia, adventitious and vicariating, may be present or absent; if present in the free-growing zoaria, they are vicariating and not raised above the surface of the zoarium. Ovicells, hyperstomial or endozooecial, may be present or absent. Kenozooids may be present or absent.

Key for Identification of the Families of the Section Malacostega

1 (4). Zoaria free-growing, branched.

2 (3). Zoaria single or double rowed; they consist of zooids connected with each other in pairs by their basal sides. Avicularia absent. Ovicells present or absent.......................... .... I. *Scrupariidae* Busk (see p. 309).

3 (2). Zoaria flexible, leaf-shaped, one- or two-sided (in some species the zoaria begin growth in the form of a prostrate, overgrowing crust, from which free-growing, leaf-shaped structures originate). Aperture occupies the whole frontal surface and is directed in one direction. Avicularia present or absent. Pore plates located in the lateral and transverse walls.................... .... III. *Flustridae* Smitt (see p. 370).

4 (1). Zoaria prostrate over the substrate in the form of a crust, consist of one-, two-, or multi-rowed zooids. Zooids rectangular with an aperture occupying from one-third to the whole of the frontal surface.

5 (6). Zoaria prostrate in the form of a crust, consist of multi- or single-rowed zooids. Zooids sometimes rectangular, sometimes

oval, with an aperture occupying from one-third to the whole of the frontal surface. Cryptocyst developed to a variable degree. Avicularia, with chitinous mandible, have no membranous lobes along the sides of their chitinous core, and are either present or absent. Spines may be present or absent. Ovicells, hyperstomial or endozooecial, either present or absent. ....II. *Membraniporidae* Busk (see p. 314).

6 (5). Zoaria prostrate in the form of a crust. Zooids large, thick-walled, with irregularly hexagonal form. Aperture occupies the entire frontal surface. Cryptocyst strongly developed. Opesium small. Avicularia large, not less than autozooids in size, vicariating, have lateral membranous lobes along both sides of their chitinous core. Spines absent. Ovicells endozooecial. ....IV. *Onychocellidae* Jullien (see p. 384).

I. Family **Scrupariidae** Busk, 1852 char. emend.

Scrupariadae Busk, 1852b : 28 (part.); *Gemellariadae* Busk, 1852b : 33 (part.); *Eucratiadae* Hincks, 1880a : 10; *Scrupariadae* Harmer, 1926 : 197 (part.).

A large part of the zoarium is free-growing and branched. The zooids are arranged either in single rows, usually in the prostrate part of the zoarium, or in pairs fused at their basal sides. The zooids are in the form of a tube with an oval aperture slanted in the distal half, and covered with the frontal membrane. The avicularia and vibracula are absent. The budding is distal, or distal and frontal.

Genus **Eucratea** Lamouroux, 1812

Eucratea Lamouroux, 1812 : 183; *Gémellaires* Savigny, 1811; *Gemellaria* van Beneden, 1845 : 9; *et auctt.*

The zoaria are bushy. The aperture of the zooids is developed to a variable degree, occupying from one-third to the whole of the frontal surface. The cryptocyst may be present. The spines may or may not be present. The radicular tubes are developed. Ovicells are absent. The budding is distal.

Genus type: *Sertularia loricata* L., 1758.

1. **Eucratea loricata** (Linnaeus, 1758) (Figure 147)

Gemellaria loricata Smitt, 1868a : 286, 324; t. 17, f. 54; Hincks, 1880a : 19, pl. 3, f. 1-4; *et auctt.; Eucratea loricata* Harmer, 1923 : 307; Borg, 1930a : 61, f. 48; Marcus, 1940 : 109, f. 59; Kluge, 1952 : 141; 1955b : 103, t. 22, fig. 1.

The free-growing, strongly branched, and bushy part of the zoarium uprises from the row of prostrate zooids attached to the substrate; it attains a height of 10 cm or more. The zooids are arranged in pairs and fuse by their basal sides. The zooids are medium in size (length 0.63 to 0.90 mm, length of aperture 0.28 to 0.48 mm); they have a form similar to a gradually widening tube with an oblique aperture. The aperture constitutes about half the length of the zooid. New daughter zooids always bud from the distal end of the maternal zooid, and the lateral zooids; they bud alternately from one or the other side and give rise to a new branch. There have been instances, however, when 3 daughter zooids originated simultaneously from the maternal zooid, and then the new branches started from both sides of the main branch. Radicular fibers start from the lateral side of the proximal part of the zooid and stretch along the lateral walls down toward the substrate. Two to 3 pore plates

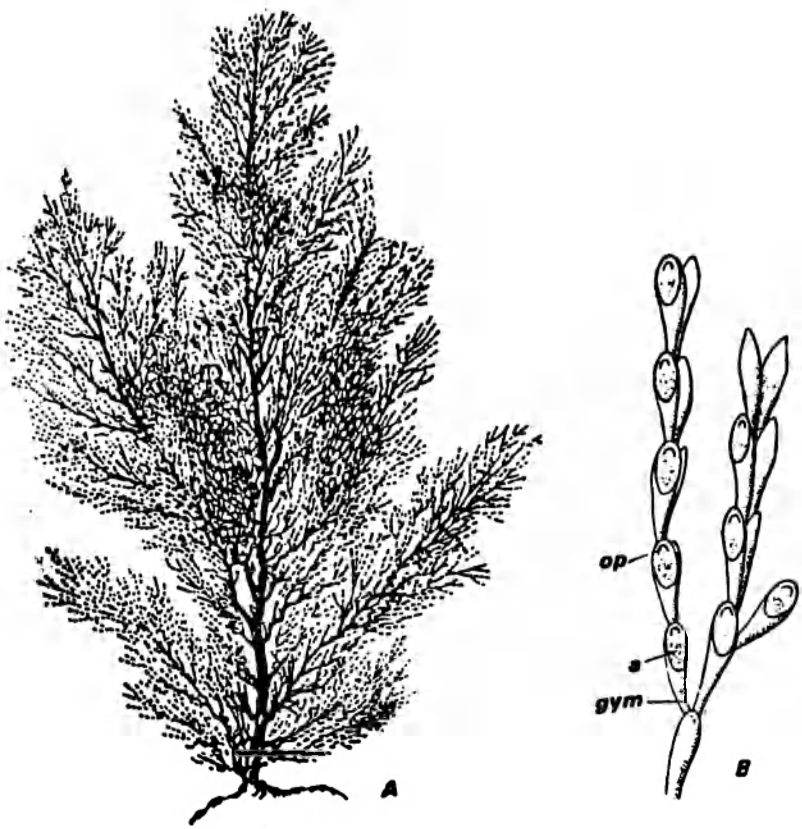


Figure 147. *Eucratea loricata* (L.). *A*—general view of the zoarium (natural size); *B*—part of the zoarial branch.

with few (4 to 6) pores are present in the lateral side of the zooid.

The species lives on stones, shells, different sessile animals, and algae, at a depth varying from the littoral up to 440 m, mostly from 0 to 75 m, under temperatures ranging from -1.82 to 5.6°C, in a salt concentration of 17.39 to 34.92‰. Although this species prefers shallow waters, it was twice recovered from the Greenland Sea at depths of 1,359 and 2,300 m.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and in the waters off Labrador and western Greenland. *Reports in literature:* Barents Sea (M. Sars, 1851; Smitt, 1868a, 1879a, 1879b; Marenzeller, 1877; Urban, 1880; Vigelius, 1881-82; Nordgaard, 1896, 1900; Bidenkap, 1897, 1900a, 1900b; Waters, 1900; Andersson, 1902; Norman, 1903a; Kluge, 1906; Kluge in Deryugin, 1915; Grieg, 1925; Kuznetsov, 1941), White Sea (Smitt, 1878b; Bidenkap, 1900a; Kluge, 1907, 1908a; Kluge in Deryugin, 1928; Guerin-Ganivet, 1911; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Levinsen, 1887; Nordgaard, 1912b; Kluge, 1929), Laptev Sea (Kluge, 1929; Abrikossov, 1932), East Siberian Sea (Kluge, 1929; Nordgaard, 1929), Chukotsk Sea (Murdoch, 1885), northern coast of North America and the Archipelago of the Canadian Islands (Verrill, 1879a; 1879b; Nordgaard, 1906a; Osburn, 1923, 1932), coastal waters of Labrador (Hincks, 1877a; Osburn, 1913), Gulf of St. Lawrence (Whiteaves, 1901), western Greenland (Fabricius, 1780; Smitt, 1868c; Hennig, 1896; Vanhöffen, 1897; Norman, 1906; Levinsen, 1914; Osburn, 1919), eastern Greenland (Andersson, 1902; Nordgaard, 1907a), Iceland (Nordgaard, 1907b, 1924), northern Norway (Nordgaard, 1918), Atlantic Ocean up to 55° n. lat. (Nordgaard, 1907b), Skagerrack and Kattegat (Smitt, 1868a; Levinsen, 1894; Marcus, 1940), North Sea (Nordgaard, 1907b), Great Britain (Hincks, 1880a), Ostend (van Beneden, 1845), along the western coast of North America from Alaska to California (Hincks, 1882; Robertson, 1900, 1905; O'Donoghue, 1923, 1926).

The species is Arctic-boreal, and rather widely distributed in the northern hemisphere.

This species varies not only in zooidal size and the ratio of the length of the aperture to the length of the entire zooid, but also in the presence of certain other characters by which a number of forms may be distinguished. The following varieties are found in our northern waters.

1 (2). Cryptocyst present near the proximal margin of the aperture. Aperture occupies less than half the frontal surface. Small denticles usually present at the distal corners.............. .... 1a. *E. loricata* var. *arctica* (Kluge).

2 (1). Cryptocyst absent. Aperture occupies more than half the frontal surface.

3 (4). One spine present in each distal corner. Aperture occupies more than half the frontal surface...1b. *E. loricata* var. *cornuta* (Osburn).

4 (3). No spines present. Aperture occupies almost the entire frontal surface. Zooids have no noticeable tapering in the proximal half..................1c. *E. loricata* var. *macrostoma* (Ortmann).

1a. **Eucratea loricata** var. **arctica** (Kluge, 1915) (Figure 148)

Gemellaria loricata var. *arctica* Kluge in Deryugin, 1915 : 377; 1929 : 3; *G. loricata* var. *aurita* Hasenbank, 1932: 324, f. 4; *G. loricata* Smitt, 1879a: 18; Ridley, 1881: 445; Levinsen, 1887 : 307; Norman, 1903a : 577; Nordgaard, 1912b : 3; *Eucratea loricata* var. *arctica* Kluge, 1929 : 3; 1952 : 141.

The zoaria are less bushy because of a sparser branching; the branches are produced at a considerable angle from the main branch. The zooids are longer and thin (length 0.88 to 1.30 mm, length of aperture 0.38 to 0.55 mm), particularly in the proximal part, as a result of which the structural arrangement of the branches is clearly visible. The aperture occupies less than half of the frontal surface. The cryptocyst, located in the proximal part of the aperture, occupies from one-fifth to one-fourth of it. A small spine is located in each distal corner of the zooid, although in some instances they may be absent.

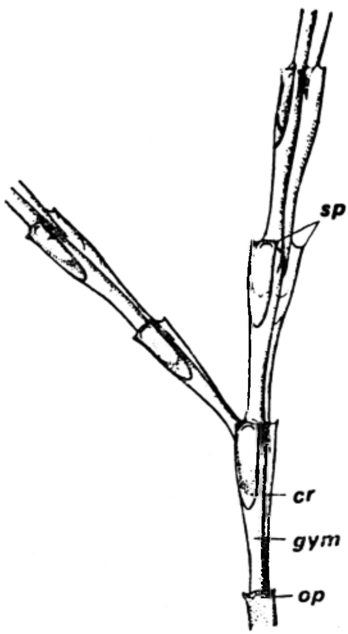


Figure 148. *Eucratea loricata* var. *arctica* (Kluge). Part of a zoarial branch.

The species lives on stones, shells, and tubes of *Polychaeta,* at a depth of 7.5 to 698 mm, often from 40 to 200 m, on a bed of silt and sand, under temperatures ranging from —1.9 to 4.95°C, in a salt concentration of 31.87 to 34.96‰.

Distribution. This form was found by me in the Barents, Kara, Laptev, East Siberian and Chukotsk seas, and in the Gulf of St. Lawrence. *Reports in literature:* Barents Sea (Ridley, 1881; Norman, 1903a), Kara Sea (Smitt, 1879a; Levinsen, 1887; Nordgaard, 1912b; Kluge, 1929), Laptev and Chukotsk seas (Kluge, 1929), on the northern side of the Rapids of the

Thompson River and the northern part of the North Sea (Hasenbank, 1932).

An Arctic form, this species dwells in deep water.

1b. **Eucratea loricata** var. **cornuta** (Osburn, 1932) (Figure 149)

Gemellaria loricata var. *cornuta* Osburn, 1932 : 6, f. C.

The zooids are shorter (length 0.58 to 0.75 mm, length of aperture 0.35 to 0.43 mm) and brown in color. The aperture is more than half the length of the frontal surface and slightly widens toward the margin. One more or less strongly developed spine is located in each distal corner.

The species lives on stones and shells, at a depth of 3.6 to 65 m, on a bed of silt and stone, under temperatures ranging from —1.6 to 4.5°C; it is more accustomed to fresh waters.

Distribution. The species was found by me in the Laptev, East Siberian, and Chukotsk seas. *Reports in literature:* Hudson Bay (Osburn, 1932).

This is an Arctic species.

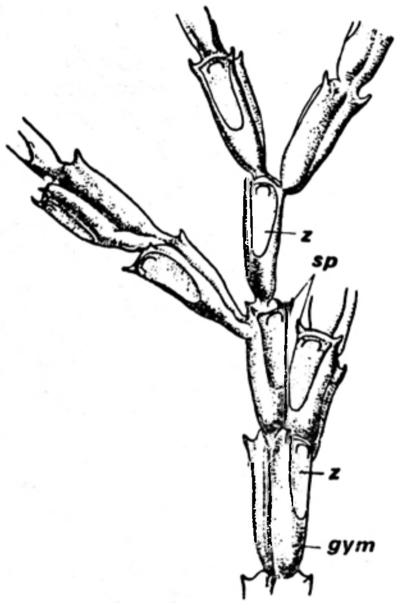


Figure 149. *Eucratea loricata* var. *cornuta* (Osburn). Part of a zoarium.

1c. **Eucratea loricata** var. **macrostoma** (Ortmann, 1890)(Figure 150)

Gemellaria macrostoma Ortmann, 1890 : 23, t. 1, f. 15.

The yellowish-gray zoaria reach up to more than 5 cm in height. The zooids are medium in size (length 0.63 to 0.88 mm) and have no noticeable tapering in the proximal half, because of which the branches look like a rod with slight graduations at the base of the zooids. The aperture occupies almost the entire frontal surface of the zooid, and is nearly uniform in width throughout its length. Spines are absent. The gymnocyst is poorly developed and the walls are weakly calcified. The radicular tubes are strongly developed, and form a more or less thick, medial stem.

This species lives on stones and shells, at a depth varying from 3.6 to 8 m, on a bed of stone and sandy silt. In the Kara Sea, a zoarium was found at a depth of 155 m, and the short zooids in the distal part of the zoaria were typical of *macrostoma;* the longer zooids in the proximal part of the zoarium had a transition toward the basic form of *loricata.*

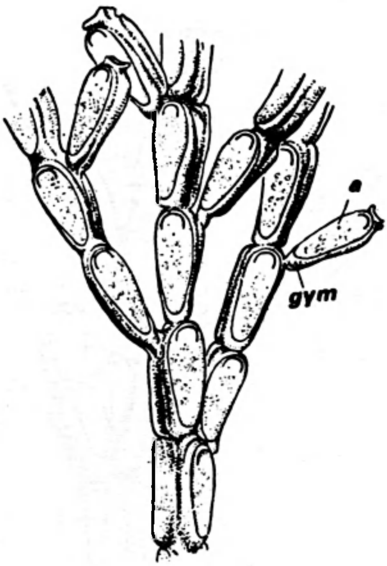


Figure 150. *Eucratea loricata* **var.** *macrostoma* **(Ortmann). Part of a zoarium.**

Distribution. The species was found by me in the Kara, Laptev, and Chukotsk seas. *Reports in literature:* Japanese Sea (Ortmann, 1890).

This is an Arctic-boreal species.

II. Family **Membraniporidae** Busk, 1854

Celleporidae Johnston, 1847 : 295 (part.); *Membraniporidae* Busk, 1854a : 55 (part.); Smitt, 1868a : 363; Hincks, 1880a : 126.

The zoaria, prostrate or in the form of an overgrowing crust, consist of zooids arranged in several regular or irregular rows, or in one row.

In the species of most of the genera constituting the family, a larger part of the frontal surface of the zooid is occupied by the aperture covered with a membrane. The margins of the aperture are usually raised, and in many species, spines are located on them which may be simple or ramified. The calcareous cryptocyst, located under the membrane, internally surrounds the border of the aperture, and is developed to a variable degree—from total absence (genera *Membranipora* and *Doryporella,* where the opesium, or the orifice, restricted by the inner border of the cryptocyst, is similar to the cryptocyst), up to a significantly developed one (genera *Amphiblestrum, Larnacicus, Rhamphonotus* where it attains up to two-thirds the size of the aperture). The gymnocyst is very poorly developed; in only a few species of the genus *Electra* and the genus *Doryporella,* does it reach up to two-thirds the length of the zooid. Avicularia, present in many genera, are either adventitious (sessile or petiolate), or vicariating, or even both. Ovicells are present in many species and peristomial in most of them. The lateral and membranous walls of the zooid have either pore plates or pore chambers, but in some species of the genus *Tegella,* both pore chambers and pore plates are found.

The family *Membraniporidae* constitutes the central group among members of *Anasca,* and develops in many directions leading to other families. The primitive nature of this group is noticeable in the similarity of many of the membranipores to the ancestrula, known under the name of "Tata-form", where the aperture is surrounded by a group of spines comparable to the marginal and oral spines of several adult membranipores.

Key for Identification of the Genera of the Family Membraniporidae

1 (20). Aperture occupies a larger part or half of the frontal surface of the zooid. Gymnocyst very poorly developed; it attains not more than half the zooidal length. Cryptocyst varies in development—from complete absence up to two-thirds the size of the aperture.

2 (9). Zooids have pore plates in the lateral and transverse walls (in *Tegella unicornis* and *T. armifera,* 1 to 2 pore chambers are found in addition to pore plates; in *T. armiferoides* and *T. amissavicularis,* although pore chambers are almost always found, the pore plates are more predominant).

3 (6). Avicularia and ovicells absent.

4 (5). Zooids in the form of a rectangle with right angles; entire frontal wall uncalcified and membranous.................................. 1. *Membranipora* de Blainville (see p. 317).

5 (4). Zooids oblong, roundish-rectangular in form; an oval aperture occupies a large part of their frontal surface and a more or less calcified gymnocyst is located in the proximal part. *Electra crustulenta* var. *catenularia-similis* is an exception in which the aperture occupies not more than half of the frontal surface of the zooid..............2. *Electra* Lamouroux (see p. 318).

6 (3). Avicularia and ovicells absent.

7 (8). Avicularia adventitious (angular or frontal or both), or adventitious and vicariating. Aperture occupies a large part of the frontal surface. Cryptocyst poorly developed. Ovicells hyperstomial or endozooecial. Spines either present or absent. ....3. *Tegella* Levinsen (see p. 325).

8 (7). Only vicariating avicularia present. Aperture occupies a larger portion of the frontal surface. Cryptocyst strongly developed. Proximal pair of spines branch in a fork-like manner at the end. Free end of the mandible of the avicula-

rium rounded.............8. *Lamacicus* Norman (see p. 365).

9 (2). Zooids have pore chambers along the margin of their basal side.

10 (13). Aperture occupies a larger portion of the frontal surface. Cryptocyst poorly developed and usually found in the form of a narrow, calcareous rim along the margin of the aperture, due to which the opesia are almost uniform in shape with the aperture, and only slightly smaller than the latter. In many species, the gymnocyst is present to a certain extent, and located proximal to the aperture.

11 (12). Margin of the aperture covered with a larger or smaller number of calcareous spines; petiolated avicularia are not found among these spines. Sessile avicularia, both adventitious and vicariating, either present or absent....4. *Callopora* Gray (see p. 341).

12 (11). Margin of the aperture covered with a varying number of calcareous spines; two petiolated avicularia located among these spines, one on each of the two sides, or on one side only. Ovicells hyperstomial...5. *Cauloramphus* Norman (see p. 352).

13 (10). Aperture constitutes a large part of the frontal surface. Cryptocyst strongly developed; it has the appearance of a more or less broad, calcareous surface, and markedly narrows the inner orifice, or opesium. Gymnocyst sometimes quite strongly developed.

14 (19). Avicularia present.

15 (16). Avicularia have a vibraculoid nature...................... ....9. *Megapora* Hincks (see p. 366).

16 (15). Avicularia do not have vibraculoid properties.

17 (18). Avicularia small, sessile, either in the proximal part of the zooid, or on one side of the aperture in the place of its largest, width..................7. *Amphiblestrum* Gray (see p. 360).

18 (17). Avicularia large, sessile, and directly under the middle part of the proximal margin of the aperture, are shaped like a bird's beak with a large and pointed mandible.................. ....6. *Ramphonotus* Norman (see p. 357).

19 (14). Avicularia absent...........11. *Reussina* Kluge (see p. 369).

20 (1). Aperture occupies only a small part of the frontal surface; whole of the remaining surface occupied by a strongly developed gymnocyst, which is 3 times (rarely, 2 times) larger than the aperture. Cryptocyst absent. Aperture either shaped like a horseshoe or oval...10. *Doryporella* Norman (see p. 368).

1. Genus **Membranipora** de Blainville, 1830

Flustra (part.) Linnaeus, 1767 : 1301; Smitt, 1868a : 357; *Membranipora* (part.) de Blainville, 1830 : 411; 1834 : 447; Hincks, 1880a : 127.

The zoaria are prostrate and consist of rectangular zooids with right angles. The frontal wall is membranous. The pore plates are in the lateral and transverse walls. Avicularia and ovicells are absent.

Genus type: *Membranipora membranacea* (Linnaeus, 1767).

Membranipora membranacea (Linnaeus, 1767) (Figure 151)

Flustra membranacea Linnaeus, 1767 : 1301; Smitt, 1868a : 357, 375; *Membranipora membranacea* Hincks, 1880a : 140, pl. 18, f. 5-6; Levinsen, 1894 : 54, pl. IV, f. 1-12; Borg, 1930a : 61, f. 49; *Nichtina telacea* Harmer, 1926 : 205.

The zoarium is prostrate in the form of a thin, flat, transparent layer, and often grows to over a meter in length, and more than a decimeter in width. The zooids are usually arranged in regular rows in a checkered pattern, and form regular rectangles with a membranous frontal surface; one thick, short, upright, calcified spine is located on each of the proximal angles. There are about 6 pore plates with a few (3 to 4) pores located in the lower half of the lateral wall; the lower half of each side of the distal septum also has either 1 large, or 2 to 3 smaller pore plates with many pores. Sometimes the frontal wall of the autozooid has upright, chitinous, tubular protuberances, which are devoid of polypides (kenozooids).

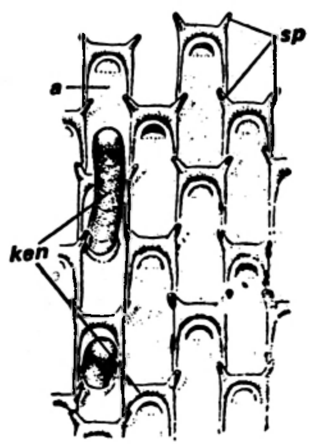


Figure 151. *Membranipora membranacea* (L.). Part of a zoarium with kenozooids (from Hincks, 1880a).

The species lives on algae, mainly on laminaria, at a depth from 0 to 40 m, on a bed of stones and shells.

Distribution. The species was found by me in the Barents Sea (Vardö), Kola Bay, and the Dal'ne-Zelenetskaya Inlet. *Reports in literature:* Barents Sea (Nordgaard, 1896; Kuznetsov, 1941), coastal waters of western Norway (Nordgaard, 1918), western coast of Sweden (Smitt, 1868a), coasts of Denmark (Levinsen, 1894; Marcus, 1940), North Sea (Nitsche, 1871; Borg, 1930a), Great Britain (Hincks, 1880a), France (Joliet, 1877), Mediterranean Sea (Calvet, 1902), and along the western coast of North

America from South Alaska (Robertson, 1900) to the Queen Charlotte Islands (Hincks, 1882).

This is an amphiboreal species, carried into the Barents Sea apparently by the Nordkapp currents.

2. Genus **Electra** Lamouroux, 1816

Flustra Linnaeus, 1767 : 1301; Smitt, 1868a : 357 (part.); *Electra* Lamouroux, 1816 : 120; Norman, 1894 : 113; *Membranipora* de Blainville, 1834 : 447; Busk, 1854a : 56(part.); Hincks, 1800a : 140.

The zoaria are prostrate and overgrowing, and consist either of many rows of zooids in the form of a thin, flat crust from which branches originate from the margin, or they consist of a very few, or even one, rows of zooids which anastomose with each other. The zooids are rectangular. The aperture, covered with a membrane, either occupies a large part of the frontal surface, or not more than half of it. The cryptocyst, hidden under the membrane, is either absent or developed to a variable degree. The gymnocyst occupies more or less than half of the frontal surface. The pore plates are located on the lateral and transverse walls. Avicularia and ovicells are absent.

Genus type: *Flustra verticillata* Ellis and Solander, 1786.

1 (4). Numerous, round-appearing pores situated on the calcified part (gymnocyst) of the frontal surface of the zooid.

2 (3). A long, flagellum-like spine situated in the middle of the proximal margin of the aperture; short, calcareous spines located along the margins of the aperture...1. *E. piloso* (L.).

3 (2). Long, chitinous spine absent; short, calcareous spines present. ....1a. *E. pilosa* var. *dentata* (Ellis and Solander).

4 (1). No pore-like stuctures appear on the calcified part (gymnocyst) of the frontal surface of the zooid; surface continuous.

5 (6). Operculum not calcified, spines absent...3. *E. catenularia* (Jameson).

6 (5). Operculum calcified; a knob with a chitinous spine either present or absent under the middle part of the proximal margin.

7 (8). Zooids oblong-rectangular in form; their length is 2 to 3 times greater than their width; aperture oblong-oval with almost parallel side walls.....2. *E. crustulenta* forma *typica* Borg.

8 (7). Zooids oblong-oval in form; their length is usually 1.5 times

greater than their width; aperture more or less a wide oval. ....2a. *E. crustulenta* var. *baltica* (Borg).

9 (10). Aperture occupies two-thirds of the frontal surface of the zooids; a knob with a chitinous spine is usually located under the middle part of the proximal margin.................. ....2b. *E. crustulenta* var. *arctica* (Borg).

10 (9). Aperture usually occupies less than half of the frontal surface of the zooid; the knob with the spine is usually absent under the middle part of the proximal margin.................. ....2c. *E. crustulenta* var. *catenularia-similis* Kluge.

1. **Electra pilosa** (Linnaeus, 1768) (Figure 152)

Membranipora pilosa Hincks, 1880a : 137, pl. 23, f. 1; Levinsen, 1894 : 54, pl. III, f. 31-36; *Electra pilosa* Norman, 1894 : 115, 132, pl. VI, f. 3-5.

The zoarium consists of several more or less regular rows of zooids and has a variable form; often there are protuberances of varying length at its margins, which consists of a few (2 to 4) rows of zooids. The gymnocyst is smooth and covered with numerous, seemingly round pores that are actually thinner and less calcified spots; these give a silvery, bright appearance to the body wall. The aperture is oval, sometimes wide, sometimes narrow; its margin is slightly thickened and covered with 4 to 8 short, calcified spines, and a flagellate, chitinous spine is located in the middle of the proximal margin at a slightly thickened place; this spine may be several times longer than the zooid. There are 4 to 5 pore plates with many pores in the lateral wall, and many (16 to 40) minute, single-pored plates arranged in the lower half of the distal septum along the entire basal margin in 1 or 2 rows.

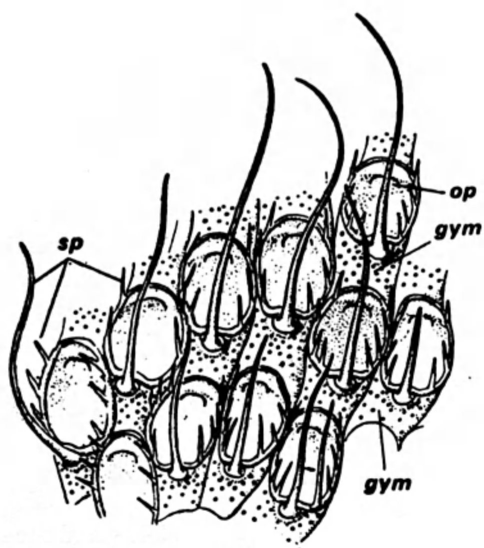


Figure 152. *Electra pilosa* (L.). Part of a zoarium. Barents Sea.

This species usually lives on fuci, laminaria, and other algae, as well as on hydroids and shells, at a depth ranging from the belt of ebb and flow up to 243 m, frequently from 5 to 75 m, on a bed of stones, shells, and sand, under temperatures ranging from −1.5 to 5.2°C, in a salt concentration of 32.27 to 34.88‰.

Distribution. The species was found by me in the Barents Sea, in the coastal waters of Finmark up to the Yugorsk Shar, and in the Baydaratskaya Inlet in the Kara Sea. *Reports in literature:* Barents Sea (Smitt, 1879b; Nordgaard, 1896; Kluge in Deryugin, 1915), White Sea (Bidenkap, 1900a; Kluge, 1908a, Guerin-Ganivet, 1911; Gostilovskaya, 1957), Kara Sea (Kluge, 1929), northern coast of North America (Osburn, 1932), waters off Labrador (Packard, 1863, 1866-69), Gulf of St. Lawrence (Dawson, 1859; Whiteaves, 1901), the region of Woods Hole (Osburn, 1912), western Greenland (Smitt, 1868c; Levinsen, 1914), Iceland (Nordgaard, 1924), along the Norwegian coast (Nordgaard, 1896), Skagerrack (Silen, 1936), Kattegat (Levinsen, 1894; Marcus, 1940), North Sea (Borg, 1930a), Great Britain (Hincks, 1880a), France (Joliet, 1877), Mediterranean Sea (Calvet, 1902), Adriatic Sea (Heller, 1867). Hincks (1880a) has indicated its presence in the waters of Australia and New Zealand.

The species is a low Arctic-boreal form.

1a. **Electra pilosa** var. **dentata** (Ellis and Solander, 1786) (Figure 153)

Membranipora pilosa var. *dentata* Hincks, 1880a : 137, pl. 23, f. 2; Levinsen, 1894 : 55, pl. III, f. 30; *M.* (*Electra*) *pilosa* forma *dentata* Borg, 1930a : 63, f. 51.

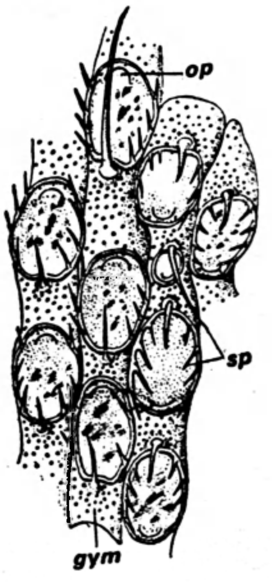


Figure 153. *Electra pilosa* var. *dentata* (Ellis and Solander). Part of a zoarium. Barents Sea.

This form is close to *Electra pilosa,* but differs from the latter in that the long, medium, flagellate, chitinous spine is absent, and a larger number of the lateral, calcified spines (from 8 to 13) are present. It should be mentioned, however, that zoaria are sometimes found which do have this flagellate spine, albeit that this spine is not developed to the same extent as in a typical *E. pilosa* Linnaeus.

This species lives on fuci and laminaria, but more often on harder substrates such as stones and shells, at a depth from 0 to 110 m, but mostly from 0 to 30 m, under temperature of 4.2°C, 6.2 to 14°C in the White Sea.

Distribution. This species was found by me in the Barents Sea, from the Motovsk Bay up to the Yugorsk Shar, and in the Kara Sea, near the southern end of Novaya Zemlya and the Baydaratskaya Inlet. *Reports in literature:* Barents Sea (Smitt, 1879b; Nordgaard, 1918; Kuznetsov, 1941), White Sea (Gostilovskaya, 1957), coastal waters of Denmark (Levinsen, 1894; Marcus, 1940), North Sea (Borg, 1930a), and Great Britain (Hincks, 1880a).

This is a low Arctic-boreal species.

2. **Electra crustulenta** forma **typica** Borg, 1931

Eschara crustulenta Pallas, 1766 : 39; *Electra crustulenta* forma *typica* Borg, 1931 : 27, pl. 3, f. 1.

The zoaria are in the form of a thin, continuous crust consisting of oblong zooids arranged in a checkered pattern. The zooids have the appearance of right-angled boxes with almost parallel, lateral walls that are much longer in length than in width (on the average, length 0.72 mm, width 0.29 mm, according to Borg); they are often subject to marked variation, sometimes reaching up to very long and narrow types (length 1.09 mm, width 0.18 mm), and sometimes being very short, almost square (length 0.54 mm, width 0.40 mm). The boundary between 2 zooids is distinctly visible in the form of a thin, chitinous cavity. The aperture is stretched, oval, and barely widened in the middle part. A weakly developed cryptocyst is situated along the margin of the aperture, under the frontal membrane, in the form of a narrow rim with a granulated surface, which is covered with minute knoblets. A calcareous knob is located at the proximal end of the aperture along the medial line of the zooid, and raised above its transverse, wide, and oval base. A chitinous spine rises upward and forward from the top of this knob, which is sharp and pointed at the end. The latter, similar to the knob, varies in its development from total absence to being strongly developed in length and width. The operculum is a characteristic feature of the zooid. Contrary to all the other species of the family *Membraniporidae*, the entire operculum—not just its margins—is strongly chitinized and saturated with calcium, because of which a white, dull, opercular plate forms, which makes this species very distinctive.

The species is mainly found on laminaria, at small depths, under a salt concentration close to normal.

Distribution. Reports in literature: Gulmar-fiord, Boguslen, on the western coast of Sweden (Borg, 1931).

This is a boreal species.

2a. **Electra crustulenta** var. **baltica** Borg, 1931 (Figure 154)

Electra crustulenta var. *baltica* Borg, 1931 : 27, pl. I, f. 6, pl. II, f. 2-3, pl. III, f. 2-3; *Membranipora mülleri* Bidenkap, 1900a : 532, pl. IX, f. 1.

The zoarium overgrows in the form of thin, wide crusts that often form multi-rowed lobes, which sometimes change into one row or, again, become wide through anastomosing with each other. The zooids are more or less long and arranged in slanted rows; their length exceeds their width by more than 2 times. The aperture occupies almost the entire frontal surface. The cryptocyst in the distal half is barely noticeable; it is in the form of a narrow edge in the proximal half, and thus the opesium is slightly different from the oblong aperture. The chitinous, calcified operculum rises abruptly in the form of a white, semi-circular surface with a slightly concave lower margin. The gymnocyst is weakly developed in the form of a wide belt in the proximal part of the zooid. It forms a knoblet directly under the middle line of the proximal margin of the aperture, on which a chitinous spine is located; however, sometimes the spine as well as the knoblet may be absent.

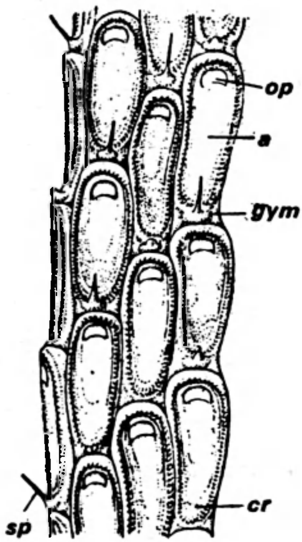


Figure 154. *Electra crustulenta* var. *baltica* Borg. Part of a zoarium. Barents Sea.

The species lives mostly on stone, at a depth varying from 0.5 to 70 m, in fresher waters where the salt concentration reaches up to 2‰, or sometimes less.

Distribution. The species was found by me in the Barents Sea in the Saida Inlet of Kola Bay, and in Mogil'ny Lake on Kildin Island, in the Kara Sea and the Baydaratskaya Inlet, and in the whole of the Baltic Sea, including the Gulf of Finland. *Reports in literature:* Barents Sea (Bidenkap, 1900a), White Sea (Gostilovskaya, 1957), North Sea (Borg, 1930a), coastal waters of Denmark (Levinsen, 1894; Marcus, 1940), and the Baltic Sea with the Gulfs of Bothnia and Finland (Nordqvist, 1890; Levander, 1900; Knipovich, 1909).

This is a boreal species and found in less salty waters.

2b. **Electra crustulenta** var. **arctica** Borg, 1931 (Figure 155)

Electra crustulenta var. *arctica* Borg, 1931: 27, 13-15, pl. I, f. 3-5, pl. II, f. 6; *Membranipora* *monostachys* Busk, 1854a : 61, pl. LXX; *M. pilosa* forma *catenularia* Smitt (part.), 1868a : 370, 417, t. XX, f. 45-46.

The zoarium is in the form of a thin, prostrate crust of a very irregular shape, from which narrower lobes of 2, 3, and sometimes more zooidal rows start along the margins. The rows anastomose among themselves. The zooids are arranged in longitudinal rows, but because of frequent branching, these rows are short and spread to different sides, which accounts for the irregular shape of the zoarium. The zooids are oblong, slightly wider in the middle and a little narrower in the proximal part; on the average, their length is 1½ times greater than their width. The stronger calcification in this species causes a thickening of the vertical walls of the zooid and the margins of the aperture, due to which the latter is slightly raised.

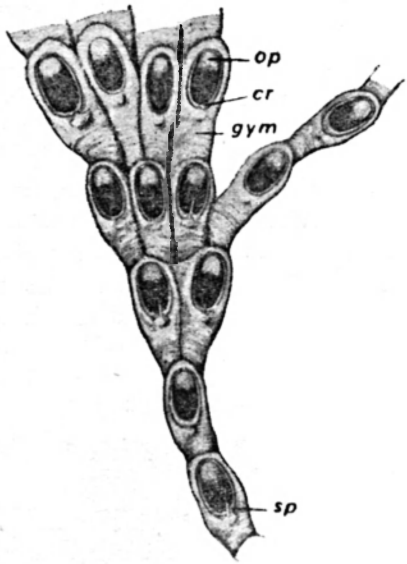


Figure 155. *Electra crustulenta* var. *arctica* Borg. Part of a zoarium. White Sea.

The aperture occupies two-thirds of the frontal surface. The cryptocyst is in the form of a more or less wide edge on the inner margin of the aperture, due to which the opesium has the same appearance as that of the aperture. A strongly calcified, chitinous operculum of oblong-roundish form, and a straight, proximal margin, is located in the distal part of the frontal surface. A knob with a chitinous spine is situated at the gymnocyst in the middle of the proximal margin of the aperture; it may be absent from some of the zooids. This species is subject to great variation with regard to zooidal size and shape, and the degree of development of the proximal, medial spine.

This species lives mostly on stones and shells, at a depth varying from 7.5 to 520 m, often from 20 to 100 m, under temperatures ranging from −1.9 to 3.7°C, in a salt concentration of 32.84 to 34.92‰.

Distribution. This form was found by me in the Barents, Kara, Laptev, Chukotsk, Bering, and Okhotsk seas, and in the Devisov Strait off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868a, 1879a; Bidenkap, 1900a; Waters, 1900; Andersson, 1902; Kuznetsov, 1941), White Sea (Kluge, 1907, 1908a; Kluge in Deryugin, 1928; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Nordgaard, 1912b; Kluge, 1929), Laptev Sea (Kluge, 1929), northern coast of North America and the Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1932), western Greenland (Levinsen, 1914; Osburn, 1919), and the Devisov Strait (Norman, 1906).

This is an Arctic, circumpolar species.

2c. **Electra crustulenta** var. **catenularia-similis** Kluge nom. n. (Figure 156)

Membranipora monostachys Waters, 1900 : 59 (part.), pl. 8, f. 3; *Electra catenularia* Nordgaard, 1918 : 39; *Pyripora catenularia* Osburn, 1933 : 21, pl. 14, f. 3.

The zoarium overgrows in the form of thin, one-rowed, rarely two- or three-rowed, strips which are strongly branched, sometimes at a right angle. The zooids are oblong, their proximal part somewhat tapering, and their length is twice greater than their width. The aperture occupies from one-half to one third of the frontal surface. An oblong-roundish, calcified, chitinous operculum with a straight, proximal margin, is located in the distal part of the frontal membrane. The cryptocyst is developed in the form of a more or less wide edge, sometimes significantly narrowing the oval opesium. The gymnocyst is strongly developed; its surface is almost smooth with a weak, transverse striping. The spines are usually absent; in rare cases, zooids are found which have a knoblet and a spine near the proximal margin of the aperture.

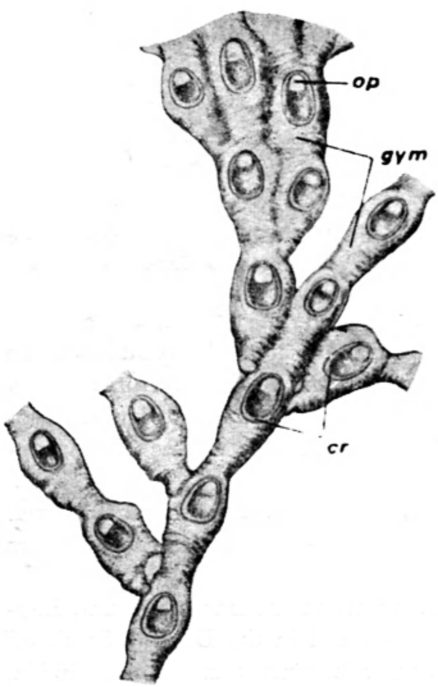


Figure 156. *Electra crustulenta* var. *catenularia-similis* Kluge. Part of a zoarium.

The species lives on stones and shells, at a depth from 20 to 230 m.

Distribution. The species was found by me in the Barents Sea in Kola Bay, and in Isfjorden in Spitsbergen. *Reports in literature:* Barents Sea (Waters, 1900), White Sea (Gostilovskaya, 1957), northern Norway (Nordgaard, 1918), and the region of Desert Island near the eastern coast of North America (Osburn, 1933).

This is an Arctic species.

3. **Electra catenularia** (Jameson, 1811) (Figure 157)

Membranipora catenularia Hincks, 1880a : 134, pl. XVII, f. 1-2; Borg, 1931 : 15, pl. I, f. 1; non 1933a : 522; Marcus, 1940 : 122, f. 64.

Branches consist of one row of zooids and anastomose with each other. The zooids are oblong with a wide distal half and a tapering proximal half. The latter usually exceeds half the length of the entire zooid; its surface is smooth and covered with a weak, transverse pattern. The average length of the zooid is 0.80 mm, and its width 0.30 mm; the length of the aperture is 0.29 mm, and its width 0.20 mm (according to Borg). The cryptocyst, in the form of a narrow edge, is located along the margin of the oval aperture under the frontal membrane. The opesium is oval. The calcareous knob with the chitinous spine is not present on the proximal margin of the aperture. The operculum is uncalcified and membranous, and chitinized only along the margin.

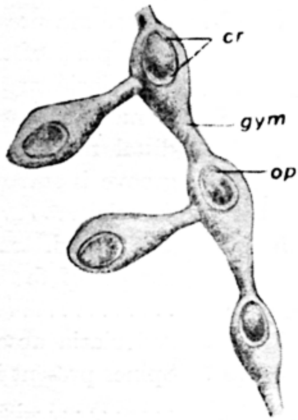


Figure 157. *Electra catenularia* (Jameson). A small part of a zoarium.

The species lives on algae, Bryozoa, shells, and stones, at a depth of 72 to 500 m, on a bed of stone, silt, and sand.

Distribution. Reports in literature: North Sea (Smitt, 1868a; Borg, 1931), Shetland and the British Isles (Norman, 1869; Hincks, 1880a). Other reports have yet to be confirmed.

This is a boreal species.

3. Genus **Tegella** Levinsen, 1909

Tegella Levinsen, 1909 : 152; *Membranipora* Hincks, 1880a : 127 (part.); *Callopora* Norman, 1903a : 588 (part.).

The zoaria are prostrate. The aperture occupies a large part of the frontal surface of the zooid. The cryptocyst is poorly developed. The gymnocyst is either poorly developed or absent. The spines are either present or absent. The avicularia are either adventitious, adventitious and vicariating, or absent. The ovicells are hyperstomial, endozooecial, or absent. The pore plates, with a varying number of pores, are located in the lateral and transverse walls of the zooid. But in some forms like *Tegella unicornis* and even *T. armifera,* sometimes 1 to 2 pore chambers can be seen along with the pore plates, while in *T. armiferoides* and *T. amissavicularis* the presence of pore chambers together with pore plates is a permanent phenomenon. Since the latter predominate, we have included these forms in the genus *Tegella.*

Genus type: *Tegella unicornis* Fleming.

1 (20). Avicularia present.
2 (17). Only adventitious avicularia present.
3 (10). Avicularia present only in the distal part, or only in the proximal part, of the zooid.
4 (7). Avicularia present in the distal part of the zooid.
5 (6). A more or less broad, transverse groove is located above the distal margin of many zooids, between the avicularia; the groove is surrounded by its own walls. The oecia are endozooecial............................7. *T. nigrans* (Hincks).
6 (5). The broad, transverse groove is not present above the distal margin of the zooid. The oecia are hyperstomial.........
..............................8. *T. anguloavicularis* Kluge.
7 (4). Avicularia absent in the distal part.
8 (9). Spines present in the distal part of adult zooids.............
..................................1. *T. unicornis* (Fleming).
9 (8). Spines absent from the distal part of adult zooids...........
............................5. *T. spitzbergensis* (Bidenkap).
10 (3). Avicularia present simultaneously in the distal and proximal parts.
11 (14). Zooids small. Distal avicularia present in both corners. The proximal (frontal) avicularium small with a triangular mandible.
12 (13). Avicularia in the distal part of the zooid, have mandibles whose pointed tips are directed toward the upper and inner sides..........................6. *T. arctica* (d'Orbigny).
13 (12). Avicularia in the distal part of the zooid, have mandibles whose sharp spikes point downward......................
.......................6a. *T. arctica* var. *retroversa* Kluge.
14 (11). Zooids large. Spines either present or absent.
15 (16). Spines present. Distal avicularium usually present on one side; a large, erect spine or 2 distal avicularia located on the other side; a spine may be found under each avicularium, or under only one. Proximal (frontal) avicularium large with a stretched mandible whose tip is directed downward........

. . . . 2. *T. armifera* (Hincks).

16 (15). Spines absent. In the distal corners, each avicularium has a mandible whose pointed tip is directed downward and outward. Frontal avicularium often present at the round conical protuberance, with a short, triangular mandible whose free apex points downward. . . . . 3. *T. armiferoides* Kluge.

17 (2). Vicariating avicularia present along with adventitious.

18 (19). There are many minute, adventitious avicularia along the lateral margins and in the proximal part of the zooid. . . . . 4. *T. kildinensis* Kluge.

19 (18). One or 2 small, frontal avicularia present in the proximal part of the zooid. . . . . 11. *T. norvegica* Nordgaard.

20 (1). Avicularia absent.

21 (22). Spines absent. . . . . 9. *T. inermis* Kluge.

22 (21). There are 2 to 3 pairs of large, distal spines. . . . . 10. *T. amissavicularis* Kluge.

1. **Tegella unicornis** (Fleming, 1828) (Figure 158)

Membranipora lineata forma *unicornis* stadium longius adultum Smitt, 1868a : 365, pl. XX, f. 30; *M. unicornis* Hincks, 1880a : 154, pl. XX, f. 4; Levinsen, 1894 : 56, pl. IV, f. 13-21.

The zoarium is small with a roundish form, and consists of zooids arranged in regular rows in a checkered manner. The zooids have an oblong-rectangular form, but slightly widen in the middle. The aperture, occupying more than half of the frontal surface, has an oval form that slightly tapers in the distal part. The cryptocyst is in the form of a narrow edge along the margin of the aperture. Two spines are located along the margin on each side of the distal part of the zooid, of which the outer ones are smaller and often not very noticeable, particularly in the zooids carrying ovicells. A conical-shaped, frontal avicularium is located proximal to the aperture, and the

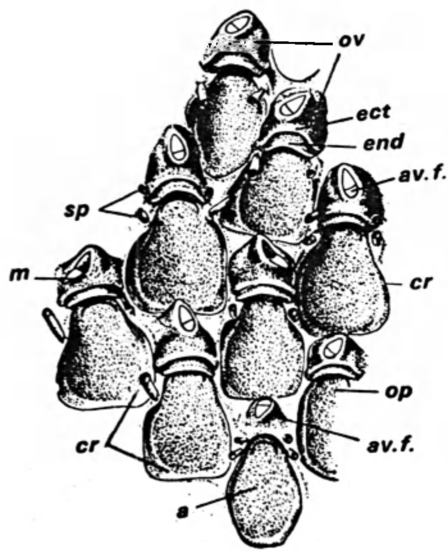


Figure 158. *Tegella unicornis* (Fleming). Part of a zoarium. Barents Sea.

tip of its mandible is usually pointed downward; in zooids carrying ovicells, the avicularium is located on the ovicell with its mandible angled toward the upper side. The ovicells are slightly oblong and smooth surfaced; their transverse rebra are slightly higher than their proximal margin, and form the thick border of the incompletely calcified, outer layer of the ectooecium. Most of the zooids have ovicells.

This species lives on mollusk shells, ascidia, and stones, at a depth of 5 to 120 m.

Distribution. Reports in literature: Barents Sea in the region of Matochkin Shar (Nordgaard, 1923), coastal waters off western Norway (Nordgaard, 1918), Skagerrack (Smitt, 1868a), Kattegat (Levinsen, 1894), North Sea (Borg, 1930a), Great Britain (Hincks, 1880a), Iceland (Nordgaard, 1924), along the eastern coast of North America from Cape Cod to the Gulf of St. Lawrence (Osburn, 1912, 1913, 1933), western Greenland (Osburn, 1919, 1936), Hudson Bay (Osburn, 1932), northern coast of North America (Osburn, 1923), along the western coast of North America from South Alaska (Robertson, 1905) up to the Queen Charlotte Islands (Hincks, 1882).

The reports found in literature about the distribution of *Tegella (Membranipora) unicornis* in the Barents Sea (Smitt, 1868a, 1879a, 1879b; Bidenkap, 1897), in the waters off western Greenland (Busk, 1880; Hennig, 1896), the Gulf of St. Lawrence (Whiteaves, 1901) and Yan-Maien Island (Lorenz, 1886) are not correct, since all the preparations on which these reports were based have been examined by me and belong to the northern species *T. armifera.* When identifying this species, it must be kept in mind that often zoaria are found in the Barents and White seas which, at first glance, resemble *T. unicornis* because the avicularia in the distal part of the zooid are absent, but a meticulous investigation reveals that 1 or 2 zooids are situated near the margin of the zoarium, which have a small, angular avicularium and a spine on the opposite side, i.e., characteristics specific to *T. armifera.* Uncertainty on this latter point makes it imperative that the reports mentioned above by Nordgaard (1923) and Osburn (1919, 1923, 1932, 1936) about the recovery of this species in the Arctic region, be verified.

This is a boreal species.

2. **Tegella armifera** (Hincks, 1880) (Figure 159)

Membranipora armifera Hincks, 1880c : 82, pl. XI, f. 5; 1892 : 155, pl. VIII, f. 4; *Callopora unicornis* var. *armifera* Norman, 1903a : 591, pl. 13, f. 10-11; *Tegella unicornis* var. *armifera* Osburn, 1933 : 24, pl. 6, f. 7.

The zoaria are prostrate in the form of a crust which consists of large zooids arranged in slanted rows. The zooids have a rectangular form that is somewhat widened in the middle. The aperture is more than half the size of the frontal surface. The margin of the aperture is raised; the cryptocyst has a granular surface and projects from the inside of the raised aperture; opesia protrude from the denticulated margin of the aperture. The width of the cryptocyst varies. The opesia, oval in shape, sometimes slightly widen in the proximal part. The angular avicularia and spines are located in the distal part of the zooid, and their arrangement varies markedly. Two small spines are usually located in the distalmost part of the zooid which are not noticeable in the zooids carrying ovicells. The avicularium follows after them, mostly on one side, with the free, sharp end of its mandible pointed downward and slightly toward one side; on the other side, there is a more or less large, erect spine. Often, a spine is also located under the avicularium, which is thinner or erect and not sharply pointed, or if pointed, sharpens toward the terminus and slants toward the aperture. Sometimes an avicularium with mandible is located on each corner; the mandibles are directed by their free ends downward and toward the side; an erect spine is located under one of the avicularia; sometimes these avicularia are replaced by 2 spines, of which one is large and erect, and the other thinner, sharply pointed, and directed toward the aperture. A raised and larger frontal avicularium is often found at the gymnocyst, proximal to the aperture, in zooids devoid of ovicells, which is directed straight, slanted downward, or even slanted upward by the free end of its mandible. This avicularium is always present in zooids carrying ovicells; it is located at the oecium and the free tip of its mandible is always slanted upward. The ovicells are round and slightly widened; the transverse rebral margin on the surface of the incompletely calcified outer layer of the ectooecium, is located slightly above its proximal margin.

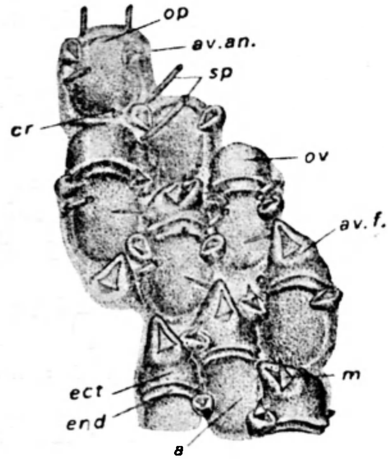


Figure 159. *Tegella armifera* (Hincks). Part of a zoarium.

The species lives on laminaria, shells, and stones, at a depth varying from 4 to 314 m, more frequently from 50 to 150 m, on a bed of stones, shells, and silty sand, under temperatures ranging from —1.9 to 4.78°C, in a salt concentration of 17.39 to 34.72‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868a, 1879a; Ridley, 1881; Vigelius, 1881-82; Bidenkap, 1897; Nordgaard, 1918, 1923), White Sea (Kluge, 1907, 1908a; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Nordgaard, 1923; Kluge, 1929), Laptev Sea (Kluge, 1929), East Siberian Sea (Kluge, 1929; Nordgaard, 1929), Chukotsk Sea (Osburn, 1923), northern coast of North America and the Archipelago of the Canadian Islands (Busk, 1880; Nordgaard, 1906a; Osburn, 1923, 1932, 1936), western Greenland (Smitt, 1868c; Hennig, 1896; Vanhöffen, 1897; Norman, 1903a, 1906; Kluge 1908b; Levinsen, 1914; Osburn, 1919, 1936), Labrador (Packard, 1863), Gulf of St. Lawrence (Hincks, 1892; Whiteaves, 1901; Norman, 1903a), eastern Greenland (Levinsen, 1916), Yan-Maien Island (Lorenz, 1886), and in the region of the Isle of Man (Osburn, 1933).

This is an Arctic, circumpolar species.

3. **Tegella armiferoides** Kluge, 1955 (Figure 160)

Tegella armiferoides Kluge, 1955a : 77, fig. 20.

The zoarium is in the form of a crust which consists of zooids arranged in slanted rows. The zooids are large, thick-walled, roundish-rectangular, broad in the middle, and tapering toward the end, particularly in the proximal part. The aperture, occupying more than half, almost two-thirds of the frontal surface of the zooids, is oval in form but tapered in the distal part. The cryptocyst is situated along the margin of the aperture in the form of a pit, which has a denticulate margin and a granular surface; it gradually widens from the distal end to the proximal one. A fairly large avicularium is located on each distal corner and raised above the surface; the free, pointed end of its mandible is directed downward and toward the outer side. A larger, frontal avicularium is located on the gymnocyst at a conical protuber-

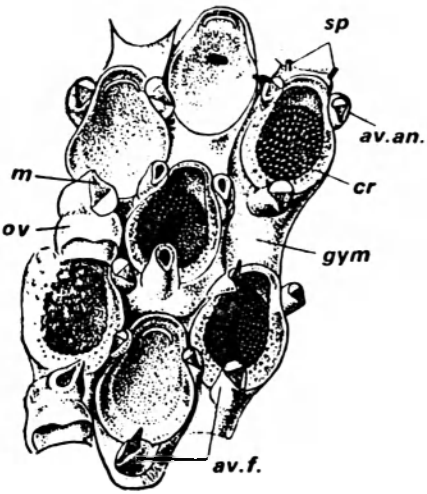


Figure 160. *Tegella armiferoides* Kluge. Part of a zoarium with closed and open apertures in the zooids.

ance, directly under the middle line of the proximal margin of the aperture, and the sharp end of its triangular mandible is pointed downward; in the zooids carrying ovicells, this avicularium is located on the ovicell, and the free end of its mandible is directed obliquely upward. The ovicell is round, comparatively small, and has a smooth surface; the outer layer of the ectooecium is not fully calcified, which gives rise to a thin, transverse, rebral margin before the proximal end of the ovicell that is slightly raised in the middle. The orifice of the ovicell is covered with a membranous lid. Pore chambers and pore plates occur simultaneously in this species; sometimes only 4 pore chambers are found along the lateral margin of the basal side of the zooid; sometimes 4 pore plates are also found in the lateral wall, but more often from 1 to 3 pore chambers are situated along the lateral margin of the lateral wall, together with 1 to 3 pore plates. Eight to 10 minute pores are found in the distal septum arranged in one row in the basal margin, which sometimes fuse into slightly larger pores, or there may be 2 pore plates with a few pores in each.

This species lives on calcareous tubes of *Polychaeta,* at a depth of 73 to 91 m.

Distribution. The species was found by me in the East Siberian Sea northward from the Novo Sibirisk Islands.

This is an Arctic species.

4. **Tegella kildinensis** Kluge, 1955 (Figure 161)

Tegella kildinensis Kluge, 1955a : 76, f. 19.

The zoarium is prostrate in the form of a thin crust, and consists of large zooids arranged in slanted rows. The zooids are oval but broaden in the proximal half. The aperture occupies almost the entire frontal surface of the zooids. The cryptocyst, slightly broader in the proximal part, develops along the margin of the aperture in the form of a rim which has a denticulate inner margin and a granular surface. There is a small spine on each side of many zooids, located on the margin of the aperture in the distal part. Numerous adventitious and vicariating avicularia cover the surface of the zoarium. There are many adventitious avicularia located particularly on the weakly developed gymnocyst, along the lateral margins of the aperture, and in the proximal part of the zooid; the pointed ends of their mandibles are directed sometimes upward, sometimes downward. In the zooids carrying ovicells, these avicularia are situated along the sides of the distal margin of the ovicell, and their mandibular free ends are directed upward and toward the sides. The large, long, vicariating avicularia are particularly characterized by

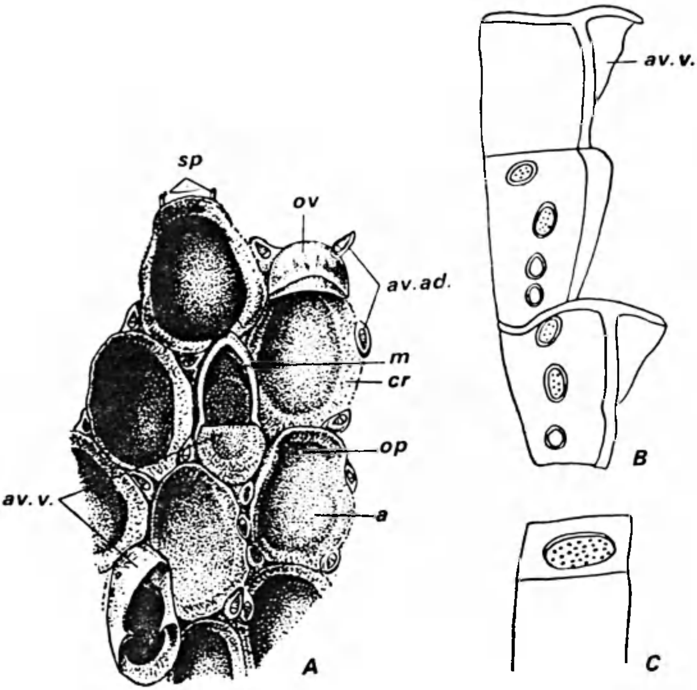


Figure 161. *Tegella kildinensis* Kluge. *A*—a small part of the zoarium with 2 vicariating and many adventitious avicularia; view from the frontal side; *B*—lateral wall of the zooids with pore plates; *C*—distal septum of the zooids with 1 pore plate.

a navicular form and a rostrum which is strongly raised above the zoarial surface; the yellow, chitinous mandibles of these avicularia are directed by their free, sharp ends toward the distal margin of the zoarium. The ovicells are semi-circular and broad, and have a radial pattern on the surface of the ectooecium. There are 3 to 4 pore plates in the lateral wall of the zooid, and 1 large pore plate with numerous pores in the distal septum.

The species lives on Bryozoa (*Hornera*), at a depth of 50 m.

Distribution. This species was found by me in the Barents Sea in the eastern half of Kildin Inlet.

Thus far the species is endemic to the Barents Sea.

5. **Tegella spitzbergensis** (Bidenkap, 1897) (Figure 162)

Membranipora arctica Smitt, 1868a : 367, t. 20, f. 33-36; *M. spitzbergensis* Bidenkap, 1897 : 619, *et auctt.; Callopora spitzbergensis* Nordgaard, 1918 : 44, f. 4-7.

The zoarium is prostrate in the form of a thick crust, which is not closely attached to the surface on the margins. The zooids are arranged in more or less regular rows; they are oblong-rectangular in shape, slightly taper in the proximal part, and have a raised margin. The aperture occupies either the entire frontal surface or, in the presence of a gymnocyst or ovicell, only two-thirds. The cryptocyst, narrow on the sides but broader in the proximal part, occupies from one-fifth to one-third of the area of the aperture; it has a granular surface and a minutely denticulate margin. The opesium is oval but slightly tapered in the proximal part. The gymnocyst occupies from one-fourth to one-third of the frontal surface. A large, frontal avicularium with a raised rostrum and a short, wide, triangular mandible, is located on the gymnocyst. The free pointed end of the mandible points toward different sides. Sometimes a small spine is found at each of the distal corners in younger zooids, but these are absent in adult zooids. The ovicells are round and broad, with a light, longitudinal striping on the smooth surface. The outer layer of the ectooecium is not fully calcified, and thus forms a thin, parallel margin ahead of the proximal margin of the ovicell. The basal sides of the zooid are densely covered with white pseudopores.

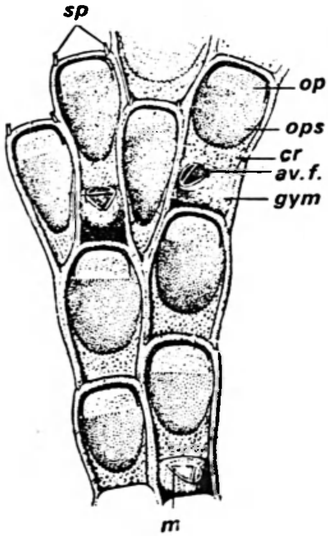


Figure 162. *Tegella spitzbergensis* (Bidenkap). Part of a zoarium with zooids devoid of ovicells. Barents Sea.

There are 4 to 5 pore plates in the lateral wall of the zooid, and each plate has many (from 8 to 15) simple pores; there are multiple (24 to 30) minute pores in the distal septum. These pores are pooled along both sides with no break in continuity.

This species lives mostly on shells and stones, at a depth of 5.5 to 1,000 m, more often from 50 to 100 m, on a bed of stone and silt, under temperatures ranging from −1.11 to 4.78°C, in a salt concentration of 24.67 to 34.07‰.

Distribution. The species was found by me in the Barents, Kara, East Siberian, Chukotsk, Bering, and Okhotsk seas. *Reports in literature:* Barents Sea (Smitt, 1868a, 1879b; Urban, 1880; Bidenkap, 1897; Nordgaard, 1900), White Sea (Gostilovskaya, 1957), northern coast of North America (Osburn, 1923, 1932, 1936), western Greenland (Norman, 1906; Levinsen, 1914; Osburn, 1919, 1936), and eastern Greenland (Levinsen, 1914).

This is an Arctic, circumpolar species.

6. **Tegella arctica** (d'Orbigny, 1850-52) (Figure 163)

Membranipora Sophiae Busk, 1855 : 255, pl. I, f. 7; *M. lineata* forma *Sophiae* Smitt, 1868a : 365, t. XX, f. 24, 25; *Callopora Sophiae* Norman, 1903a : 590; *Membranipora arctica* Lorenz, 1886 : 3, pl. VII, f. 1; *Tegella arctica* Osburn, 1933 : 23, p. 6, f. 5.

The zoaria are round in the form of a prostrate crust. The zooids are minute, oblong-rectangular, and arranged in rows. The aperture, with a raised margin, occupies from one-half to two-thirds of the frontal surface; it is oval in shape but slightly tapered in the distal half. The cryptocyst, in the form of a rim along the margin of the aperture, has a granular surface and a minutely denticulate margin. The opesium is oval. One to 3 spines are often located almost horizontally on each of the lateral margins of the aperture, or on one or both sides. The spines, when present, are pointed toward the medial line of the individual. One small spine is located on each side of the distal corners, and an oval avicularium with a mandible whose sharp end is directed upward and inward, is located either under or above each spine. In addition to the foregoing avicularia, a rectangular surface is located in the proximal part on the gymnocyst, under the proximal margin of the aperture; this surface is surrounded by thick walls on which the frontal avicularium develops in the form of a conical, raised protuberance, and the sharp end of its mandible usually points downward. In zooids carrying ovicells, this avicularium is located on the oecium, and the sharp end of its mandible is directed obliquely upward. If the frontal avicularium does not develop, the depressed surface stretches through a denser membrane. The ovicells are round; the outer layer of the ectooecium is not fully calcified on the frontal surface.

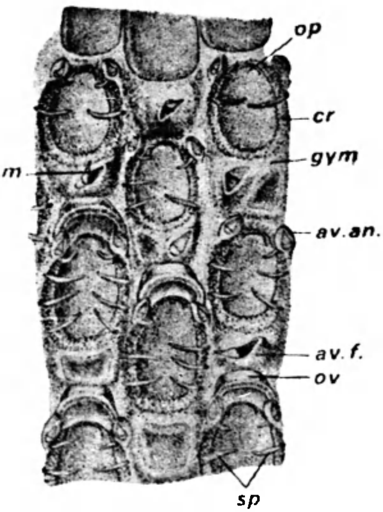


Figure 163. *Tegella arctica* (d'Orbigny). Part of a zoarium. Barents Sea (Eastern Litsa).

The species varies rather strongly with regard to the development of spines, the location of the angular avicularia, and the development of the frontal surface.

It lives on shells, ascidia, Bryozoa, and stones, at depths ranging from 0 to 300 m, more often from 0 to 75 m, under temperatures ranging from −1.2 to 4.5°C, in a salt concentration of 32.86 to 33.90‰.

Distribution. The species was located by me in the Barents, Kara, Chukotsk, Bering, and Okhotsk seas, and in the coastal waters off western Greenland. *Reports in literature:* Barents Sea (M. Sars, 1851; Smitt, 1868a; Urban, 1880; Ridley, 1881; Vigelius, 1881-82; Nordgaard, 1896, 1900, 1918, 1923; Bidenkap, 1897, 1900a; Waters, 1900; Andersson, 1902; Norman, 1903a; Kuznetsov, 1941), White Sea (Smitt, 1879b; Kluge, 1907, 1908a; Gostilovskaya, 1957), Kara Sea (Levinsen, 1887; Nordgaard, 1923), northern coastal waters of North America (Busk, 1855; Verrill, 1879; Nordgaard, 1906a; Osburn, 1932, 1936), western Greenland (Smitt, 1868c; Hincks, 1877a; Vanhöffen, 1897; Norman, 1903a, 1906; Kluge, 1908b; Levinsen, 1914; Osburn, 1919), Gulf of St. Lawrence (Whiteaves, 1901; Norman 1903a), eastern Greenland (Levinsen, 1916), Yan-Maien Island (Lorenz, 1886), northern Norway up to the Lofoten Island in the south (Nordgaard, 1918), and the Queen Charlotte Islands along the western coast of North America (Hincks, 1882).

This is an Arctic, circumpolar species.

6a. **Tegella arctica** var. **retroversa** Kluge, 1952 (Figure 164)

Tegella arctica var. *retroversa* Kluge, 1952 : 148.

The zoaria are prostrate in the form of a crust, and resemble *Tegella arctica* (d'Orbigny) in the arrangement of their zooids. The zooids are oblong-rectangular in shape. The aperture, occupying from two-thirds to three-fourths of the frontal surface, has a raised, sharp margin, is oval in form, and slightly tapers in its distal part. The cryptocyst, of uniform width along the margin of the aperture, has a granular surface, and a minutely denticulate inner margin. The opesium is oval. There is one avicularium in each of the distal corners; the free, sharp tip of its mandible is pointed downward. The frontal avicularium, of the same structure as in *T. arctica*, is located on the gymnocyst under the proximal margin of the aperture. However, the avicularium itself often does not develop, and only its base remains in the form of

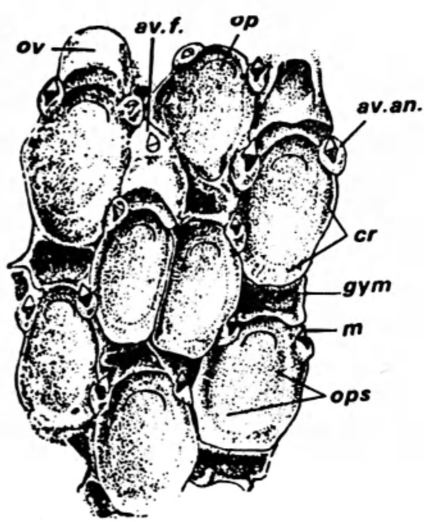


Figure 164. *Tegella arctica* var. *retroversa* Kluge. Part of a zoarium.

a depressed, transverse, rectangular surface that is restricted by its own walls; 2 pore plates are located on the bottom of this surface. Therefore, in zooids carrying ovicells, one frequently finds on the ovicell, not the avicularium, but the aforementioned surface stretched in the form of a membrane. In the growing margin of the zoarium, one often finds one small spine on each of the distal corners above the angular avicularium. The ovicells are round and have a smooth surface; the rebral margin of the incompletely calcified outer layer of the ecto-oecium lies ahead of the proximal margin of the ovicell.

The zoarium and structure of the zooids of this species make it appear to be very similar to *T. arctica* at first glance, but it differs from the latter primarily in that the pointed tips of the mandibles are directed downward, and often somewhat toward the inner side, and secondly, by the absence of horizontal spines at the lateral margins of the aperture.

The species lives on shells and calcareous Bryozoa, at depths varying from 3 to 40 m.

Distribution. This form was found by me in the Barents, Kara, East Siberian, Chukotsk, Bering, and Okhotsk seas.

The species is Arctic.

7. **Tegella nigrans** (Hincks, 1882) (Figure 165)

Membranipora nigrans Hincks, 1882 : 467, pl. XIX, f. 2; Nordgaard, 1906a: 12, pl. I f. 7-9; *Callopora nigrans* Norman, 1903a: 593, pl. VIII, f. 1, 2; Osburn, 1923: 8D; *Membrani pora macilenta* Waters, 1900 : 61, pl. 8, f. 9.

The zoarium is in the form of a crust and dark brown in color. The zooids are large, more or less broad, roundish, rectangular, or oval in shape. The aperture occupies almost the entire frontal surface; its raised margin is finely or minutely denticulate. The cryptocyst, slightly broader in the proximal part, has a granular surface, and is located along the margin of the aperture in the form of a rim. The opesium, oval or roundish-rectangular in shape, has a denticulate margin. A large avicularium with a raised rostrum and a mandible whose sharp apex is directed downward and slightly toward the outer side, is located in one of the distal corners, or there may be one in each distal corner. Besides these avicularia, there are residues of two, rarely one, frontal avicularia near the proximal end of the zooid (Figure 165, *ken*). They are usually in the form of a wide, rectangular depression which has its own walls, of which the upper corners are rounded and the lower ones sharper. The lateral part of this depression is somewhat broader compared to the middle wall which sometimes tapers up to the extent of fusing completely with the opposite walls; when this happens, the lateral parts are raised in the form of knobs. These depressions are usually covered with a membrane that is sometimes calcified; when this is removed, 2 pore plates with a few pores can be seen at the bottom (Figure 165, *p.pl.*). Occasionally, instead of a broad depression, a narrower, raised, high structure is found, which has a small oblong depression in the middle and a broad proximal side. This is the vestige of an unpaired, medium, frontal avicularium. For a long time, such structures were reported in literature as undeveloped ovicells which did not have the characteristics of genuine ovicells. It is true that the structure described here, a kenozooid, is often related to the ovicell. When the kenozooid is well developed, it is very difficult to notice that under the bare, proximal, transverse wall lies another more or less convex wall with a minutely denticulate margin; when the kenozooid is poorly developed, the latter is more prominently raised in the form of a semi-circular wall with a smooth surface. This is the ovicell which is a low, semi-circular, hyperstomial structure.

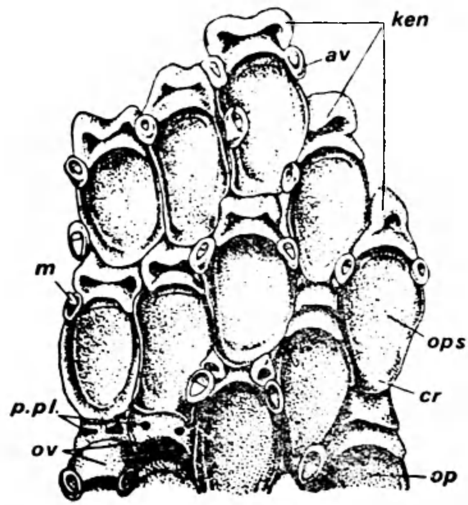


Figure 165. *Tegella nigrans* (Hincks). Part of a zoarium showing the ovicells of an angular and a residual, frontal avicularium. Barents Sea.

There are 4 pore plates in the lateral wall, and 2 with many pores in the distal septum.

This species lives on laminaria, shells, and stones, at a depth varying from 5 to 300 m, more often from 10 to 75 m, under temperatures ranging from −1.69 to 2.42°C, in a salt concentration of 29.96 to 34.27‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Waters, 1900; Norman, 1903a; Nordgaard, 1918, 1923), White Sea (Kluge, 1907, 1908a; Gostilovskaya, 1957), Kara Sea (Nordgaard, 1912; Kluge, 1929), Laptev Sea (Kluge, 1929; Abrikossov, 1932), East Siberian Sea (Kluge, 1929), Chukotsk Sea (Kluge, 1929), waters of the Archipelago of the Canadian Islands (Nordgaard, 1906; Osburn, 1923), Hudson Bay (Osburn, 1932), western Greenland (Kluge, 1908b; Levinsen, 1914; Osburn, 1919), eastern Greenland (Levinsen, 1914), and the Queen

Charlotte Islands (Hincks, 1882).

This is an Arctic-boreal, circumpolar species.

8. **Tegella anguloavicularis** Kluge, 1952 (Figure 166)

Tegella anguloavicularis Kluge, 1952 : 149, fig. 6; 1955a : 78, fig. 22.

The zoaria are prostrate in the form of a crust, yellowish in color, and consist of medium-sized zooids arranged close to the center of the zoarium in transverse rows; with further growth, the rows become longitudinal in a checkered pattern. In those instances in which the zoaria, prostrate along both sides of the substrate (as in *Flustra*), outgrow their edges or margins, then in their subsequent growth, they may converge by their basal sides and grow for some time as a free-growing, two-sided zoarium. The zooids are oblong-rectangular in form, wider in the distal part and slightly tapered in the proximal. They have a raised, denticulate margin. The aperture occupies the entire frontal surface of the zooid. The cryptocyst is like a border along the margin of the aperture, narrower on the sides of the aperture and broader in the proximal part. Its surface is granular and its inner margin denticulate. The opesium has an oval shape. A markedly raised avicularium with a raised rostrum and a broad, triangular mandible, whose free, pointed end is directed downward and outward, is usually located in one of the distally angled corners; rarely, an avicularium is found in each corner. In zooids carrying ovicells, this avicularium is located near the distal margin of the ovicell on one side, and the mandible's sharp end is pointed upward and outward. The hyperstomial ovicells are semi-circular and slightly flattened; their width is greater than their height; the surface of the ectooecium has a radial pattern. As the middle part of the proximal margin of the outer layer of the ectooecium is slightly longer, an impression is created that the outer and inner layers of the ectooecium are fused in the middle of their separating slit. From 3 to 5 pore plates with many (5 to 8) pores are located in the lateral wall along the lower half, and about 10 to 14 minute pores are arranged as though stretched in a narrow, transverse row in the distal septum, near the turn of its lower vertical part toward the upper

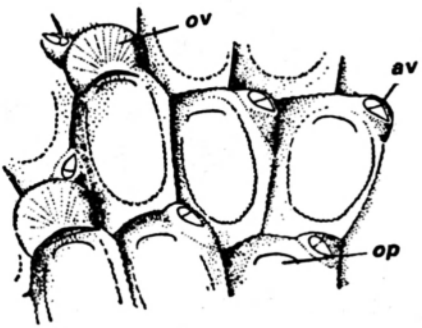


Figure 166. *Tegella anguloavicularis* Kluge. Part of a zoarium (from Kluge, 1952).

sloping one. The basal wall of the zooids is covered with dense, white, minute pseudopores.

The species lives on *Flustra,* mollusk shells, and stones, at a depth of 30 to 60 m, under a temperature of 0.6°C.

Distribution. The species was found by me in the Chukotsk Sea in the region of Cape Intsov.

9. **Tegella inermis** Kluge, 1959 (Figure 167)

Tegella inermis Kluge, 1952 : 149, fig. 5; 1955a : 79, fig. 21.

The zoarium is prostrate in the form of a yellowish crust, and consists of large zooids arranged in longitudinal rows in a checkered pattern. The zooids are oblong-hexagonal in shape. The borders of the distal half of the zooid are raised and those of the proximal half are concave; as a result, the distal half is broader, while the proximal half tapers. The aperture has a raised, thin, denticulate margin, and occupies the entire frontal surface of the zooid. The opesium, occupying a large part of the aperture, is bordered by the cryptocyst in only the proximal half; the cryptocyst, gradually broadening on the sides, has 5 to 6 pore plates with 2 to 3 minute pores each, along the lower half. There are 15 to 18 simple pores in the distal septum arranged along the lateral and lower margins almost in a single row. The basal wall is smooth and has no pseudopores. Avicularia are absent. Ovicells have not been reported.

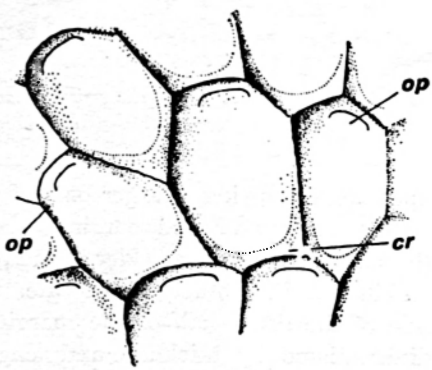


Figure 167. *Tegella inermis* Kluge. Part of a zoarium (from Kluge, 1952).

Distribution. The species was found by me in the Bering Strait, on shells, at a depth of 50 m.

10. **Tegella amissavicularis** (Kluge, 1952) (Figure 168)

Callopora amissavicularis Kluge, 1952 : 150, fig. 7; 1955a : 80, fig. 24.

The zoarium is prostrate in the form of a brown-gray crust, and consists of large zooids arranged in regular rows. The zooids have an oblong, more or less hexagonal shape with roundish corners. The

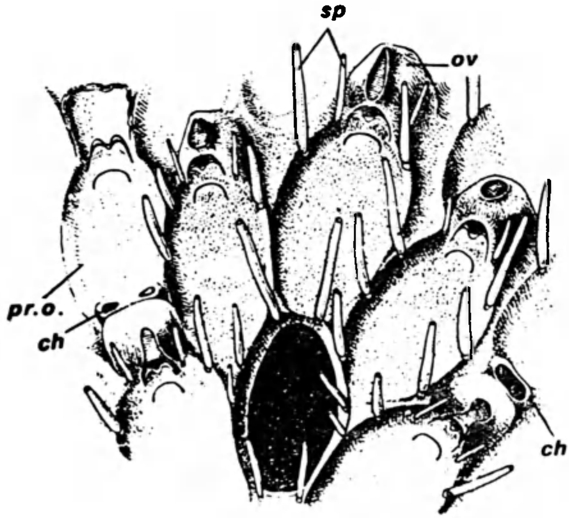


Figure 168. *Tegella amissavicularis* (Kluge). Part of a zoarium (from Kluge, 1952).

aperture, occupying a larger part of the frontal surface, has an irregular oval shape with a raised margin. The cryptocyst is like a rim, narrow on the sides and slightly broader in the proximal part; its surface is granular and its margin minutely denticulate. Two to 3 spines are located on each side of the distal half of the margin of the aperture. The spines are differentiated by thickness and length: the first (distal) pair is short and thin, the second is thick and long, and the third is slightly shorter and thinner than the second, but larger than the first. The spines are jointed with thick and chitinous articulations near their bases; hence, when the spines fall, scars are left on the margin of the aperture in the form of large orifices. The spines are hollow and terminate in a broad orifice by their slightly tapered tips. The ovicells are small, but quite variable in structure. In their simplest form, they are semi-circular with a smooth frontal surface, but the outer layer of the ectooecium usually forms a hollow protuberance of different shapes on the frontal surface to give the ovicells a typical appearance. The orifice of the ovicell is covered with its own lid. Although avicularia are absent (perhaps a secondary phenomenon since a chamber with a large orifice is relatively more often located on the frontal side of the ovicell's distal surface), the orifice is covered with a membrane which, in my opinion, is the sign of a large, frontal avicularium located at the proximal part of the zooid on a comparatively small gymnocyst. Sometimes there are lateral orifices instead of one orifice on the frontal surface of the chamber;

this would suggest a pairing of the avicularia. Pore plates and pore chambers are common to this species, but 4 pore plates with a few pores each are usually found in the lateral wall, or sometimes 2 to 3 pore plates and 1 to 2 pore chambers; in the distal septum there is only 1 pore plate with 3 to 4 pores.

Distribution. The species was found by me in the Bering Strait between the Diomede Islands and Cape Prince of Wales, at a depth up to 50 m.

11. **Tegella norvegica** (Nordgaard, 1918) (Figure 169)

Callopora aurita var. *norvegica* Nordgaard, 1918 : 47, f. 8-10.

The zooids are medium in size and roundish-rectangular in form. The oval aperture, occupying a larger part of the zoöidal surface, has a rebral margin along which a narrow cryptocyst with a granular surface is located inside. There are 2 to 3 spines along the margin of the aperture in the distal part. In addition to the small, adventitious, frontal avicularia, there are vicariating avicularia of navicular form; the latter almost reach the size of the zooid, and have an oblong, triangular mandible. The ovicells are round and have a semi-circular, rebral margin on their surface. There is usually one avicularium on the oecium on each side of the distal margin, and their pointed mandibles are directed upward and toward the sides.

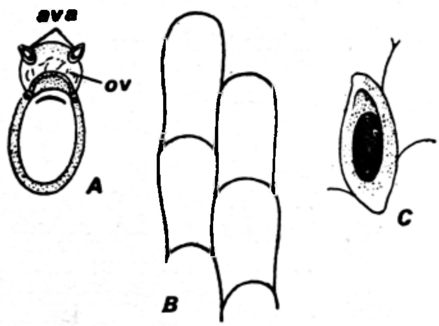


Figure 169. *Tegella norvegica* (Nordgaard). *A*—zooid with ovicell and avicularia, from the frontal side; *B*—basal side of the zooid; *C*—vicariating avicularium (from Nordgaard, 1918).

Distribution. Reports in literature: This species has been found in the waters off northern Norway in the region of Evensher, at a depth of 60 to 70 m.

This is a boreal species.

4. Genus **Callopora** Gray, 1848

Callopora Gray, 1848 : 109, 146; Norman, 1903a : 588 (part.); *Membranipora* Hincks, 1880a : 127 (part.).

The zoarium is prostrate. The zooids with pore chambers are located along the margin of the basal side. The aperture occupies a larger part of the frontal surface. The cryptocyst is weakly developed. The opesium is large. The margin of the aperture has spines. Sessile adventitious or vicariating avicularia are either present or absent. Ovicells may be present or absent.

Genus type: *Callopora lineata* (L.).

1 (10). Avicularia absent.
2 (9). Spines simple, not ramified.
3 (8). Number of spines around aperture, from 9 to 20.
4 (7). All spines similar, erect, and thin or thick.
5 (6). Number of spines varies from 12 to 20; all spines thin and long, or shorter and slightly tilted toward the aperture...... ....5. *C. whiteavesi* Norman.
6 (5). Number of spines varies from 9 to 13 spines thick or thin; after their fall, large orifices remain in the middle of the low, broad crest........................7. *C. obesa* Kluge.
7 (4). Spines dissimilar: distal 2 to 3 pairs erect and thick; other 3 to 5 pairs thinner and tilted inward to the middle of the aperture..cf. *Cauloramphus spiniferum* (Johnston) (see p. 353).
8 (3). Number of spines not more than 5, arranged irregularly. Outer layer of ectooecium has an outer notch in the middle ....6. *C. lata* (Kluge).
9 (2). Spines have fork-like branching; usually there are 3 pairs ....8. *C. derjugini* (Kluge).
10 (1). Avicularia present.
11 (18). Spines along the margin of the aperture are many (6 to 18), well-developed, erect or slanted toward the aperture.
12 (13). Number of spines varies from 6 to 10; they are slightly slanted. Only adventitious avicularia present........1. *C. lineata* (L.).
13 (12). Number of spines varies from 10 to 18. Adventitious and vicariating, or only vicariating, avicularia present.
14 (17). Adventitious and vicariating avicularia present.
15 (16). Number of spines varies from 10 to 18; except for the 2 forward pairs, spines are near the aperture. Frontal avicularia low. ....2. *C. craticula* (Alder).
16 (15). Frontal avicularia high and pedunculate; lateral adventitious avicularia often present.................................. ....2a. *C. craticula* var. *sedovi* Kluge var. n.
17 (15). Only vicariating avicularia present........4. *C. smitti* Kluge.
18 (11). At most, 4 spines along the margin of the aperture; avicularia adventitious; outer layer of oecium has a rebral margin which

bends upward at a sharp angle by its tip ....3. *C. aurita* (Hincks).

1. **Callopora lineata** (Linnaeus, 1767) (Figure 170)

Flustra lineata Linnaeus, 1767 : 1301; *Membranipora lineata* Hincks, 1880a : 143, pl. 19, f. 3-6; Levinsen, 1894: 60, pl. V, f. 1-3; *et auctt.; Callopora lineata* Norman, 1903a: 589, pl. XIII, f. 2.

The zoarium is prostrate like a roundish crust. The zooids are minute, oval, and broader in the middle. The aperture, occupying a larger part of the frontal surface, is broad and oval with a raised margin. The cryptocyst stretches along the latter in the form of a narrow border. The poorly developed gymnocyst tapers toward the proximal end. Six to 12 cylindrical spines are located along the margin of the aperture; they are erect or slightly tilted toward the aperture. A small frontal avicularium is often found directly under the middle part of the proximal margin of the aperture on the gymnocyst; it has a mandible whose pointed end is directed downward. In the zooids carrying ovicells this avicularium is located on the distal end of the ovicell on one or the other side, and the tip of its mandible is directed upward and outward. Lateral adventitious and vicariating avicularia are absent. There are numerous, minute, sharp denticles along the margin of the basal wall in the pore chambers; the denticles are pointed toward the cavity of the chamber.

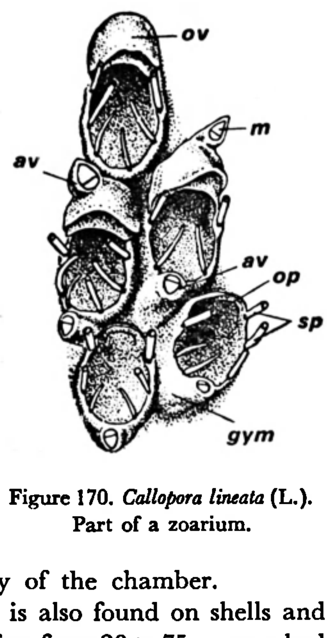


Figure 170. *Callopora lineata* (L.). Part of a zoarium.

The species lives mostly on algae, but it is also found on shells and other objects, at a depth of 0 to 378 m, more often from 20 to 75 m, on a bed of stone, silty sand, and shell, under temperatures ranging from -1.9 to 4.78°C, in a salt concentration of 31.80 to 34.83‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and in the waters of Labrador and western Greenland. *Reports in literature:* Barents Sea (M. Sars, 1851; Smitt, 1868a, 1879a, 1879b; Urban, 1880; Vigelius, 1881-82; Bidenkap, 1900a; Waters, 1900; Norman, 1903a; Kuznetsov, 1941), White Sea (Smitt, 1879b; Bidenkap, 1900a; Kluge, 1908a; Gostilovskaya, 1957), Kara Sea (Smitt, 1879b; Nordgaard, 1912b), along the northern coast of North America (Osburn, 1923, 1932, 1936), Labrador (Packard, 1863, 1866-69; Hincks, 1877a), western Greenland (Smitt, 1868c; Hincks, 1877a; Kluge, 1908b; Levinsen, 1914; Osburn, 1936), Gulf of St. Lawrence (Dawson, 1859; Whiteaves, 1901), eastern Greenland (Kirchenpauer, 1874; Levinsen, 1916), Yan-Maien Island (Lorenz, 1886), in the boreal region along the eastern coast of the Atlantic Ocean from northern Norway to the Mediterranean Sea (Joliet, 1877; Hincks, 1880a; Levinsen, 1894; Calvet, 1902; Nordgaard, 1918; Borg, 1930a), along the western coast of the Atlantic Ocean from New Scotland to Woods Hole (Osburn, 1912, 1933), and on the eastern coast of the Pacific Ocean, near northern Alaska (Robertson, 1900).

This is an Arctic-boreal, circumpolar species.

2. **Callopora craticula** (Alder, 1857) (Figure 171)

Membranipora craticula Hincks, 1880a : 147, pl. 19, f. 7; Levinsen, 1894 : 60, pl. V, f. 4-6; 1916 : 439, pl. XIX, f. 4-7; *et auctt.; Callopora craticula* Norman, 1903a : 589; *et auctt.*

The zoaria are small, thin, and prostrate; they consist of zooids arranged in slanted rows. The zooids are small and oval, broader in the middle and tapering in the proximal part. The aperture occupies from one-half to two-thirds of the frontal surface of the zooid, its raised margins cause a lowering of the lateral side and the proximal part of the gymnocyst, and the neighboring individuals are clearly separated from each other by this depression. The cryptocyst with its smooth, inner margin, forms a narrow rim along the margin of the aperture. The opesium is oval. Eleven to 16 spines are arranged along the margin of the aperture, of which the 4 distal ones usually point upward, while the remainder bend inwardly and markedly taper toward their ends at about the middle of the aperture, to cover it like an arch. Sometimes the gymnocyst has a small frontal avicularium and mandible, whose tip is pointed downward, under the middle part of the proximal margin of the aperture. In zooids carrying ovicells, this avicularium is often sessile on the ovicell with its upper portion pointed upward. Besides the

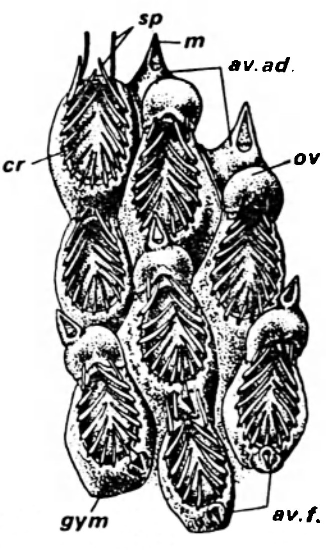


Figure 171. *Callopora craticula* (Alder). Part of a zoarium with frontal and vicariating avicularia.

aforementioned frontal avicularium, small adventitious avicularia are also found (rarely) on either or both sides of the zooid; the pointed tips of their mandibles are directed outward, almost perpendicular to the length of the zooid, and located on the raised, one-third distal part of the aperture. In addition to these adventitious avicularia, one quite often finds still larger vicariating avicularia at the periphery of the zoarium, which have a broad base, a raised rostrum, and a pointed, triangular mandible. The ovicells are round, comparatively large, and have a transverse, rebral margin at the surface because of the incompletely calcified outer layer of the ectooecium, which is slightly bent in the middle in a proximal direction. Denticles are not present along the margin of the basal wall in the pore chambers.

The species lives on laminaria, shells, and other objects, at a depth varying from 5 to 280 m, more often from 50 to 150 m, on a bed of stone, shell, and silt, under temperatures ranging from −1.82 to 4.78°C, in a salt concentration of 31.64 to 34.79‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868, 1879a, 1879b; Urban, 1880; Ridley, 1881; Bidenkap, 1900a; Andersson, 1902; Norman 1903a; Nordgaard, 1918; Kuznetsov, 1941), White Sea (Smitt, 1879b; Kluge, 1908a; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a), Laptev Sea (Kluge, 1929), East Siberian Sea (Kluge, 1929; Nordgaard, 1929), Chukotsk Sea (Kluge, 1929), northern coastal waters of North America and the Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn 1923, 1932, 1936), Labrador (Osburn, 1913), northern coast of Greenland (Smitt, 1868c; Hincks, 1877a; Hennig, 1896; Vanhöffen, 1897; Norman, 1903a, 1906; Kluge, 1908c; Levinsen, 1914; Osburn, 1919), Gulf of St Lawrence (Whiteaves, 1901; Norman, 1903a), eastern Greenland (Levinsen, 1916), Yan-Maien Island (Lorenz, 1886), Iceland (Nordgaard, 1924), along the Norwegian coast (Nordgaard, 1918), Skagerrack and Kattegat (Levinsen, 1894; Borg, 1930a), British Isles (Hincks, 1880a), and the eastern coast of North America from New Scotland to Woods Hole (Osburn, 1912, 1913, 1933).

This is an Arctic-boreal, circumpolar species.

2a. **Callopora craticula** var. **sedovi** Kluge var. n. (Figure 172)

This form is close to *C. craticula* in all important characters, differing from the latter only in the structure of the avicularium, which is taller and pedunculate, broader near the base, and slightly tapering toward its free end; a pointed and slightly sharp, triangular mandible is located on the tip of the avicularium, with its free, sharp end directed upward toward the proximal side. In the zooids carrying ovicells, this avicularium is located at the top of the ovicell, and the mandible's free end is pointed in the distal direction. In addition to this pedunculate avicularium, there is a sessile avicularium of triangular form on some of the zooids in the upper part on one side; it has a triangular, pointed mandible whose free end is directed outward. Vicariating avicularia are present. The ovicells are more or less round, large, two-layered, and the outer layer of the ectooecium incompletely covers the endooecium, and its free margin is curved in a proximal direction.

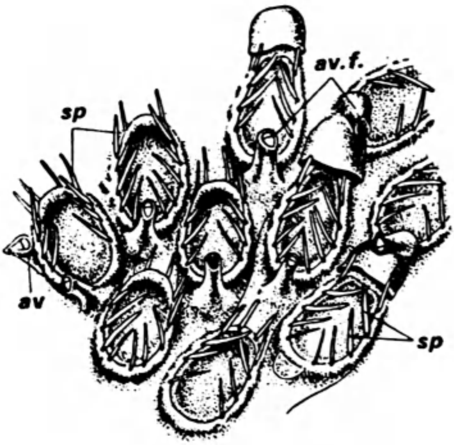


Figure 172. *Callopora craticula* var. *sedovi* Kluge var. n. Part of a zoarium.

This species lives on Bryozoa *Flustra* and *Tricellaria*, at a depth ranging from 30 to 170 m, on a bed of stones.

Distribution. This species was found by me in the Barents Sea and near Franz Josef Land.

This is an Arctic species.

3. **Callopora aurita** (Hincks, 1877) (Figure 173)

Membranipora aurita Hincks, 1880a : 159, pl. XXI, f. 5-6; Levinsen, 1894 : 59, pl. IV, f. 31-38; Osburn, 1912 : 230, pl. XXIII, f. 37, a-b; 1933 : 21, pl. 6, f. 2-3; *et auctt.; Callopora aurita* Levinsen, 1909 : 150; non *Callopora aurita* var. *norvegica* Nordgaard, 1918 : 46.

The zoarium, prostrate in the form of a crust, consists of zooids arranged in regular rows in a checkered pattern. The zooids, oblong-rectangular in shape, broaden in the middle and slightly taper at the ends. The pyriform-oval aperture is broader in the proximal part, and occupies a larger portion of the frontal surface of the zooid; the remaining part of the frontal surface is occupied by the gymnocyst. The cryptocyst stretches along the raised margin of the aperture; it is sometimes narrower (from the sides), sometimes broader (in the proximal part), and has a minutely denticulate margin which surrounds the pyriform-oval opesium. Sometimes in sterile zooids, there is one frontal avicularium at the gymnocyst under the proximal margin of the aperture, which has a mandible whose sharp end is pointed downward; sometimes there are two avicularia with the sharp ends of their mandibles directed downward and inward. There is usually one avicularium on each side of the distal part of the oecium in the zooids carrying ovicells, which has a mandible with its pointed end directed upward and outward The ovicells are round with a rebral margin on the outer edge of the ectooecium, which bends at a sharp angle in the middle of the surface and sometimes curves away toward the distal margin of the oecium. There are 4 small spines at the distal end in young zooids; only 1 spine is preserved on either side in adult zooids, and sometimes even that disappears.

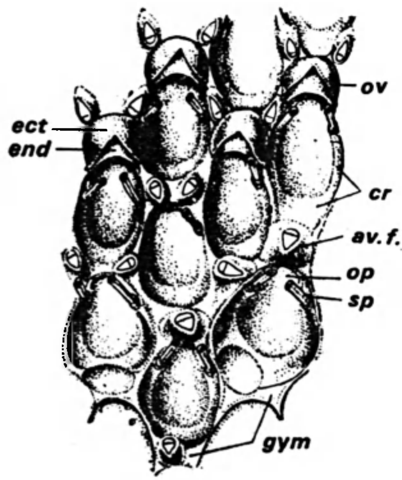


Figure 173. *Callopora aurita* (Hincks). Part of a zoarium with sterile and fertile zooids.

The species lives on algae, shells, and stones, at depths from 4 to 142 m, often at smaller depths, on sand and stone.

Distribution. The species was found by me in the Barents Sea above Kolguyev Island, and in the Gulf of St. Lawrence. *Reports in literature:* White Sea (Kluge, 1908a; Gostilovskaya, 1957), Baltic Sea (Levinsen, 1894; Kluge in Knipovich, 1909), coastal waters of Kattegat and Oresund (Levinsen, 1894), North Sea (Möbius, 1873; Borg, 1930a), British Isles (Hincks, 1880a; Nichols, 1911), the Azores (Jullien and Calvet, 1903), Mediterranean Sea (Calvet, 1902), Hudson Bay (Osburn, 1932), region of the Island of Man (Osburn, 1933), and the region of Woods Hole (Osburn, 1912).

This is an Arctic-boreal, amphi-Atlantic species.

4. **Callopora smitti** Kluge, 1946 (Figure 174)

Membranipora lineata forma *discreta* Smitt, 1868a : 365, t. XX, f. 28; *Callopora smitti* Kluge, 1946 : 196, t. IV, f. 1.

The zoarium, prostrate in the form of a crust, consists of zooids arranged sometimes in straight, sometimes in slanted rows. The zooids are medium in size, oblong, and distinctly restricted by depressed margins.

The oval aperture is sometimes stretched and narrow, sometimes short and broad; it has a raised margin along which the cryptocyst stretches like a narrow border. There are 9 to 14 straight spines slightly tilted toward the aperture. The ovicells are small and have a granular surface. In addition to the large, vicariating avicularium with its long, sharp mandible almost the size of the zooid, there are small, frontal avicularia on the gymnocyst sometimes, under the middle part of the proximal margin of the aperture, which have mandibles whose sharp tips are pointed downward. These avicularia are more often found in the zooids carrying ovicells; then they are located at the distal margin of the oecium and the sharp tips of their mandibles are either pointed upward, or downward toward the side.

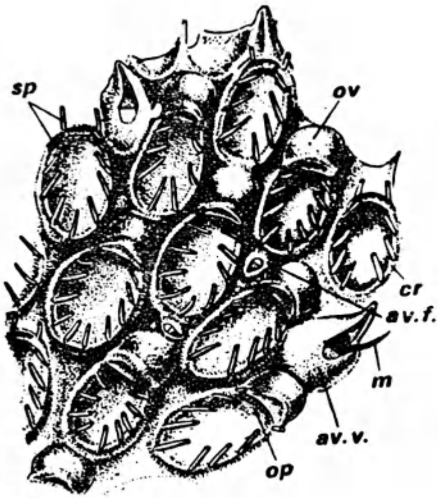


Figure 174. *Callopora smitti* Kluge. Part of a zoarium with vicariating and adventitious frontal avicularia.

The species lives on hydroids, shells, and stones, at depths of 23.5 to 130 m, on a bed of stone, sand, and silt.

Distribution. The species was found by me in the Barents, Kara, Laptev, and East Siberian seas, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868a; Kluge, 1929), Laptev Sea (Kluge, 1929), coastal waters of North America (Osburn, 1923), Hudson Bay (Osburn, 1932), and western Greenland (Osburn, 1919).

This is an Arctic species.

5. **Callopora whiteavesi** Norman, 1903 (Figure 175)

Membranipora lineata forma *lineata* Smitt, 1868a : 364 (part.), t. 20, f. 26; *Callopora whiteavesi* Norman, 1903a : 589, pl. XIII, f. 9; *Membranipora* (*Callopora*) *whiteavesi* Levinsen, 1916 : 443, pl. XIX, f. 11-14.

The zoarium, prostrate like a crust, consists of zooids arranged in irregular rows. The zooids have an oblong-oval shape, and are clearly separated from each other by depressed margins.

The pyriform-oval aperture occupies a larger part of the frontal surface; the gymnocyst is weakly developed and tapers toward the proximal end.

The cryptocyst has a granular surface and is located along the margin of the aperture. There are 12 to 16, or even 20, spines along the entire margin of the aperture. These spines are usually comparatively long, straight, or slightly bent forward and inward, but sometimes they are short and slightly bent toward the aperture. In addition to those which surround the cryptocyst, often there are 5 to 10 thinner spines in the distal part of the zooid, which are located on the wall from the outer side at a variable height. The hyperstomial ovicells are round and have a rebral margin on the surface that bends at an angle in the middle.

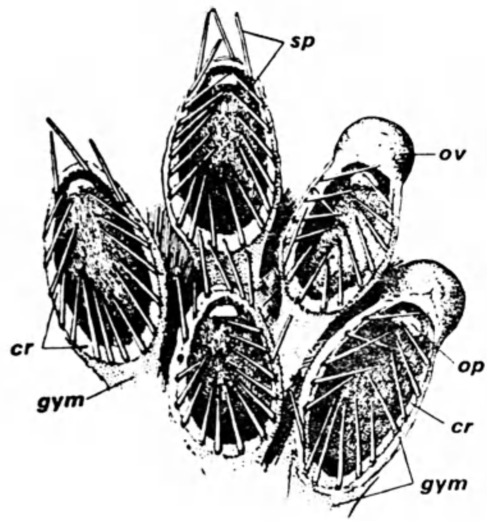


Figure 175. *Callopora whiteavesi* Norman. Part of a zoarium.

The species lives on shells, stones, and other hard objects, at a depth of 10 to 520 m, more often from 100 to 300 m, on a bed of stone, shells, and silt, under temperatures ranging from —1.7 to 3.7°C, in a salt concentration of 29.00 to 34.96‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, and Chukotsk seas, and in the waters along western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868a; Nordgaard, 1918), White Sea (Gostilovskaya, 1957), Kara Sea (Kluge, 1929), Laptev Sea (Kluge, 1929), Hudson Bay (Osburn, 1932), western Greenland (Norman, 1903a, 1906; Levinsen, 1914), Gulf of St. Lawrence (Whiteaves, 1901; Norman, 1903a), and eastern Greenland (Levinsen, 1916).

This is an Arctic, circumpolar species.

6. **Callopora lata** (Kluge, 1907) (Figure 176)

Membranipora lata Kluge, 1907 : 193, f. 1; *M. unicornis* Smitt, 1879a : 17 (part.); *M. lineata* Lorenz, 1886 : 2 (part.); *Callopora ungavensis* Osburn, 1932 : 8, f. 1A, B.

The zoaria consist of large zooids arranged in slanted rows. The zooids have an oblong-rectangular shape, broaden in the middle, and slightly taper in the proximal part. The gymnocysts are poorly developed. The aperture has a raised, denticulate margin, and occupies a larger part of the frontal surface. The cryptocyst, in the form of a narrow border along the margin of the aperture, is slightly broader in the proximal part, and has a smooth inner margin. The opesium has an oval shape. There are 2 to 5 erect, standing, calcareous spines located along the margin of the aperture, mostly in the distal half, but sometimes also in the proximal. The ovicells are round and convex; the outer layer of the ectooecium is calcified almost up to half of the frontal surface, and forms an angular to semi-angular border ahead of the smooth, proximal margin of the ovicell. There are 3 to 4 pore chambers along, and 1 perpendicular to, the lateral margin of the basal side of the zooid. There are a large number of simple pores in each chamber.

The species lives on shells and stones, at a depth of 17 to 108 m, more often from 30 to 40 m, on a bed of stone and silt, under temperatures ranging from -1.24 to 3°C, in a salt concentration of 34.83‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, and East Siberian seas, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868a), White Sea (Kluge, 1907, 1908a; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a), Yan-Maien Island (Lorenz, 1886), and Ungava Bay (Osburn, 1932).

This is an Arctic species.

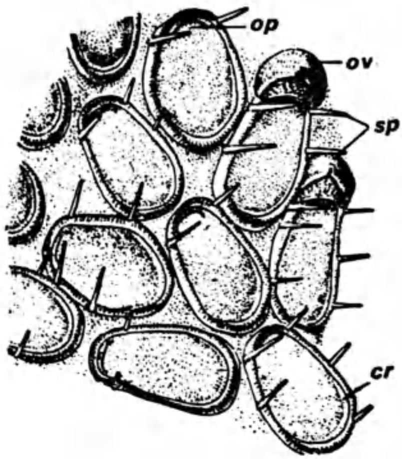


Figure 176. *Callopora lata* (Kluge). Part of a zoarium.

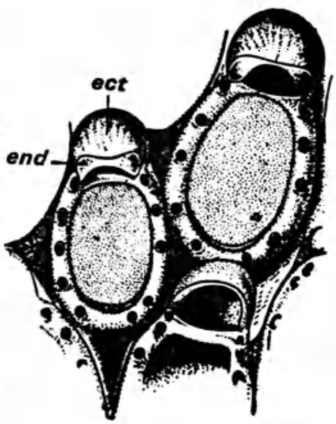


Figure 177. *Callopora obesa* Kluge. Zooids with fallen spines (from Kluge, 1952).

7. **Callopora obesa** Kluge, 1952 (Figure 177)

Callopora obesa Kluge, 1952 : 151, fig. 8; 1955a : 81, fig. 25.

The zoarium, prostrate in the form of a crust, consists of large zooids arranged in irregular rows. The zooids are somewhat oblong, or roundish-hexagonal, and have a slightly convex aperture which occupies about two-thirds of the frontal surface. The zooids are separated from each other by prominent depressions. The margin of the aperture is raised in the form of a low and wide collar, in the middle of which thick spines are located. The number and arrangement of the latter varies: spines are sometimes located in the distal half (usually 3 pairs), followed by a gap, and 2 to 4 spines in the proximal part; sometimes they total 9 to 13, and are uniformly distributed all along the margin. Since the spines drop off easily, large gaping orifices are seen in the places of their attachment. The cryptocyst has a smooth, narrow margin, and is located under the membrane covering the aperture; it surrounds the large, oval orifice of the opesium. Avicularia are absent. The ovicells, hyperstomial and semi-circular, have a smooth surface; the outer layer of the ectooecium does not fully cover the inner layer of the endooecium in the proximal part, and their margins either run parallel to each other, or closer in the middle, or closer from one side. There are 7 to 8 pore chambers with a few pores each along the lateral margin of the basal side, and 1 to 2 pore chambers with 3 to 4 pores each in the distal septum.

The species lives on shells of Pelecypod mollusks, at a depth of 50 m, under a temperature of 0.63°C, in a salt concentration of 32.38‰.

Distribution. The species was found by me in the Bering Strait between the Diomede Islands and Cape Prince of Wales.

8. **Callopora derjugini** (Kluge, 1915) (Figure 178)

Membranipora derjugini (nomen nudum) Deryugin (apud Kluge) 1915 : 380; *Callopora derjugini* Kluge, 1955a : 79, fig. 23.

The zoaria, small and prostrate, consist of regular rows of zooids arranged in a checkered pattern. The zooids are oval in shape, and have a large oval aperture which occupies not less than two-thirds of the frontal surface. This aperture is surrounded by a gymnocyst raised from the sides and in the proximal half, as a result of which the zooids are separated from each other by a prominent depression. The cryp-

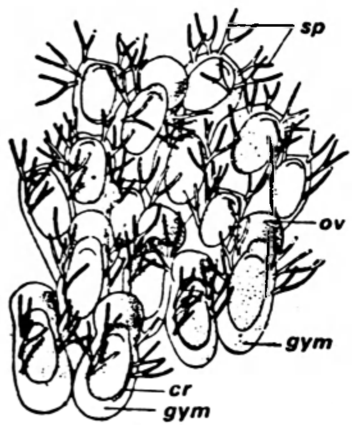


Figure 178. *Callopora derjugini* (Kluge). Part of a zoarium (from Kluge, 1955a).

tocyst is very poorly developed. Three pairs of upward directed, branched spines are usually located along the margin of the aperture in the distal half. Avicularia are absent. The ovicells are large, spherical, smooth surfaced, and covered with a membranous lid.

The species lives on ascidia and the radicular tubes of *Pseudoflustra anderssoni,* at depths of 65 to 460 m, under a temperature above 0°C.

Distribution. The species was found by me in the Barents Sea in Kola Bay, and in the southwestern trough between Bear Island and Nordkapp.

Thus far, this species is endemic to the Barents Sea.

5. Genus **Cauloramphus** Norman, 1903

Membranipora Alder, 1857b : 143 (part.); Hincks, 1880a : 127 (part.); *et auctt.; Cauloramphus* Norman, 1903a : 587; *Callopora* Nordgaard, 1918 : 40 (part.).

The zoaria are prostrate and overgrowing. The zooids have pore chambers along the margins of the basal side (in *C. cymbaeformis* they are not always clearly expressed). The aperture occupies a larger portion of the frontal surface. The cryptocyst is in the form of a narrow border and surrounds the large opesium. The number of spines on the margin of the aperture varies (from 7 to 16). A jointed, pedunculated avicularium is usually located in the distal half, from either or both sides, and slightly below the margin of the aperture. Ovicells may be present.

As of this writing, only 2 species have been reported in our northern seas: the more widely distributed Arctic species, *C. cymbaeformis,* and the rarely occurring, boreal *C. spiniferum.* A more detailed study of the Bryozoa of the Barents and White Seas revealed that the form which had been reported by some authors as *C. spiniferum,* is a new and comparatively widespread form in our northern seas, *C. intermedius,* but the boreal *C. spiniferum* was certainly recovered in the southern part of the Barents Sea and definitely in the White Sea. It must be pointed out that with regard to the latter species, in these regions the majority of zooids are quite often either absent or so small throughout the entire zoarium, as to be easily overlooked—which is what happened in my description of the new species *Callopora heterospinosa* (Kluge, 1908a: 522). This phenomenon has been observed quite frequently in the aforementioned regions, while in the zoaria of this species in the boreal region, these avicularia are quite common; it can be assumed that in these regions the formation of a new species takes place through the loss of avicularia.

Genus type: *Flustra spinifera* (Johnston).

1 (4). Zooids attached to the substrate by their basal surfaces; their lateral walls are not high; spines are arranged around the

aperture. Pore chambers are clearly distinguishable along the margin of the basal side.

2 (3). Spines numerous (12 to 16), and strongly tilted toward the aperture in the proximal half. Avicularia short with a thick chamber that bends slightly toward the aperture; they may be absent in some zoaria.......................1. *C. spiniferum* (Johnston).

3 (2). Spines not many (7 to 11); they are tilted toward the aperture in the proximal part. Avicularia on thin stems and not taller than the spines.......................2. *C. intermedius* Kluge.

4 (1). Zooids attached to the substrate only by the middle part of their basal surfaces; their lateral walls are high. Spines not many (7 to 9) and most are long; they are usually located in the distal half. Avicularia straight and more or less long. Pore chambers not clearly distinguishable..........3. *C. cymbaeformis* (Hincks).

1. **Cauloramphus spiniferum** (Johnston, 1832) (Figure 179)

Membranipora spinifera Hincks, 1880a : 149, pl. XIX, f. 1a-c; *M.* (*Cauloramphus*) *spinifera* Marcus, 1940 : 130, f. 69; non *M. spinifera* Smitt, 1868a : 366; *Membranipora heterospinosa* Kluge, 1908a : 522, f. 1.

The zoarium, in the form of an overgrowing crust, consists of zooids which, for the most part, are arranged in regular rows. The zooids are small (length 0.50 to 0.60 mm, width 0.35 mm), oblong-oval in shape, grow attached to the substrate by their basal surfaces, and have low lateral walls. The aperture occupies almost the entire frontal surface; 12 to 16 spines are located along its raised margin. The distal 2 to 3 pairs of spines are strongly directed upward and slightly forward; the others are thinner, have sharp ends, and tilt rather strongly toward the middle of the aperture. The cryptocyst, developed in the form of a narrow rim along the margin of the aperture, surrounds the large, oval opesium. Short, pedunculate avicularia are attached slightly below the margin of the aperture, from either or both sides, and usually between the 2nd and 3rd pairs of distal spines. These avicularia are distinguished by a short, thin stem, and a comparatively large, thick

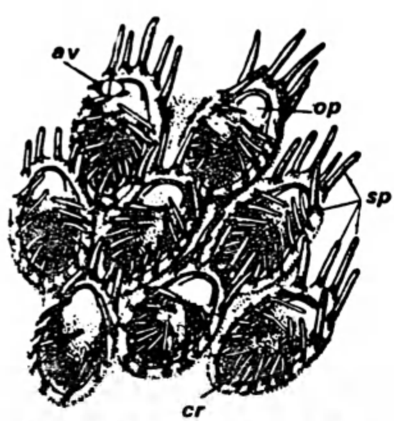


Figure 179. *Cauloramphus spiniferum* (Johnston). Part of a zoarium with one avicularium. Barents Sea.

chamber which bends slightly toward the aperture. The mandible is pointed and its tip is directed outward. Ovicells are more or less flat and smooth, and have a transverse, rebral margin on the surface.

The basal side has 5 to 6 pore chambers along its lateral margin, and 2 to 3 along its distal margin. It should be pointed out that zoaria are often found in the Barents and White seas, in which avicularia are not seen; it could be that they are so small in size as to be unnoticeable, or that they are totally absent, in which case, these zoaria should be included in the genus *Callopora*. This is the reason why I gave a place to this species in the identification key for the genus *Callopora,* indicating all its other characteristics with the exception of the presence of avicularia (see p. 341).

The species lives on stones, shells, and laminaria, at depths ranging from the littoral to 50 m, on a bed of shell, silt, and stone.

Distribution. The species was found by me in the Barents Sea (in Kola Bay, Dal'ne-Zelenetsk Inlet, and the Yugorsk Shar), and in Providence Bay (near Cape Chukotsk). *Reports in literature:* Barents Sea, Matochkin Shar (Gostilovskaya, *mss.*), White Sea, Anzersky Strait, and Zayatsky Islands (Kluge, 1908a), region of the Solovetsky Islands, along the southern coast of Kandalakshsky Bay, and the Karelian coast (Gostilovskaya, 1957).

In the boreal region, this species has been found in the coastal waters of Shetland (Norman, 1869), the British Isles (Hincks, 1880a), and in the waters off California (Robertson, 1908).

This is an amphi-boreal species.

2. **Cauloramphus intermedius** Kluge sp. n. (Figure 180)

Membranipora spinifera Waters, 1900 : 61; Andersson, 1902 : 539; Kluge, 1908a : 522 (part.).

The zoaria, small and prostrate in the form of a crust, consist of zooids arranged in more or less regular, slanted rows. The zooids are small (length 0.50 mm, width 0.30 mm), oblong-oval in shape, grow attached to the substrate by their entire basal surfaces, and have low, lateral walls. The aperture is oval and has a raised margin around which spines are arranged in small numbers (from 7 to 11). The spines are sometimes thick, sometimes thin, and the distal 3 to 4 spines are usually directed upward; the others are slightly tilted toward the aperture. The cryptocyst, developed in the form of a narrow rim along the margin of the aperture, surrounds the opesium. A slightly bent, often jointed, pedunculate avicularium is located between the 2nd and 3rd pairs of distal spines, slightly below the margin of the aperture, on each side. These avicularia

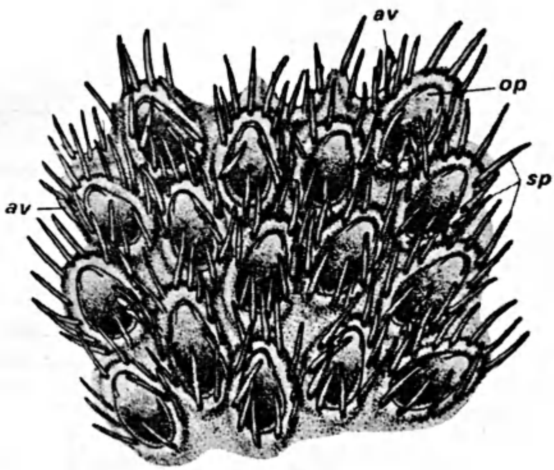


Figure 180. *Cauloramphus intermedius* Kluge, sp. n.
Zoarium with avicularia. Barents Sea.

usually have thin stems and do not exceed the spines in length. The tips of their sharp mandibles are pointed upward. In 2 pieces of 1 or 2 zoaria in the collections of the expedition of Vega 1878 from the Yugorsk Shar, there were a few zooids in which the pedunculate avicularia formed daughter avicularia on the lateral margin of the frontal surface, in addition to the distal half, i.e., a wide avicularian chamber had formed with a fully developed, chitinous, and sharp mandible whose terminal end was also pointed upward. Ovicells were not found. The pore chambers were clearly distinguishable along the margin of the basal surface, and were similar to those in *C. spiniferum*.

Due to short lateral walls, well-developed pore chambers, and the spines arranged around the aperture being slightly tilted toward it, this form is close to *C. spiniferum*, but on the basis of its smaller number of spines, and almost straight, pedunculate avicularia, it is closer to *C. cymbaeformis*. Thus it occupies a somewhat transitional position between the two aforementioned species.

This species lives on laminaria, hydroids, shells, and stones, at depths varying from 7 to 78 m, often from 7 to 32 m, under temperatures ranging from 0.6 to 1.95°C, in a salt concentration of 31.87‰.

Distribution. The species was found by me in the Barents Sea, in the waters of Spitsbergen, the southeastern part of the Sea, and in the Yugorsk Shar Strait; in the White Sea in the region of the Solovetsky Islands; in the Kara Sea in Neznaemy Bay and near Cape Chelyuskin; and in the Chukotsk Sea near the cape of Intsov, and along the northwestern coast of Alaska. *Reports in literature:* Barents Sea (Waters, 1900;

Andersson, 1902).
This is an Arctic species.

3. **Cauloramphus cymbaeformis** (Hincks, 1877) (Figure 181)

Membranipora spinifera Smitt, 1868a : 366, t. XX, f. 32; *M. cymbaeformis* Hincks, 1877a : 99, 110; 1888 : 217, pl. XV, f. 4; *et auctt.*

The zoarium is prostrate, and consists of zooids arranged in slanted rows in a checkered pattern. The zooids are medium in size (length 0.63 to 0.75 mm, width 0.33 mm), oval in shape, and broaden sometimes in the middle, sometimes in the proximal part. The zooids are attached to the

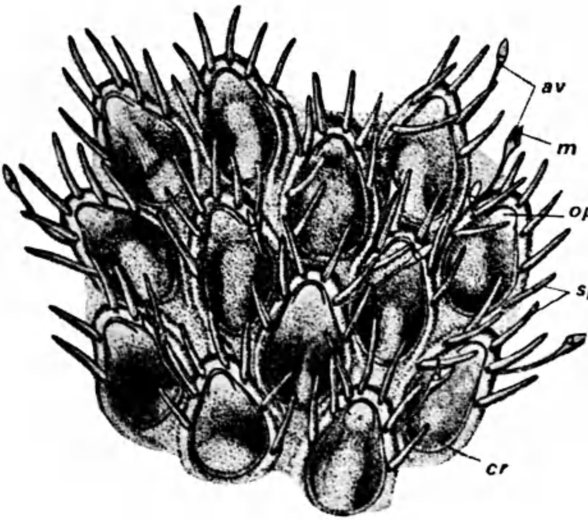


Figure 181. *Cauloramphus cymbaeformis* (Hincks). Part of a zoarium (from the expedition of Vega).

substrate only by the middle part of their basal surfaces; the marginal parts are inconspicuously transformed into the lateral walls, due to which the latter become taller, resulting in one of the characteristic features of the given species. Starting from the middle of the zooid, this wall gradually rises toward the distal margin, as a result of which the latter is raised above the level of the proximal half of the overlying daughter zooid. The oval aperture, sometimes broadened in the proximal part, occupies a considerable portion of the frontal surface. The gymnocyst is poorly developed. The cryptocyst stretches along the raised margin of the aperture in the form of a narrow rim; it is slightly broadened in the proximal part and surrounds a large opesium. A few, often 7 to 8, long spines which point upward, are located along the margin of the distal half of the aperture. One to 2 spines are sometimes located in the proximal half also. An articulated, thin, pedunculate avicularium of the same length as the spine, is usually attached between the 2nd and 3rd spine on one side of the lateral wall, or one on each side; its sharply pointed mandible is directed upward. Ovicells have not been found. Like *C. spiniferum,* this species also has pore chambers, but in adult zooids they are difficult to notice because of the change in the growth of the marginal parts on the basal side, a fact pointed out by me, but in young zooids, particularly those which grow on a flatter substrate, these chambers are observable.

The species is most commonly found on hydroids and branched Bryozoa (and not on shells and stones), at a depth varying from the littoral to 228 m, more often from 50 to 150 m, on a bed of stone, shells, and silt, under temperatures ranging from —1.9 to 4.78°C, in a salt concentration of 31.80 to 34.83‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868a, 1879b; Vigelius, 1881-82; Nordgaard, 1896, 1918; Bidenkap, 1897, 1900a; Waters, 1900; Norman, 1903a; Kluge, 1906), White Sea (Smitt, 1879b; Bidenkap, 1900a; Gostilovskaya, 1957), Kara Sea (Levinsen, 1887; Kluge, 1929), Laptev Sea (Kluge, 1929; Abrikossov, 1932), Chukotsk Sea (Kluge, 1929), northern coastal waters of North America and the Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1923, 1932), Labrador (Hincks, 1877a; Osburn, 1913), western coast of Greenland (Smitt, 1868c; Hincks, 1877a; Hennig, 1896; Vanhöffen, 1897; Kluge, 1908b; Levinsen, 1914; Osburn, 1919, 1936), Gulf of St. Lawrence (Hincks, 1888; Whiteaves, 1901; Norman, 1903a), eastern Greenland (Levinsen, 1916), Yan-Maien Island (Lorenz, 1886), northern Norway (Nordgaard, 1918), and along the eastern coast of North America from Woods Hole to the Island of Man (Osburn, 1912, 1933).

This is an Arctic, circumpolar species.

6. Genus **Ramphonotus** Norman, 1894

Membranipora Busk, 1860 : 125; *Ramphonotus* Norman, 1894 : 123.

The zoarium is prostrate. The zooids have pore chambers along the margins of the basal side. The aperture, with its raised margin, occupies a larger portion of the frontal surface. The cryptocyst is developed to a small or large degree. The height of the opesium, along the central, medial line, is either greater or less than the height of the cryptocyst. Spines are present around the orifice of the zooid. Usually one (rarely two) frontal avicularium is strongly developed under the proximal margin and resembles a bird's beak. Ovicells are present.

Genus type: *Ramphonotus minax* (Busk).

1 (2) Zoods medium in size. Opesium height along the medial line is, on the average, 1½ times greater than that of the cryptocyst...... ....1. *R. minax* (Busk).

2 (1) Zooids large. Opesium height along the medial line is, on the average, 1½ to 2 times less than the height of the cryptocyst...... ....2. *R. gorbunovi* Kluge.

1. **Ramphonotus minax** (Busk, 1860) (Figure 182)

Membranipora Flemingii forma *minax* Smitt, 1868a : 367, pl. XX, f. 43, 44; *M. minax* Hincks, 1880a : 169, pl. 22, f. 2; *Ramphonotus minax* Norman, 1903a : 597, pl. XIII, f. 7.

The zoarium, prostrate in the form of a crust, consists of zooids arranged in slanted rows in a checkered pattern. The oval zooids are medium in size, sometimes short, sometimes long, and broadened in the middle. The aperture has a strongly raised, sharp margin, and occupies a larger portion of the frontal surface of the zooid. The gymnocyst is more weakly developed in the shorter zooids, and more strongly developed in the longer ones, sometimes reaching up to one-third the length of the zooid. The aperture is oval, and strongly broadened in the proximal half. Two more or less long, thin spines are located on each side of the aperture, along its margin in the distal part. The cryptocyst, stretched along the margin of the aperture in the form of a broad, sharply depressed border with an uneven surface, gradually widens from the sides toward the proximal margin, and surrounds the roundish-rectangular opesium, which becomes gradually wider toward the proximal margin. The average height of the opesium at the medial line, is 1½ times greater than the height of the cryptocyst. A large, frontal avicularium is located on the gymnocyst near the aperture. The avicularium, situated on a broad, cylindrical base, has a raised rostrum, and a large, sharp mandible

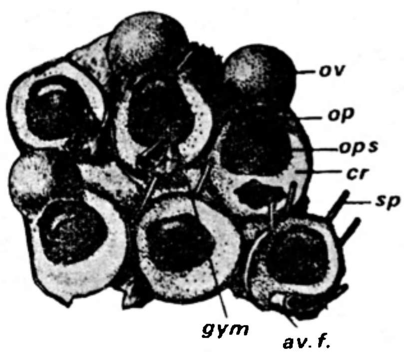


Figure 182. *Ramphonotus minax* (Busk). Part of a zoarium. Barents Sea.

which resembles a bird's beak, whose terminal part points upward and toward one side. The ovicells are small and round, and have a continuous, finely granulated surface; their proximal margin is in the form of a peak.

This species lives on shells, stones, and certain calcified Bryozoa, at a depth of 25 to 300 m, on a bed of stone, shells, and silt, under a temperature of 3.5°C, in a salt concentration of 35.01 ‰.

Distribution. The species was found by me in the Barents Sea, in the waters of western Murmansk and western Spitsbergen, and in the Gulf of St. Lawrence. *Reports in literature:* Barents Sea, in the waters of northern Finmark (Smitt, 1868a; Nordgaard, 1896), western Norway (Norman, 1894, 1903a), Shetland Islands (Norman, 1903a), Iceland (Levinsen, 1914; Nordgaard, 1924), and the Gulf of St. Lawrence (Whiteaves, 1901; Norman, 1903a).

This is an Arctic-boreal, Atlantic species.

2. **Ramphonotus gorbunovi** Kluge, 1946 (Figure 183)

Ramphonotus gorbunovi Kluge, 1946 : 197, fig. 2.

The zoarium is prostrate, and consists of zooids arranged in more or less regular slanted rows. The zooids are large, and oval either in their middle, or in their proximal one-third part. The aperture, occupying a larger portion of the frontal surface, is surrounded by a thin, rebral margin that abruptly drops down from the outer side, due to which the zooids are sharply separated from each other by depressions. The gymnocyst is poorly developed. The distal half of the cryptocyst drops down toward the opesium more or less sharply, while the proximal half slopes gently. The form of the opesium, like that of the one in *R. minax*, is roundish-rectangular, but it contrasts with the latter species in that its height at the medial line is 1½ to 2

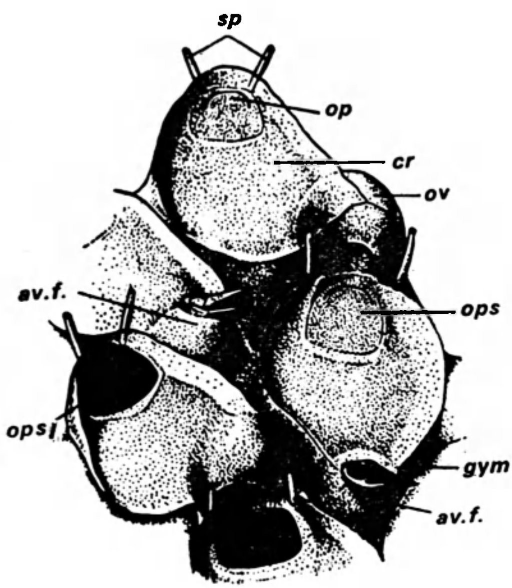


Figure 183. *Ramphonotus gorbunovi* Kluge. Part of a zoarium (from Kluge, 1946).

times less than the height of the cryptocyst. The surfaces of the cryptocyst and gymnocyst are granular. The proximal margin of the opesium bends strongly toward the inner side of the zooidal cavity, the bend continuing in the sides up to a fusion with the lateral walls of the cystid. This bent margin is visible through the wall of the cryptocyst, and can be seen from outside in the form of a strongly reflected light from a narrow cavity bordering the proximal margin of the opesium. There is usually 1 (but often 2) thin, short spine in the corner of the distal rebral margin of the aperture. One frontal avicularium (sometimes 2) is located near the proximal margin of the aperture, in the place of its transformation into the gymnocyst. The avicularium is situated on a small, broad, and conically raised portion; its rostrum is raised at the end, and the long, terminally pointed mandible is obliquely directed toward one side. The ovicells are spherical and only slightly raised; their outer surface is covered with the cryptocyst of the upper neighboring zooids. The orifice of the ovicell is covered with a peculiar semi-circular lid. There are 4 pore chambers in the lateral wall of the cystid, and 1 in the distal wall; all the chambers have many pores in their internal wall.

The species is found on shells and stones at depths of 80 to 160 m.

Distribution. The species was found by me in the East Siberian Sea, near the margin of the Novo Sibirisk shoals.

The species is Arctic.

7. Genus **Amphiblestrum** Gray, 1848

Amphiblestrum Gray, 1848 : 110; *Membranipora* Busk, 1854a : 58, *et auctt.*

The zoarium is prostrate. The zooids have pore chambers along the margin of their basal sides. The aperture occupies a larger part of the frontal surface. The cryptocyst varies in development. The height of the opesium at the central medial line is either greater or smaller than the height of the cryptocyst. Spines are either absent or present around the zooidal orifice. One or 2 small frontal avicularia are present with a sharp, triangular mandible under the proximal, or lateral (in *A. trifolium*), margin of the aperture. Ovicells are present.

Genus type: *Membranipora flemingii* Busk.

1 (4). Zooids medium in size. Two to 6 spines located along the margin of the aperture in the distal part. Height of the cryptocyst at the medial line is, on the average, twice less than the height of the opesium.

2 (3). Only 2 spines remain in most of the zooids of an adult zoarium, one of which on either side is strongly developed and looks like

a sabre. Ovicells large; the rebral margin of the outer layer at the surface, usually surrounds the roundish-rectangular surface of the inner layer..................1. *A. flemingii* (Busk).

3 (2). Two pairs of small spines located in the distal part in most zooids of an adult colony. Ovicells round, oblong; they have a continuous, granulated surface and bend sharply at the medial line.... ....2. *A. septentrionalis* (Kluge).

4 (1). Zooids large. Spines either absent at the margin of the aperture in the distal part, or present as 2 small, barely noticeable spinules. Cryptocyst strongly developed; its height at the medial line is, on the average, 1½ times greater than the height of the opesium.

5 (6). Spines not present at the distal corners. Avicularia, found rarely, are located near the margin, on one side of the frontal surface in its broadest part....................3. *A. trifolium* (S. Wood).

6 (5). One small, barely noticeable, spinule located in each distal corner. Avicularium present in the middle of the proximal, tapering part of the gymnocyst........3a. *A. trifolium* var. *quadrata* (Hincks).

1. **Amphiblestrum flemingii** (Busk, 1854) (Figure 184)

Membranipora Flemingii Busk, 1854a : 58, pl. LXI, f. 2; LXXXIV, f. 4-6; Hincks, 1880a : 162, pl. 21, f. 1-3; Levinsen, 1894 : 58, pl. IV, f. 28-30; Marcus, 1940 : 139, f. 74.

The zoarium, prostrate in the form of a crust, has a regular shape. The zooids are oval-pyriform. The aperture occupies a large part of the frontal surface. The cryptocyst is narrow on the sides and broader in the proximal part. The opesium often assumes a more or less clearly trilobate shape. Two to 6 spines are present along the margin of the distal half of the aperture, of which only 2 remain in most zooids in an adult colony; one of these is sometimes quite strongly branched in the form of a long, narrow, sabre. Two avicularia are often situated on the gymnocyst near the aperture, which have mandibles whose sharp tips bend downward and inward; when ovicells are present however, these avicularia are located on both sides of the distal margin, and the ovicells and mandibles are directed with their pointed tips upward and outward; sometimes instead

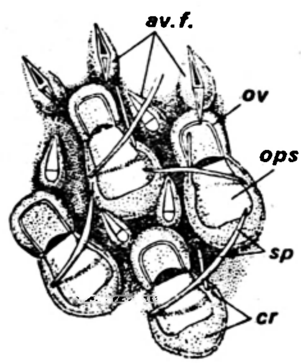


Figure 184. *Amphiblestrum flemingii* (Busk). A small part of a zoarium (from Hincks, 1880a).

of 2 avicularia, only one frontal avicularium is situated on the gymnocyst in a transverse direction. The ovicells are large, and the rebral margin on the frontal surface usually surrounds the roundish-rectangular, finely granulated surface of the inner layer of the endooecium.

The species lives mostly on shells and stones, at a depth varying from the littoral up to 400 m, or often in shallow waters.

Distribution. Reports in literature: Barents Sea near Cape Nordkapp (Nordgaard, 1896), western coastal waters of Norway (Nordgaard, 1918) and Sweden (Smitt, 1868a), Denmark (Levinsen, 1894; Marcus, 1940), North Sea (Borg, 1930a), British Isles (Hincks, 1880a), northern France (Joliet, 1877), Mediterranean Sea (Calvet, 1902), and the eastern coast of North America from Cape Cod to northern Scotland (Osburn, 1933).

This is a boreal, Atlantic species.

2. **Amphiblestrum septentrionalis** (Kluge, 1906) (Figure 185)

Membranipora flemingii var. *septentrionalis* Kluge, 1906 : 38, f. 1; *M. flemingii* forma *trifolium* Smitt, 1868a : 367 (part.), t. XX, f. 40.

The zoarium, prostrate in the form of a crust, consists of zooids arranged in slanted rows. The oval zooids, medium in size, broader in the middle and slightly tapering toward the ends, relatively closely adjoin each other in a checkered pattern. The aperture is oval, but broader in the middle, and occupies a larger part of the frontal surface of the zoid; it has a raised margin, as a result of which the adjoining zooids are clearly separated from each other. Only frontal avicularia are located on the short gymnocyst; the latter is sometimes oblong and tapering toward the proximal end. The cryptocyst, located along the margin of the aperture, tapers toward the middle and gradually broadens from the lateral margins to the proximal side. Its surface is granulated and its height at the medial line is, on the average, half that of the opesium's. The oval-pyriform opesium, broadens in the proximal half, corresponding to the place of the maximum broadening of the aperture. Two pairs of small spinules are located along the margin of the aperture in the distal part. Under the proximal

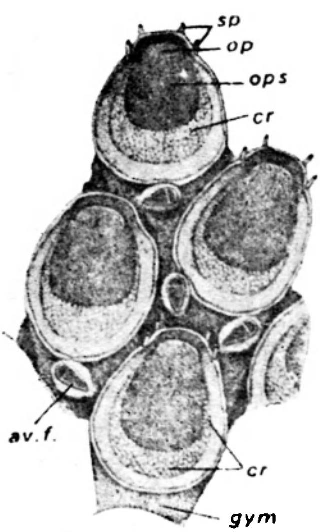


Figure 185. *Amphiblestrum septentrionalis* (Kluge). Part of a zoarium. Barents Sea.

margin of the aperture, either 1 avicularium is situated in the middle with the sharp end of its mandible directed downward or toward the side, or 2 avicularia are located on the sides with the sharp ends of their mandibles usually directed downward and inward. The ovicells are round and slightly oblong; they have a continuous, granulated surface that is markedly raised with a bend at the medial line; they taper slightly before the proximal margin, but near it broaden somewhat.

The species lives on Bryozoa, shells, and stones, at depths from 10 to 175 m, on a bed of stone, sand, and silt, under temperatures ranging from −1.02 to 3.6°C.

Distribution. The species was found by me in the East Siberian and Barents seas, and in the waters off eastern and western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868a; Kuznetsov, 1941), White Sea (Gostilovskaya, 1957), waters of the Archipelago of the Canadian Islands (Nordgaard, 1906a), western Greenland (Smitt, 1868c; Kluge, 1908b; Levinsen, 1914), Gulf of St. Lawrence (Whiteaves, 1901), eastern Greenland (Kirchenpauer, 1874; Andersson, 1902), and Yan-Maien Island (Lorenz, 1886).

This is an Arctic species.

3. **Amphiblestrum trifolium** (S. Wood, 1844) (Figure 186)

Membranipora trifolium Hincks, 1880a : 167, pl. 22, f. 5; *Amphiblestrum trifolium* Osburn, 1933 : 26, pl. 14, f. 2.

The zoarium consists of zooids arranged in slanted rows. The zooids are large, hexagonal, sometimes narrower, sometimes broader, and closely adjoin each other; they have a raised, minutely denticulate margin. The cryptocyst has a granulated surface and is strongly developed; on the average, its height is 1½ times greater than that of the opesium at the medial line. For the most part, the opesium is roundish-trapeziform in shape; sometimes the lateral margins of the cryptocyst close to the middle part and raised with either smooth or sharp angles, as a result of which the opesium is separated into a narrow upper part, and a broad lower part, giving it the look of a clover. Spines are not present at the distal corners. Small avicularia are rarely

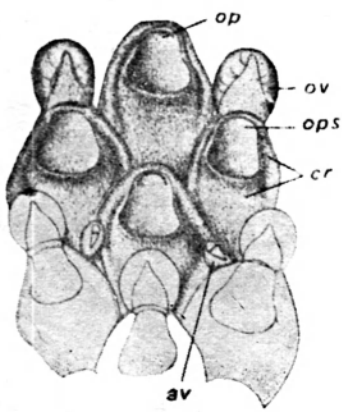


Figure 186. *Amphiblestrum trifolium* (S. Wood). Part of a zoarium (from Hincks, 1880a).

found, located near the margin on one side of the frontal surface in its broadest part. The smooth ovicells have a miter-like shape; the rebral margin on the surface broadens the triangular, slightly granulated surface of the inner layer of the endooecium.

The species lives mostly on shells and stones, rarely on algae, at a depth ranging from 13 to 300 m, on a bed of stone, gravel, and silt.

Distribution. The species was found by me in the Barents Sea. *Reports in literature:* Barents Sea (Nordgaard, 1918), the coastal waters of the Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1923, 1932), Labrador (Packard, 1863, 1866-69; Osburn, 1913), western Greenland (Norman, 1876, 1903a, 1906; Levinsen, 1914), Gulf of St. Lawrence (Whiteaves, 1901; Norman, 1903a), eastern Greenland (Levinsen, 1916), western Norway (Nordgaard, 1896, 1905; Norman, 1903a), Skagerrack and Kattegat (Marcus, 1940).

This is an Arctic-boreal, Atlantic species.

3a. **Amphiblestrum trifolium** var. **quadrata** (Hincks, 1880) (Figure 187)

Membranipora trifolium var. *quadrata* Hincks, 1880a : 167, pl. 22, f. 6, *M. flemingii* forma *trifolium* Smitt, 1868a : 367 (part.), t. XX, f. 42; *M.* (*Amphiblestrum*) *trifolium* Marcus, 1940 : 141, f. 75.

This form is very similar to *A. trifolium* in the structure of the frontal surface, but differs from the latter in the following ways: first, a slightly raised, granulated margin around the aperture; second, frequently occurring, small spinules on each of the distal corners; third, the location of the frontal avicularium in the very proximal part of the cryptocyst, whose triangular mandible has its sharp apex pointed downward; and fourth, a pattern on the surface of the ovicell which varies in different colonies as well as in different ovicells in the same colony. Often the outer layer of the ectooecium is not continuously calcified, and leaves a central orifice, shaped like a pod, on the surface of the ovicell, which is directed by its bent broad side toward the proximal margin of the ovicell; sometimes the outer layer under this orifice, is not continuously calcified up to the

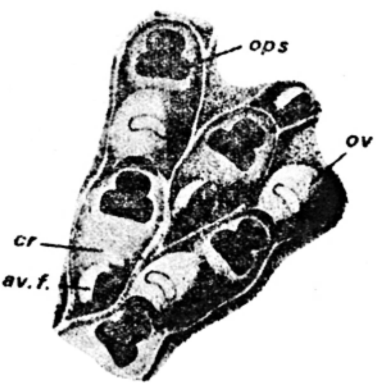


Figure 187. *Amphiblestrum trifolium* var. *quadrata* (Hincks). Part of a zoarium.

proximal margin of the oecium, as in the former case, but forms a rebral margin turned at an angle, the tip of which is situated near the lower margin of the orifice; sometimes the central orifice is not present and the rebral margin of the incompletely calcified outer margin forms a triangular slit, and the margin of the distal tip of the angle is often thickened; and lastly, in a few cases, the outer layer of the ectooecium is calcified only on the sides and the upper side, leaving a large area uncalcified at the surface of the roundish-rectangular form.

This species lives on shells and stones, at a depth of 26 to 80 m, on a bed of stone, silt, and red algae, under temperatures ranging from −1.61 to 3.5°C, in a salt concentration of 34.07‰.

Distribution. The species was found by me in the Barents and Chukotsk seas, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868a; Bidenkap, 1900a), coastal waters of the Archipelago of the Canadian Islands (Nordgaard, 1906a), western Greenland (Smitt, 1868c; Norman, 1876, 1903a, 1906; Kluge, 1908b; Levinsen, 1914; Osburn 1919), Gulf of St. Lawrence (Whiteaves, 1901; Norman, 1903a), western Greenland (Levinsen, 1916), Yan-Maien Island (Lorenz, 1886), Shetland Islands (Norman, 1903a), and northern Norway (Nordgaard, 1918).

This is an Arctic-boreal species.

8. Genus **Larnacicus** Norman, 1903

Membranipora Busk, 1860 : 124; *Larnacicus* Norman, 1903b : 87.

A strongly developed cryptocyst is located under the aperture membrane, and occupies about half of the frontal surface of the zooid. The distal end of the zooid is divided into 2 or 3 chambers. Two to 3 pairs of spines are arranged along the distal part, of which the proximal pair is bifurcated at the tip. Vicariating avicularia are often found between the zooids. The ovicells are hyperstomial.

Genus type: *Membranipora cornigera* Busk.

Larnacicus corniger (Busk, 1859) (Figure 188)

Membranipora cornigera Busk, 1860 : 124, pl. XXV, f. 2; Hincks, 1880a : 164, pl. 21, f. 4, pl. 22, f. 3; *M. flemingii* forma *cornigera* Smitt, 1868a : 367, 403, pl. XXIV, f. 1; *Larnacicus corniger* Norman, 1903b : 87, pl. VIII, f. 3; Marcus, 1940 : 144, f. 77.

The small, prostrate zoaria consist of irregularly arranged zooidal rows. The zooids are oblong, or roundish-hexagonal in shape. Their margins are raised in the distal half, while their surface is depressed;

in the proximal half, the margins are depressed, while the surface is slightly raised; the latter is granular. All the margins of the opesium are smooth, but its lower margin is concave. The distal end of the zooid is divided by 1 or 2 short, longitudinal tubercles into 2 or 3 chambers. The hyperstomial, spherical ovicell is located above these, and there is a thin, multi-faced figure on the surface of the continuously calcified outer layer of the ectooecium; the orifice of the ovicell is covered with a lid. Along the margin of the distal part of the zooid are located 2 or 3 pairs of spines, the proximal pair of which is the largest and bifurcated at the ends. Small, vicariating avicularia of rectangular shape are quite often found between the zooids; the distal margin of the rostral part is raised and has a semi-circular form, to which the semi-circular free end of the mandible corresponds.

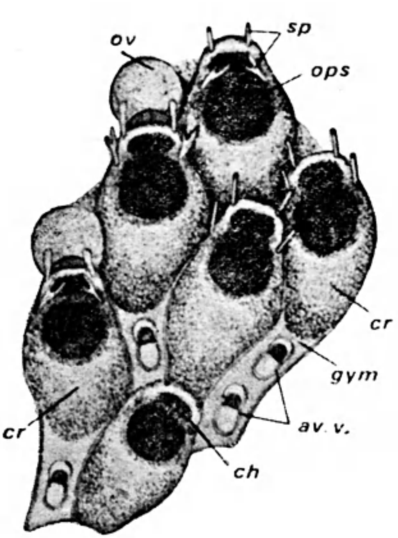


Figure 188. *Larnacicus corniger* (Busk). Part of a zoarium with vicariating avicularia.

The species lives on shells and stones, at a depth of 135 to 660 m, on a bed of stone and silt, under temperatures ranging from 3.5 to 8.46°C.

Distribution. Reports in literature: Barents Sea, between northern Finmark and Bear Island (Nordgaard, 1900), Hardanger Fiord (Norman, 1903b), Shetland Islands (Norman, 1903b), Iceland (Nichols, 1911), eastern Greenland (Levinsen, 1914), and in the Atlantic Ocean in the region of the Faeroes Islands (Nordgaard, 1907b).

This is a deep-water, boreal, Atlantic species.

9. Genus **Megapora** Hincks, 1877

Lepralia Busk, 1856a : 308; *Megapora* Hincks, 1877b : 529.

The zoarium is prostrate. The zooids have pore chambers on the basal sides, and a deep cryptocyst surrounded by the raised margin of the oval aperture. The gymnocyst is well-developed. The small opesium, in the upper part of the aperture, is shaped like a clover leaf. The orifice of the zooid is surrounded by spines. The avicularia, when found, are vicariating. The ovicells are peristomial.

Genus type: *Lepralia ringens* Busk, 1856.

Megapora ringens (Busk, 1856) (Figure 189)

Lepralia ringens Busk, 1856a : 308, pl. IX, f. 3-5; *Megapora ringens* Hincks, 1880a : 172, pl. XXII, f. 1; Marcus, 1940 : 145, f. 78.

The small zoarium is in the form of a translucent crust, and consists of minute, irregularly arranged zooids. The zooids are oval-hexagonal in shape, and have depressed margins. The oval aperture occupies an insignificant part of the frontal surface; it has a raised margin from which the gymnocyst drops down up to the margin of the zooid, along its sides and in the proximal part. A deep cryptocyst, located inside the aperture, borders the opesium in the upper, one-third of the former. The opesium would appear to consist of 2 parts: the upper, larger, semicircular one is occupied by a chitinized operculum, and the lower part is in the form of a broad slit, covered by a common, transparent aperture membrane. Because the lateral margins of the opesium are close to each other in the place of transition of the upper part into the lower one, and the proximal margin of the oecium is slightly bent, the opesium projects the impression that it is shaped like a clover leaf. The brighter, transverse strip separating the upper part from the lower, is the straight, proximal margin of the chitinized operculum; it reflects light rather strongly.

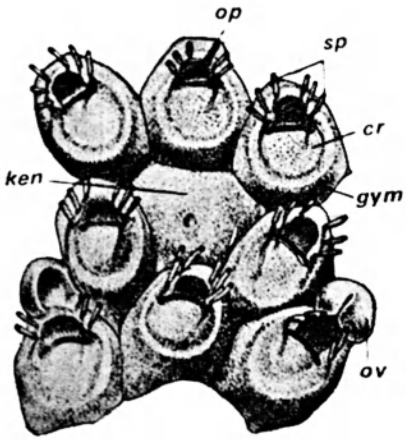


Figure 189. *Megapora ringens* (Busk). Part of a zoarium.

Six more or less long, thin spines are located along the distal margin of the aperture, around the orifice of the zooid. The avicularia mentioned for this species, supposedly located on the gymnocyst and provided with large, chitinous, vibraculoid spines, were not present in our two colonies. The ovicells are small, round, and smooth, and have a rebral margin on the surface of the outer layer of the ectooecium, which is in the form of a bent line whose tip points in a distal direction.

The species lives on stones and shells, at a depth of 150 to 660 m, on a bed of gravel, under a temperature of 3.6°C.

Distribution. The species was found by me in the Barents Sea, in the waters of Finmark. *Reports in literature:* Western coast of Norway in the region of Bergen (Hincks, 1880a), Shetland Islands (Norman, 1869), and westward of northern Ireland (Nichols, 1911).

This is a deep-water, boreal, Atlantic species.

10. Genus **Doryporella** Norman, 1903

Lepralia Smitt, 1868b : 20; *Microporella* Waters, 1900 : 87; *Doryporella* Norman, 1903b : 106; *Membranipora* (*Callopora*) Levinsen, 1914 : 576.

The zoarium is prostrate. The zooids have pore chambers and a strongly developed gymnocyst. The small aperture is horse-shoe shaped, and its proximal margin slightly bent, while the distal one is surrounded by spines. A spear-like spine is located under the aperture, and covers it. Beneath the spine, there is a frontal avicularium. In the distal part of each zooid, there is one angular avicularium. The ovicells are small and spherical.

Genus type: *Doryporella spathulifera* Smitt.

Doryporella spathulifera (Smitt, 1868) (Figure 190)

Lepralia spathulifera Smitt, 1868b : 20, 124, t. 26, f. 94-98; *et auctt.*; *Membranipora* (*Callopora*) *spathulifera* Levinsen, 1914 : 576; *Microporella spathulifera* Waters, 1900 : 87, pl. 12, f. 6; *Doryporella spathulifera* Norman, 1903b : 106.

The zoarium is prostrate in the form of a small, round crust. The small, hexagonal zooids are arranged in longitudinal rows, and have a honed surface. The proximal half of the zooid has a small (about one-third the entire frontal surface), horse-shoe shaped aperture which broadens toward the proximal margin and narrows slightly from the lateral sides in the middle. Sometimes 4 to 6 long, thin spines are located along the margin of the distal part of the aperture; more often 4 spines are present; the 2 proximal ones are sometimes bifurcated at the tips. The proximal margin of the aperture is slightly bent. A small, oval orifice is usually located under the margin in approximately the

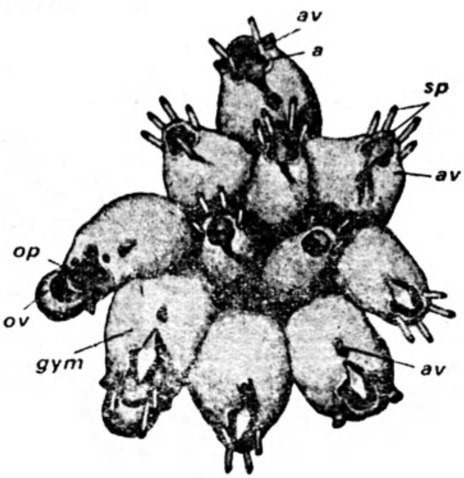


Figure 190. *Doryporella spathulifera* (Smitt).

middle of the gymnocyst; a flat spine is located just ahead of the orifice, which covers the aperture and looks like a palette knife, being broader in the middle and gradually tapering toward the distal end. A small avicularium is often situated on the oval orifice, whose mandible has its sharp end directed downward. In addition to this frontal avicularium, other similar avicularia are located near each distal corner of the zooid with the sharp ends of their mandibles pointed outward. The ovicells are small and spherical, and have a granulated surface. There are 4 pore chambers in the lateral walls and 2 in the distal ones.

The species lives on shells and stones, at depths ranging from 20 to 300 m, more often from 50 to 150 m, on a bed of stone, silt, and shells, under temperatures ranging from −1.23 to 3.5°C, in a salt concentration of 32.86 to 34.79‰.

Distribution. The species was found by me in the Barents, Kara, Chukotsk, Bering, and Okhotsk seas. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Waters, 1900; Andersson, 1902; Norman, 1903b; Nordgaard, 1918), White Sea (Gostilovskaya, 1957), Kara Sea (Nordgaard, 1912b), Waters of the Archipelago of the Canadian Islands (Nordgaard, 1906a), western Greenland (Smitt, 1868b; Norman, 1906; Kluge, 1908b; Osburn, 1919), Newfoundland (Osburn, 1913), Gulf of St. Lawrence (Whiteaves, 1901), eastern Greenland (Levinsen, 1916), Yan-Maien Island (Lorenz, 1886), Iceland (Nordgaard, 1924), and northern Norway (Nordgaard, 1918).

This is an Arctic, circumpolar species.

11. Genus **Reussina** Kluge gen. n.

Escharina Reuss, 1846 : 68; *Discopora* (?) *impressa* Smitt, 1872a : 1126.

The zoarium is prostrate. The zooids have pore chambers on the basal side. The aperture occupies a larger portion of the frontal surface. The cryptocyst is strongly developed under the frontal membrane; its distal half is surrounded by the thick raised margin of the aperture, and its proximal half transforms imperceptibly into a weakly developed gymnocyst with a lowered margin. The small opesium has a roundish-trapeziform shape. The orifice of the zooid is surrounded by spines. Avicularia are absent. Ovicells are present.

Genus type: *Escharina impressa* Reuss.

Reussina impressa (Reuss, 1846) (Figure 191)

Escharina impressa Reuss, 1846 : 68, t. XV, f. 24; *Discopora* (?) *impressa* Smitt, 1872a : 1126, t. XXI, f. 17-19.

The zoarium, prostrate in the form of a crust, consists of zooids arranged in regular rows. The zooids, small, irregular, and rhombic-hexagonal in shape, attain maximum width in the proximal half, and have an aperture which occupies a larger portion of the frontal surface. Sometimes the proximal ends, located between 2 adjacent zooids, become sharp, but the distal margin of the zooid is always truncated and slightly rounded. The thick margin of the aperture is raised in the distal half, and lowered in the proximal half correspondingly. The cryptocyst is lowered in the distal half on the sides up to the level of the opesium, while its proximal half is slightly convex; a deep furrow is formed on both sides of the convex cryptocyst below the proximal margin of the opesium. The surface of the cryptocyst is granular, and its inner margin is minutely denticulate. The opesium has a roundish-trapeziform shape, and a broader, slightly bent, proximal margin. The orifice of the zooid is semi-circular and covered by the straight proximal margin of the chitinous operculum. The opesium is a little larger than the orifice, and therefore a narrow, transverse, membranous strip is visible between the proximal margin of the operculum, and the margin of the translucent cryptocyst. Two small spines are located on the distal margin of the aperture. Avicularia are absent. Ovicells are peristomial, small, and semi-circular. Pore chambers are located along the margin of the basal side of the zooid, probably up to 7 to 8 in the lateral wall, and 1 in the transverse wall.

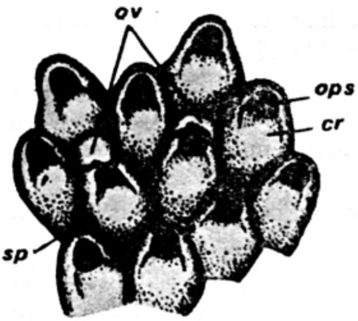


Figure 191. *Reussina impressa* (Reuss). Part of a zoarium (from Smitt, 1872a).

The species lives on stones, at a depth ranging from 36 to 144 m.

Distribution. The species was found by me in the Barents Sea in the Khinlopen Strait (Spitsbergen). *Reports in literature:* Along the western and northern coasts of Spitsbergen (Smitt, 1872a), and, in fossil form, in the Bogemsky cretaceous deposits (Reuss, 1846).

III. Family **Flustridae** Smitt, 1868

Escharidae (part.) Johnston, 1838 : 248; *Flustridae* (part.) Busk, 1852b : *Flustridae* Smitt, 1868a : 357, 374.

The zoaria are usually in the form of free-growing, comparatively strongly branched, flexible, one- or two-sided, leafy plates. Only in a few species (*Flustra foliacea, F. serrulata, F. barleei,* and *Sarsiflustra* *abyssicola*) do the zoaria start their growth in the form of crusts overgrowing the plates. The zooids are slightly calcified. The aperture occupies the entire frontal surface. In some species, the cryptocyst is developed along the margin of the aperture in the form of a more or less narrow rim. The avicularia are vicariating. The ovicells are endozooecial. Pore plates are always present in varying number (from 2 to 12) in the lateral walls, which have different numbers (from 1 to 30) of minute pores arranged in a different manner in different species. In certain species, the free margin is surrounded by kenozooids in the lower parts of the branches. Sometimes radicular fibers are found, which originate from the basal side of the zooids.

Key for Identification of the Genera of the Family Flustridae

1 (2). Avicularia absent, or if present, always smaller than the autozooids; they have a simple, semi-circular mandible..1. *Flustra* Linnaeus. (see below)
2 (1). Avicularia present, large in size (not smaller than the autozooids), have a large, broad mandible shaped like a palette knife...................................2. *Sarsiflustra* Jullien (see p. 382).

1. Genus **Flustra** Linnaeus, 1767

Flustra Busk, 1852b : 47; Smitt, 1868a : 357 (part.); Hincks, 1880a : 114, *et auctt.*; *Carbasea* Gray, 1848 : 105; Norman, 1903a : 582; Silen, 1942c : 49.

The zoaria are free-growing, foliate shaped, divided into lobes, and one- to two-sided. The zooids may or may not have spines. Avicularia are either absent, or if present, smaller than the autozooids; they have a simple, semi-circular mandible. Ovicells are either present or absent. In certain species, kenozooids and radicular fibers are present.

Genus type: *Flustra foliacea* Linnaeus.

1 (6). Zoaria free-growing throughout their length, foliate, and single-layered.
2 (5). Avicularia and ovicells absent from the zoarium.
3 (4). Zoaria affixed to the substrate with the help of a small, round surface; radicular fibers absent. Zooids, stretched and ligulate, broaden in the distal half and narrow in the proximal. Distal margin of the zooid semi-circular.....................................1. *F. carbasea* (Ellis and Solander).
4 (3). Zoarium affixed to the substrate with the help of radicular

fibers. Zooids oblong-rectangular, but broaden in the middle and taper toward the ends. Distal margin straight; a narrow, white, calcareous border stretches along the margin, which slightly broadens toward the corners.................... ....2. *F. nordenskjoldi* Kluge.

5 (2). Avicularia and ovicells present in the zoarium.............. ....3. *F. membranaceo-truncata* Smitt.

6 (1). Zoaria always double-layered in the free, leafy part; in certain cases *(F. foliacea, F. serrulata)*, zoaria start growing in the form of a prostrate and partly single-layered crust.

7 (8). Avicularia and ovicells not present in the zoarium. Zoarium starts growing in the form of a prostrate and partly single-layered crust. Zooids have a stretched, ligulate shape; the narrow, denticulate rim of the cryptocyst is clearly visible along the entire magin of the aperture......................... ....4. *F. serrulata* Busk.

8 (7). Avicularia and ovicells present in the zoarium.

9 (12). Zooids have no spines at the distal margins.

10 (11). Zoarium foliate with short, rounded lobes; zooids irregular, hexagonal in shape; avicularia short and rectangular, with an obliquely located, semi-circular mandible................. ....5. *F. barleei* Busk.

11 (10). Zoarium foliate with long, narrow, straight lobes truncated at the ends; zooids long, right-angled; avicularia rectangular with a mandible whose free end is turned upward......... ....6. *F. securifrons* (Pallas).

12 (9). Zooids have 1 to 2 spines at each distal corner; avicularium oval in shape, broadens in the distal half and obliquely sharpens in the proximal; it has a semi-circular mandible whose free end is directed upward.........7. *F. foliacea* Linnaeus.

Since it is difficult, using the characters included in the above key, to immediately identify certain species of *Flustra* accurately, it becomes essential to study the pore plates in the lateral walls, and the pores in the distal septum, of the zooid. These characters are quite typical for each species, and therefore, I give an additional key for the identification of species of the genus *Flustra,* on the basis of the orifices in their lateral walls and in the transverse septum.

1 (8). Every pore plate in the lateral wall has 1 pore.

2 (3). There are 2 uniporous plates in the lateral wall........... ....4. *F. serrulata* Busk.

3 (2). A large number of uniporous plates exist in the lateral wall.

4 (7). There are 6 to 8 uniporous plates in the lateral wall.
5 (6). There is 1 simple pore in the distal septum...6. *F. securifrons* (Pallas).
6 (5). There are 3 to 4 simple pores in the distal septum...3. *F. membranaceo-truncata* Smitt.
7 (4). There are 11 to 12 uniporous plates in the lateral wall...5. *F. barleei* Busk.
8 (1). There are pore plates with many pores in the lateral wall.
9 (10). There are 8 to 12 simple pores in the distal septum, arranged in one row along the lateral and lower margins; there are 3 to 5, often 4, pore plates with 2 to 5 minute pores each in the lateral wall.......................7. *F. foliacea* (Linnaeus).
10 (9). There are numerous (from 20 to 30) simple pores in the distal septum.
11 (12). There are simple pores in the distal septum arranged mostly along the lower margin, but raised along the lateral walls; there are 5 to 7, often 6, pore plates with 5 to 7 pores each in the lateral wall...........1. *F. carbasea* Ellis and Solander.
12 (11). There are simple pores in the distal septum arranged in a number of rows along the lower margin; there are 3 to 4 pore plates with 5 to 10 pores each in the lateral wall...2. *F. nordenskjoldi* Kluge.

1. **Flustra carbasea** (Ellis and Solander, 1786) (Figure, 192)

Flustra carbasea Hincks, 1880a : 123, pl. 14, f. 1, pl. 16, f. 4; Levinsen, 1894 : 50, pl. 2, f. 38-46, *et auctt.* ; *F. papyrea* Smitt, 1868a : 359, 380, pl. XX, f. 9-11; *Carbasea Solanderi* Norman, 1903a : 582; *C. carbasea* Borg, 1930a : 69, f. 65-66.

The zoarium is thin, single-layered, and divided several times into lobes of roundish shape. The live zoarium is yellow-brown in color. The fixation to the substrate takes place with the help of a round surface; radicular fibers are absent. The zooids, more or less narrow, stretched, and ligulate, broaden in the distal half, and taper in the proximal. The lateral margins of the zoarium are surrounded by 2 or more long, very narrow kenozooids which have fairly thickened walls in their proximal part. Sometimes in the proximal parts of the zoarium, the cryptocyst develops in the proximal part of the zooid. The lateral wall has 5 to 7, usually 6, pore plates with 5 to 7 pores each; there are numerous (20 to 25) simple pores in the distal septum arranged along the lateral and lower margins of the septum.

This species lives on shells and stones, at a depth of 3 to 230 m, often from 10 to 30 m, on a bed of stone and silt, under temperatures ranging

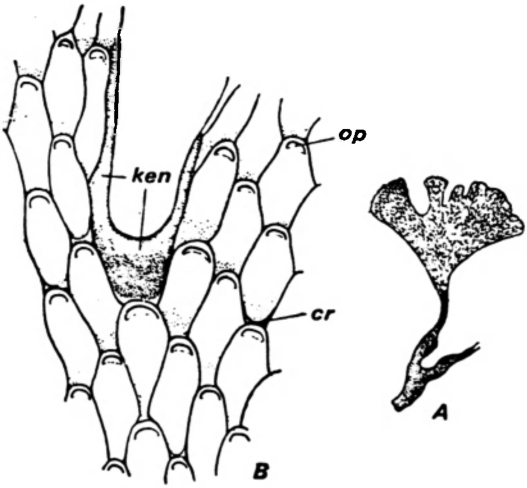


Figure 192. *Flustra carbasea* (Ellis and Solander). *A*—a lobe of a zoarium in natural size; *B*—part of a lobe of a zoarium from the frontal side.

from −1.6 to 4.78°C, in a salt concentration of 24.67 to 33.15‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas. *Reports in literature:* Barents Sea (Smitt, 1868a; Ridley, 1881; Nordgaard, 1896, 1905; Bidenkap, 1897, 1900a; Waters, 1900), Kara Sea (Smitt, 1879a), Laptev Sea (Kluge, 1929), East Siberian Sea (Kluge, 1929; Nordgaard, 1929), Hudson Bay (Osburn 1932), Labrador (Packard, 1866-69; Osburn, 1913), western Greenland (Smitt, 1868c; Levinsen, 1914), Gulf of St. Lawrence (Dawson, 1859; Whiteaves, 1901), Yan-Maien Island (Lorenz, 1886; Nordgaard, 1918), northern Norway from Finmark to the Lofoten Islands (Smitt, 1868a; Nordgaard, 1918), Kattegat (Levinsen, 1894), North Sea (Ortmann, 1894), and the British Isles (Hincks, 1880a).

This is an Arctic-boreal, circumpolar species.

2. **Flustra nordenskjoldi** Kluge, 1929 (Figure 193)

Flustra nordenskjoldi Kluge, 1929 : 8; 1955a : 82, fig. 26; *F. papyrea* Murdoch, 1885 : 167; *F. carbasea* Osburn, 1923 : 12D.

The zoarium is thin, single-layered, and divided into more or less narrow lobes, similar to those of *F. carbasea.* The live zoarium has a dark brown color which preserves well in alcohol. The zooids, arranged in regular rows in a checkered pattern, are rectangular in shape, and slightly

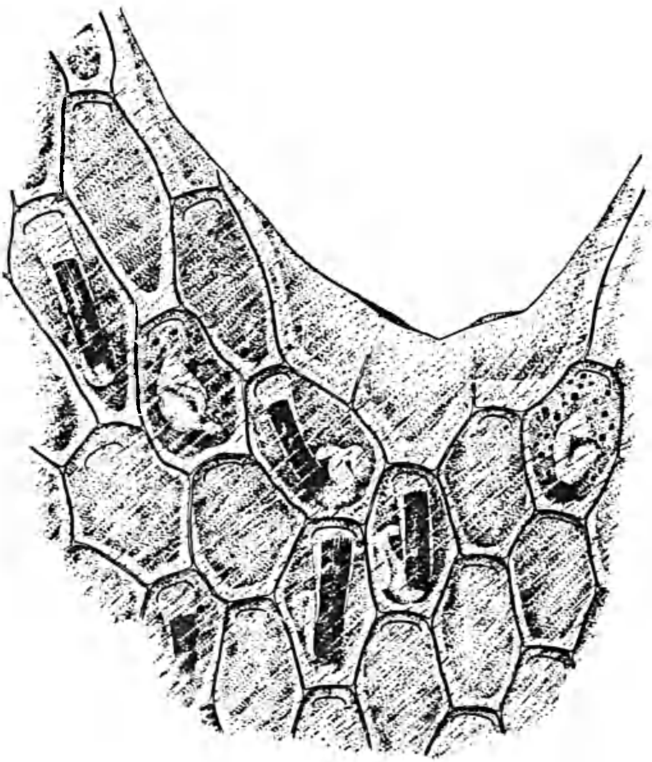


Figure 193. *Flustra nordenskjoldi* Kluge. Part of a zoarial lobe from the frontal side.

broader in the middle. The distal margin of the zooid is straight; the narrow, white, calcareous margin of the gymnocyst, which slightly broadens toward the corners, is stretched along the proximal side of the distal margin of the zooid. Sometimes the cryptocyst develops in the lower part of the zoarium, under the frontal membrane in the proximal part. The lateral margins of the zoarium are surrounded by a row of long kenozooids, which convert into radicular fibers near the base of the zoarium. The lateral kenozooids, along with the radicular fibers, originate from the distal half of the zooid at the basal side, and form a thick bundle which helps attach the zoarium to the substrate. There are 3 to 4 pore plates with 5 to 10 pores each in the lateral wall; there are 20 to 30 simple pores arranged in several rows along the lower margin of the distal septum.

The species lives on shells and stones, at a depth of 3.6 to 110 m, on a bed of stone and silty sand, under temperatures ranging from —1.69 to 8.8°C, in a salt concentration of 32.4 to 33.2‰.

Distribution. The species was found by me in the Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas.

This is an Arctic-boreal, Pacific species.

3. **Flustra membranaceo-truncata** Smitt, 1868 (Figure 194)

Flustra membranaceo-truncata Smitt, 1868a : 358, t. XX, f. 1-5, *et auctt.*; *Carbasea membranaceo-truncata* Norman, 1903a : 583.

The zoarium is thin, single-layered, and divided sometimes in broader, sometimes in narrower, roundish lobes. The zoarium is translucent and grayish in color. The zooids, arranged in irregular rows, have thin margins; they are sometimes oblong-rectangular in shape, and sometimes hexagonal. A membrane covers the entire frontal surface of the zooid. Sometimes there is a spine on each distal corner of the zooid. The avicularia, unevenly distributed among the autozooids. have an oblong, roundish-rectangular shape, and a broad, rounded mandible whose free end is directed toward the distal side. The endozooecial ovicells, small, semi-circular, and somewhat narrower than the autozooids, have a weak radial pattern on the surface. The proximal margin of the ovicell is usually covered with a strip of cryptocyst, formed by the fusion of its two lateral protuberances near the proximal margin of the overlying zooid. There are 6 to 8 simple uniporous plates in the lateral wall, and 3 to 4 simple pores in the distal septum.

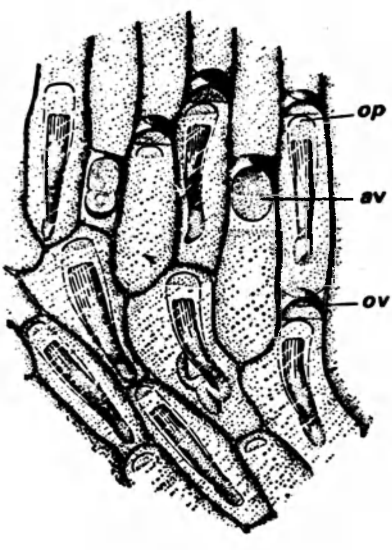


Figure 194. *Flustra membranaceo-truncata* Smitt. Part of a lobe of a zoarium, from the frontal side, with 2 avicularia.

The zoaria are attached to the substrate by radicular fibers, which originate from the basal side of the zooids.

The species lives on the tubes of annelids, ascidia, etc., mostly on a bed of sand and pebbles, at a depth of 1.5 to 520 m, often from 50 to 200 m, under temperatures ranging from —1.7 to 4.78°C, in a salt concentration of 24.67 to 34.96‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868a, 1879b; Urban, 1880; Nordgaard, 1896, 1900, 1912a, 1918, 1928; Bidenkap, 1897, 1900a; Waters, 1900; Andersson, 1902; Norman, 1903a; Kuznetsov, 1941), White Sea (Bidenkap, 1900a; Kluge, 1907, 1908a; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Levinsen, 1887; Nordgaard, 1912b, 1923; Kluge, 1929), Laptev, and East Siberian seas (Kluge, 1929), Archipelago of the Canadian Islands (Nordgaard, 1906a), western Greenland (Smitt, 1868c; Norman, 1876; Vanhöffen, 1897; Levinsen, 1914), Gulf of St. Lawrence (Whiteaves,1901), eastern Greenland (Andersson, 1902; Levinsen, 1914), Yan-Maien Island (Nordgaard, 1900, 1907b), and northern Norway (Nordgaard, 1918).

This is an Arctic, circumpolar species.

4. **Flustra serrulata** Busk, 1880 (Figure 195)

Flustra serrulata Busk, 1880 : 234, pl. XIII, f. 2-4, *et auctt.*; *Membranipora serrulata* Levinsen, 1887 : 316, pl. 27, f. 1-2; *Flustra spitzbergensis* Bidenkap, 1897 : 617, t. 25, f. 1-2; *F. carbasea* var. *spitzbergensis* Nordgaard, 1918 : 30.

The zoaria, double-layered, flexible, and broadly foliate, have a wavy margin. The color of the zoarium varies in the old from bright brown to a lighter color around the zoarial margin. The zooids have a stretched,

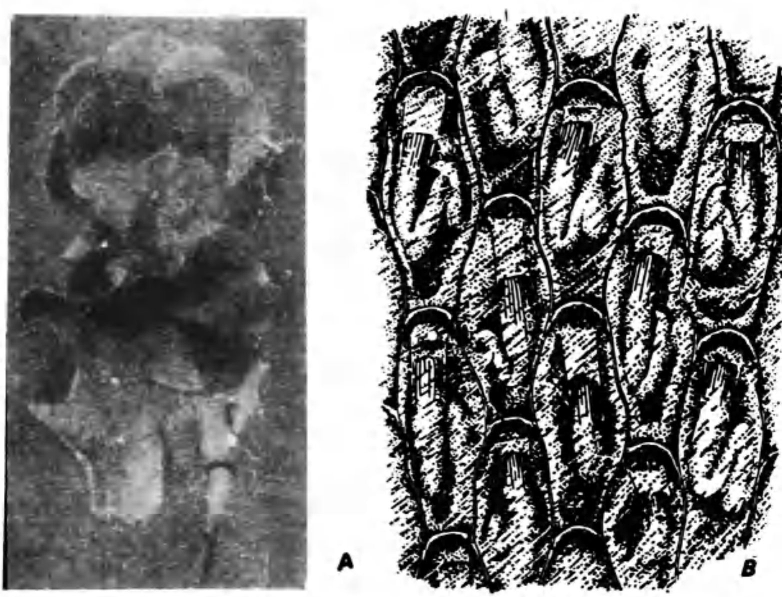


Figure 195. *Flustra serrulata* Busk. *A*—general view of the zoarium in natural size; *B*—part of a lobe of the zoarium.

ligulate shape, similar to that in *F. carbasea,* and a clearly noticeable, denticulate, inner margin on the narrow cryptocyst, which extends along its entire length, and slightly broadens near the proximal part. Avicularia and ovicells are absent. The zoarium is partly prostrate when it starts to grow, and partly in the form of a single-layered crust from which free-growing, double-layered, foliate lobes uprise. There are 2 uniporous plates in the lateral wall, and 2 in the distal septum on the lower and lateral sides; each plate has one simple pore.

The species lives on hydroids, tubes of annelids, etc., at a depth varying from 5.5 to 195 m, more often from 20 to 30 m, on a bed of stone and silt, under temperatures ranging between −1.75 to 0.8°C, in a salt concentration of 24.67 to 33.35‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868a; Bidenkap, 1897, 1900a; Kluge, 1929), Kara Sea (Smitt, 1879a; Levinsen, 1887; Kluge, 1929), Laptev Sea (Kluge, 1929; Abrikossov, 1932), East Siberian Sea (Kluge, 1929; Nordgaard, 1929), Chukotsk Sea (Kluge, 1929; Nordgaard, 1929), western Greenland (Smitt, 1868c; Hennig, 1896; Kluge, 1908b; Levinsen, 1914; Osburn, 1919), Archipelago of the Canadian Islands (Busk, 1880; Nordgaard, 1906a; Osburn, 1923), Labrador (Osburn, 1913), Newfoundland (Jullien and Calvet, 1903), and the Gulf of St. Lawrence (Whiteaves, 1901).

This is a high Arctic, circumpolar species.

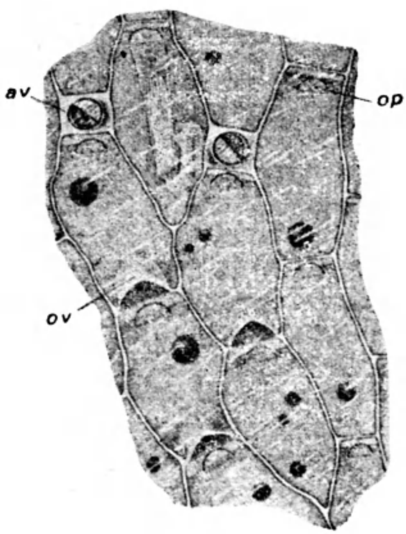


Figure 196. *Flustra barleei* Busk. Part of a zoarial lobe.

5. **Flustra barleei** Busk, 1860 (Figure 196)

Flustra barleei Busk, 1860 : 123, pl. XXV, f. 4; Hincks, 1880a : 122, pl. 5, f. 6-8; *Terminoflustra barleei* Silen, 1944e : 3, f. 1-2.

The zoaria are double-layered, thin, brittle, and repeatedly divide into narrow lobes which terminate in shorter, roundish lobes. The live zoaria are light-grayish-yellow in color. The zooids, arranged in regular rows, are oblong-hexagonal for the most part, and rarely, irregular, triangular in shape; their margins are straight and thin. The avicularia, distributed between the autozooids, are rectangular, and have an obliquely placed, semi-circular mandible. The ovicells are small and round; their proximal margin is covered by a narrow strip of the cryptocyst, which broadens toward the lateral margins of the proximal part of the zooid. The lateral wall has 11 to 12 simple pores, and the distal septum 5 to 6. The zoarium is attached to the substrate by a small, round surface.

The species lives on shells, stones, etc., at a depth of 350 to 1,100 m, under temperatures ranging from 3.89 to 8.07°C.

Distribution. Reports in literature: Barents Sea to the north of Finmark, (Smitt, 1872a), fiords of western and southern Norway (Nordgaard, 1918), western Sweden (Silen, 1944e), Shetland Islands (Norman, 1869; Hincks, 1880a), and in the Atlantic Ocean in the region of the Shetland and Faeroes Islands (Nordgaard, 1907b, 1918).

This is a deep-water, Atlantic-boreal species.

6. **Flustra securifrons** (Pallas, 1766) (Figure 197)

Eschara securifrons Pallas, 1766 : 56; *Flustra truncata* Busk, 1852b : 48, pl. 56, f. 1-2, pl. 58, f. 1-2; *F. securifrons* Smitt, 1868a : 358, 378, t. XX, f. 6-8; Levinsen, 1894 : 50, t. III, f. 16-29.

The zoarium branches dichotomously several times into long, narrow, straight lobes, which slightly widen toward the distal end where they become truncated, and their base sometimes strongly overstretched. The live zoarium is light straw-yellow in color. The zooids, arranged in regular rows in a checkered pattern, have oblong, right-angle shapes; their length is about 4 times greater than their width. The avicularia, spread in different parts of the zoarium, are located between 2 successive autozooids in the same row. They are rectangular in form, and have a semicircular mandible whose free end is directed upward. The

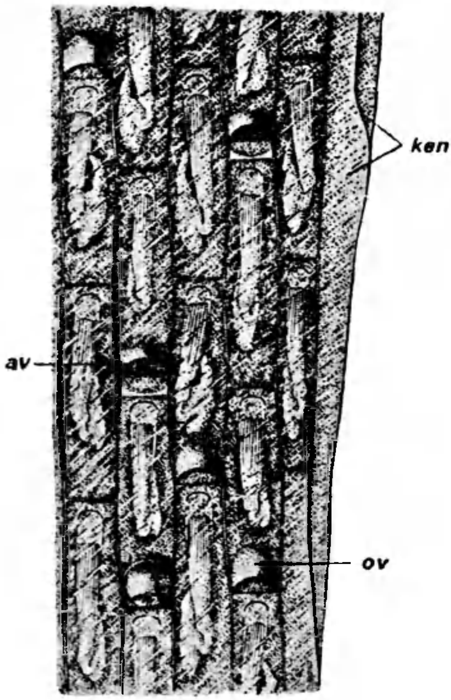


Figure 197. *Flustra securifrons* (Pallas). Marginal part of a zoarial lobe with kenozooids.

ovicells are endozooecial, semi-circular, smooth surfaced, and occupy about one-fourth of the cavity of the overlying zooid. One row (sometimes 2) of fairly long, tubular kenozooids is located along the lateral margin of the zoarium. Numerous narrow tubes or radicular fibers, not only broaden the discoidal base of the zoarium, but help affix it to the substrate. There are 6 to 8 uniporous plates in the lateral wall of the zooid, but only one simple pore in the distal septum.

The species lives on shells of mollusks, ascidia, and stones, mostly on a rocky and sandy bed, at a depth ranging from 10 to 300 m, often from 50 to 200 m, under temperatures ranging from −1.7 to 3.2°C, in a salt concentration of 33.87 to 34.63‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, and Chukotsk seas, and in the waters off Labrador and western Greenland. *Reports in literature:* Barents Sea (M. Sars, 1851; Smitt, 1868a, 1879b; Ridley, 1881; Nordgaard, 1896, 1905, 1912a, 1912b, 1918; Bidenkap, 1897, 1900a; Andersson, 1902), White Sea (Bidenkap, 1900a; Kluge, 1907, 1908a; Kluge in Deryugin, 1928; Gostilovskaya, 1957), Kara Sea (Levinsen, 1887; Nordgaard, 1912b), Laptev Sea (Kluge, 1929), Hudson Bay (Osburn, 1932), Labrador (Packard, 1863), western and eastern Greenland (Nordgaard, 1907a; Levinsen, 1914), Newfoundland (Osburn, 1913), Yan-Maien Island (Nordgaard, 1907a), northern Norway (Nordgaard, 1896, 1918), Skagerrack (Smitt, 1868a), Kattegat (Levinsen, 1894; Marcus, 1940), North Sea (Nordgaard, 1907c; Borg, 1930a), British Isles (Hincks, 1880a; Nichols, 1911), and Belgium (Loppens, 1907).

This is an Arctic-boreal, circumpolar species.

7. **Flustra foliacea** (Linnaeus, 1758) (Figure 198)

Flustra foliacea Smitt, 1868a : 360, t. XX, f. 12-16; Hincks, 1880a : 115, pl. 16, f. 1; Levinsen, 1894 : 51, t. III, f. 1-15.

The zoarium starts its growth partly in the form of a single-layered crust from which a free-growing, two-layered, foliate structure rises, which is either dichotomously or irregularly divided into lobes of varying width that are slightly broadened and rounded at the tips. The live zoarium varies in color from gray-brown to green-brown; it has a typical smell when withdrawn from the sea. The zooids are short and broad; their length is twice greater than their width; their distal half is broadened and rounded, and the proximal narrowed and truncated. Two spines are usually located on each of the distal corners (but in the initial, single-layered part of a zoarium from the White Sea, there was only one spine on each). The cryptocyst, more or less strongly developed in the zooids of the prostrate part of the zoarium, has a granular surface and a denticulate inner margin. There are no kenozooids in the lateral margins of the zoarium. Radicular fibers are also absent. The ovicells are endozooecial and, for the most part, lowered in the distal septum; their

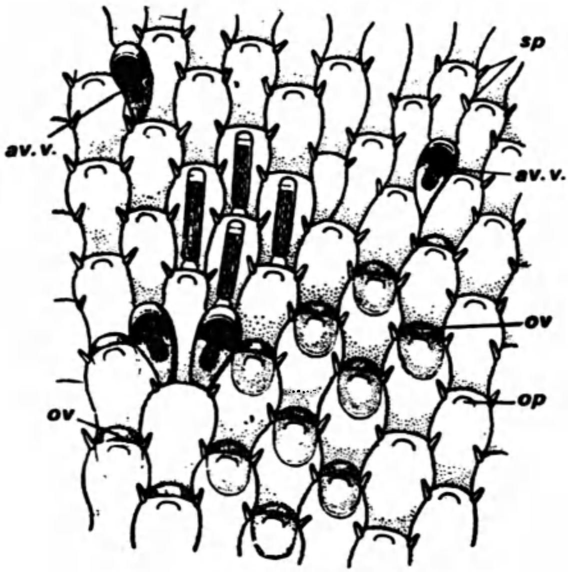


Figure 198. *Flustra foliacea* (L.). Part of a lobe of a zoarium, with avicularia and ovicells. Barents Sea.

upper, distal part is visible in the form of a whitish, shell-like, raised portion at the distal end of the zooid. The avicularia, located between the autozooids, are slightly smaller than the latter, semi-circular in the distal half, and obliquely sharpened in the proximal; they have a semi-circular mandible whose free end is raised upward. There are 3 to 5, usually 4, pore plates in the lateral wall with 2 to 5 pores each; there are many (8 to 12) simple pores in the distal septum, arranged along the lateral and lower margins.

The species lives on shells or stones, at a depth of 15 to 280 m, more often from 40 to 75 m, on a bed of sand and shells, under temperatures ranging from -2.13 to 0.83°C, in a salt concentration of 26.47 to 33.87‰.

Distribution. The species was found by me in the Barents Sea in the southeastern part, and in the Kara Sea in the southern part. *Reports in literature:* White Sea (Bidenkap, 1900n; Kluge, 1908a; Guerin-Ganivet, 1911; Kluge in Deryugin 1928; Gostilovskaya, 1957), the southwestern part of the Baltic Sea (Freese, 1888), Kattegat (Levinsen, 1894), North Sea (Ortmann, 1894; Nordgaard, 1907b), Great Britain (Hincks, 1880a), Belgium (van Beneden, 1845), southwestern France (Fischer, 1870), and northeastern Greenland (Nordgaard, 1907a), but this last report has still to be verified.

This is an Arctic-boreal species.

2. Genus **Sarsiflustra** Jullien, 1903

Flustra G. Sars, 1872 : 19, *et auctt.; Biflustra* Smitt, 1879 : 16; *Sarsiflustra* Jullien and Calvet, 1903 : 49.

The zoaria, free-growing, foliate, and branched into short, narrow lobes, are thick, and double-layered. The zooids are large and have no spines. The ovicells are poorly developed. The avicularia are large, never smaller than the autozooids, and have a large mandible shaped like a palette knife, in the middle of which 2 chitinous cylinders stretch which separate toward the corners of the proximal margin, but fuse with each other along the proximal margin by a transverse roller.

Genus type: *Sarsiflustra abyssicola* G. Sars.

Sarsiflustra abyssicola (G. Sars, 1872) (Figure 199)

Flustra abyssicola G. Sars, 1872 : 19, pl. 2, f. 25-30, *et auctt.; F. separata* Waters, 1888 : 38, pl. I, f. 9; *Sarsiflustra abyssicola* Jullien and Calvet, 1903 : 43, 126, pl. V, f. 6.

The zoarium is a small, prostrate structure, which initially looks like a single-layered crust from which double-layered, thick, foliate plates with narrow lobes soon originate. The zoarial color varies from sepia to dark brown. The zooids, arranged in irregular rows, are large, tall, stretched rectangularly, and slightly broadened in the middle; they have a convex distal, and a concave proximal, margin. The margins of the aperture are thin, smooth, and raised, particularly in the distal half. Cryptocysts are not present in the autozooids. Large avicularia are located after every 2 to 3 autozooids, more or less uniformly; rather than being smaller than the autozooids, these avicularia are often larger. They have a ligulate shape that is slightly broadened in the distal end and pointed on the proximal side. The larger, distal half of the avicularian chamber has raised, lateral, calcareous margins which slope inward; it is covered by a large, convex mandible that is shaped like a palette knife, under which the cryptocyst is located at a small distance in the form of a narrow rim along the proximal margin and the lateral walls; it has a broad surface along its distal wall, with a large, oval orifice in the middle—the opesium—through which the strong occlusor muscles pass distally, and the abductor muscles pass proximally. A triangular surface in the

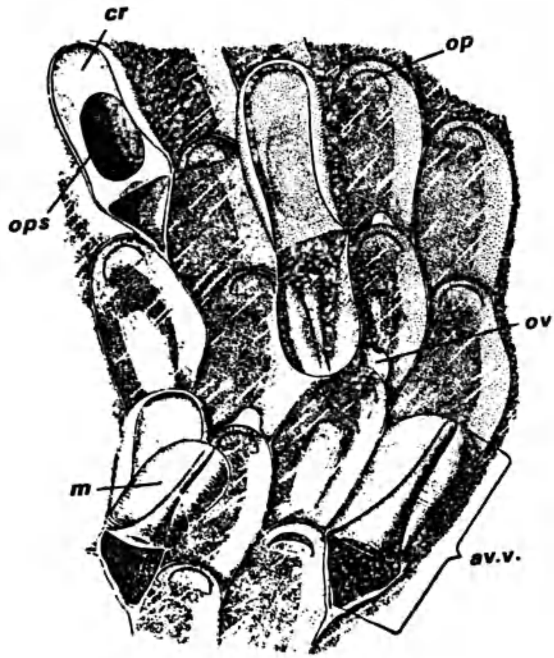


Figure 199. *Sarsiflustra abyssicola* (G. Sars). Part of a zoarial lobe with four avicularia. Barents Sea.

proximal, smaller half of the avicularian chamber, stretches in the form of a membrane, and the parietal muscles are attached to its inner side. the mandible consists of a central part, which occupies the whole of its length, and 2 lateral parts. The central part itself is a cavity, bordered on the sides by 2 strongly chitinized, thin, vertical plates which taper near the distal end, and diverge toward the proximal ends where they are joined by a narrow, transverse, chitinous strip. On the upper and lower sides, this cavity is surrounded by weakly chitinized and lighter walls. Weakly chitinized, lateral lobes originate on both sides of the central part. The ovicells are barely visible at the distal end of the zooid as slightly convex, hollow, plastic structures, on whose distal ends a strongly bordered, transverse orifice is located. There are 4 pore plates with 4 to 6 pores each in the lateral wall of the zooids and about 10 to 12 simple pores in the distal septum, arranged in one row along the lower margin.

This species lives on the tubes of *Polychaeta*, mollusks, shells, and other hard objects, at a depth of 82 to 1,275 m, more often from 200 to 400 m, on a bed of silt, stone, and sand, under temperatures ranging from −1.66 to 4.9°C, in a salt concentration of 34.47 to 34.92‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, and East Siberian seas. *Reports in literature:* Barents Sea (Bidenkap, 1900a; Nordgaard, 1900), Kara Sea (Smitt, 1879a; Nordgaard, 1912b), western Greenland (Levinsen, 1914), Gulf of St. Lawrence (Whiteaves, 1901), eastern Greenland (Andersson, 1902), northwest of Yan-Maien Island (Andersson, 1902), eastern Iceland (Nordgaard, 1907b), western coast of Norway (G. O. Sars, 1872; Nordgaard, 1900, 1905, 1912a, 1918), northwestern Scotland (Nordgaard, 1907b), near the Azores (Jullien and Calvet, 1903), and in the waters of New Scotland, North America (Waters, 1888).

This is a deep-water, Arctic-boreal, and Atlantic species.

IV. Family **Onychocellidae** Jullien, 1882

Onychocellidae Jullien, 1882 : 276.

The zooids have an aperture which occupies the entire frontal surface. The zooidal orifice is either membranous or chitinous. The cryptocyst is strongly developed. The avicularia are large and representative; their mandibles have a single- or double-sided, fine, membranous enlargement of the rachis. Spines are absent. Ovicells are endozooecial. The body walls are lateral as well as transverse, and double, i.e., each zooid has its own distal and proximal walls. The lateral and transverse walls have pore plates.

Genus **Smittipora** Jullien, 1882

Vincularia Smitt, 1873 : 6; *Smittipora* Jullien, 1882 : 284; *Onychocella* Nordgaard, 1907b : 8.

The zoaria, mostly prostrate, are sometimes free-growing. The zooids are large, thick-walled, and have an aperture covered with a membrane, which occupies the entire frontal surface. The orifice of the zooid is covered with a membranous or chitinous operculum. A strongly developed cryptocyst is located under the frontal membrane, and surrounds a small opesium. The avicularia are vicariating, and have a strongly developed cryptocyst, and a symmetrical, beak-shaped, oblong mandible with large, membranous widenings on each side of the rachis. The ovicells are endozooecial and poorly visible.

Genus type; *Vincularia abyssicola* Smitt.

***Smittipora solida** (Nordgaard, 1907) (Figure 200)

Onychocella solida Nordgaard, 1907b : 8, t. I, f. 1-5.

The zoarium is prostrate in the form of a thick cork of yellowish color, and consists of irregularly arranged zooids. The zooids are large, and thick-walled, and have an irregular hexagonal shape. The aperture is covered with a membrane and occupies the entire frontal surface. The strongly developed, particularly in the proximal half, cryptocyst, descends in a circular manner from the raised margin of the aperture toward the opesium. The surface of the cryptocyst is granular, and it has a denticulated, inner margin. The shape of the opesium varies from roundish-triangular to oval; its size is less than half of the frontal surface. The semi-circular operculum is membranous, and it has a chitinized free margin. Vicariating avicularia are located between the autozooids; though equal in size to the autozooids, they are slightly narrower and often longer, with sometimes sharply pointed, sometimes blunted, ends. The cryptocyst in them is also strongly developed; an oblong opesium is situated in the middle of it. A small, chitinous roller with a concave surface is located in the middle, on each side of the lateral margins of the avicularium; the ends of the proximal margin of the mandible rest against it. The mandible consists of an axial, chitinous core (rachis) to which a thin membrane is fastened on both sides by a little more than half its length. The rachis is dark brown in color; its end is bent downward, and its tip raised far beyond the limit of the distal end of the avicularium. The ovicells are endozooecial and barely noticeable. There are 2 pore plates with a few pores in each of the lateral and membranous walls.

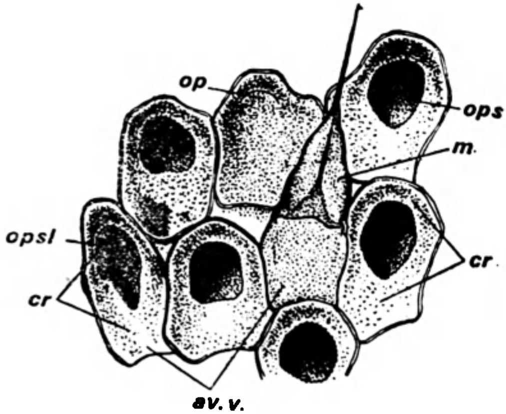


Figure 200. *Smittipora solida* (Nordgaard). Part of a zoarium with 2 avicularia (from the collection of D'Arcy Thompson).

The species lives on stones at a depth of 215 to 1,105 m.

Distribution. The species was found by me in the waters off eastern Greenland. *Reports in literature:* Atlantic Ocean, on the eastern side of Iceland (Nordgaard, 1907b), and western Greenland (Levinsen, 1914).

This is a deep-water, Atlantic-boreal species.

II. Section *COELOSTEGA* Harmer, 1926

Coelostega Levinsen, 1909 : 161; *Coelostega* Harmer, 1926 : 188.

The zooids have an aperture which occupies the entire frontal surface. A strongly developed and depressed cryptocyst, covered with pores, is located under the frontal membrane; an oblong orifice (opesiule) is located on each side of its distal part, through which the parietal muscles pass toward the frontal membrane.

Family **Microporidae** Gray, 1848

Microporidae Gray, 1848 : 115, 147; Smitt, 1873 : 13 (part.); Hincks, 1880a : 172; Levinsen, 1909 : 161.

The zoarium, either prostrate or free-growing, consists of dichotomously branched, cylindrical branches, which are segmented by chitinous articulations into internodes. The orifice of the zooid is semi-circular and covered with a chitinous operculum. Avicularia, when present, are vicariating or adventitious. Ovicells, when present, are endozooecial or peristomial.

Genus **Microporina** Levinsen, 1909

Cellularia Fabricius, 1821 : 27; *Salicornaria* Busk, 1855 : 213; *Cellaria* Smitt, 1868a : 361; *Microporina* Levinsen, 1909 : 162.

The zoaria are free-growing, branched, and jointed. The strongly developed cryptocyst is surrounded by the raised margin of the aperture. The semi-circular orifice of the zooid is located on the distal end, and covered with a strongly chitinized operculum. Avicularia are present. Ovicells are absent.

Genus type: *Cellularia articulata* Fabricius.

Microporina articulata (Fabricius, 1821) (Figure 201)

Cellularia articulata Fabricius, 1821 : 27; *Salicornaria borealis* Busk, 1855 : 254, pl. I, f. 1-3; *Cellaria borealis* Smitt, 1868a : 361, 384, t. XX, f. 17; Robertson, 1905-1906 : 287, pl. XIV, f. 86, pl. XVI, f. 102.

The zoarium is free-growing and consists of dichotomously branched, cylindrical branches which are segmented by chitinous articulations into internodes. The zooids are arranged in the internode in a checkered pattern in regular oblong rows. They have an oblong, right-angled shape which slightly broadens in the middle part. The aperture, covered with a membrane, occupies the entire frontal surface of the zooid. The margins of the aperture are raised around the deep cryptocyst, along the lateral margins, and near the proximal margin of the zooidal orifice.

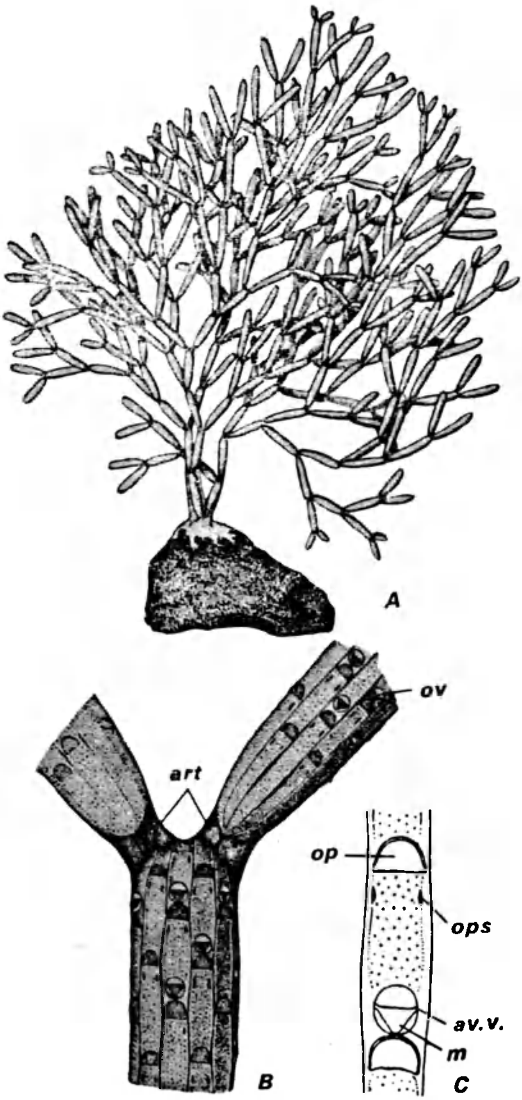


Figure 201. *Microporina articulata* (Fabricius). *A*—general view of a zoarium; *B*—part of a branch with ramification; *C*—a zooid (all sketches from Kluge, 1955b).

the surface of the cryptocyst is covered with numerous pores, and 2 longitudinal orifices (opesiules) are located on the sides of the distal part of the depressed surface. A round, vicariating avicularium with a triangular mandible is located between 2 successive zooids, and the sharp apex of its mandible is pointed downward. Ovicells are absent. There are 8 to 10 pore plates with 1 or 2 pores each in the lateral wall, and many pores along the sides of the lower half in the distal septum. A few radicular fibers originate from the proximal internodes of the zoarium.

The species lives on stones, at a depth of 6 to 400 m, on a bed of stone and silt.

Distribution. The species was found by me in the Okhotsk Sea, along the western coast of Greenland. ***Reports in literature:*** Barents Sea in the Isfjorden in Spitsbergen [Smitt (1868a) reported this species as coming from Spitsbergen, but I am deeply convinced that this is an error, probably due to incorrect labeling], northern coast of North America and the Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1929, 1932, 1936), western Greenland (Fabricius, 1780; Busk 1855; Smitt, 1868a; Hennig, 1896; Vanhöffen, 1897; Norman, 1906; Kluge, 1908b; Levinsen, 1914; Osburn, 1936), along the western coast of North America in the waters of southwestern Alaska (Robertson, 1900, 1905-1906), and the region of the Queen Charlotte Islands (Hincks, 1882).

The species is Arctic-boreal, Pacific, and spreads toward the cast up to the southwestern part of Greenland.

III. Section *CELLULARINA* Smitt, 1868

Cellularina Smitt, 1868a : 279 (part.); Harmer, 1915 : 190; Borg, 1930 : 73.

The zoaria are either free-growing or creeping and branched. The branches consist of either one layer of zooids with their frontal side directed toward one side, or 2 layers arranged in pairs and fused by their basal sides. The branches are either continuous and undivided, or segmented by chitinous articulations into internodes. The oblong zooids usually taper slightly toward the proximal end, and are calcified to a different degree in various families. The aperture varies from one-fourth to the full length of the zooid, it often has spines on the distal margin and on the sides. Heterozooids, in the form of avicularia, are found in almost all species, while in the family *Scrupocellariidae*, vibracula are found as well. The ovicells are hyperstomial and, except in the genus *Bicellariella,* located on the distal margin of the zooid; in *Bicellariella* they are attached to the inner margin of the aperture by a peduncle. Radicular tubes are found in the majority of the species, which help attach the zoaria to the substrate. This group most probably developed from single-layered, prostrate, membraniporous ancestors, and became free-growing and divided into individual branches from the margins. The heterozooids, in the form of avicularia and vibracula, have attained a high degree of development.

Key for Identification of Families of
the Section Cellularina

1 (4). Zoaria free-growing, creeping, branched, jointed, or unjointed. Branches single-layered and all zooids directed with the frontal surface to one side; or if double-layered, zooids arranged in pairs and fused by their basal sides.

2 (3). Zoaria either free-growing or creeping. Branches single-layered, unjointed, and one-, two-, or multi-rowed. Zooids mildly branched. Avicularia flexibly articulate (except in the genus *Semibugula* where they are like a bird's beak). Vibracula absent ....I. *Bicellariidae* Busk (see below).

3 (2). Zoaria free-growing and branched. Branches double-layered. Zooids arranged in pairs with their frontal surface directed in opposite directions; each successive pair is turned (bent) at an angle of 90° toward its preceding pair. Long, pedunculate avicularia present............II. *Sadkoidae* Kluge (see p. 436).

4 (1). Zoaria free-growing. Branches jointed (except for the genus *Caberea*). Branches two-rowed or two to four-rowed. Zooids strongly calcified. Avicularia sessile and immobile. Vibracula present. ....III. *Scrupocellariidae* Levinsen (see p. 440).

I. Family **Bicellariidae** Busk, 1852

Bicellariidae Busk, 1852b : 41; *Bicellarieae* Smitt, 1868a : 288; *Bicellariidae* Hincks, 1880a : 64.

The zoaria are free-growing or creeping, and branched. Branches are single-layered and consist of one, two, or many rows of zooids. The zooids are more or less soft and not very strongly calcified. The aperture occupies from one-third to almost the entire frontal surface. The operculum is slightly detached from the frontal membrane of the aperture. One or several spines are located on the margin of the aperture. Avicularia may be present or absent. In most species, the avicularia are in the form of a mobile, attached bird's head; only in the genus *Semibugula* is it angular and immobile. The ovicells are hyperstomial, round, or semi-circular, with an open or closed orifice; in many species, they have an incompletely calcified ectooecium, and the calcareous, frontal surface of the endooecium has a radial pattern. Radicular tubes develop in many species.

Key for Identification of the Genera of the Family Bicellariidae

1 (2). Zoaria minute; thin branches, consisting of one row of oblong zooids, dichotomously branch and separate from the very base of the zooids at an angle. Avicularia short, and semicircular. Ovicells present...6. *Corynoporella* Hincks (see p. 432).

2 (1). Zoaria large; branches consist of 2, rarely 1, and more rows of large zooids; after bifurcation daughter zooids more or less closely adjoin each other, starting from the base of the zooids up to a certain length, after which they diverge at a sharp angle; sometimes single-rowed branches are interspersed with the two-rowed ones. Avicularia large and oblong. Ovicells present.

3 (14). Zoaria consist of two rowed-branches.

4 (5). Branches connected with each other by a membrane, either form free-growing, hollow, cylindrical tubes in certain places, or transform into a hollow, cylindrical stem at the proximal end...................3. *Kinetoskias* Danielssen (see p. 418).

5 (4). Branches not connected by any membrane, but independent throughout their length.

6 (9). Zooids consist of a distal, broadened part, and a proximal, more or less long, narrow, cylindrical part.

7 (8). Zooids seem divided into 2 parts by a transverse interception—a narrow, cylindrical, proximal part, and a broad, distal one. There are many thin, long, bent spines on the distal margin.................4. *Bicellariella* Levinsen (see p. 429).

8 (7). Zooids not divided by a transverse interception. There are 1 to 2 bent spines at the outer distal corner.................. ....5. *Bicellarina* Levinsen (see p. 431).

9 (6). Zooids oblong, with a stretched rectangular or oval aperture; the proximal part is usually narrow, but does not stretch out into a long, narrow, cylinder.

10 (11). Zooids small and oblong, with a basal, fork-like, branched, proximal end, which encloses the distal end of the preceding zooid like a saddle; the stalk of attachment of the avicularium is almost perpendicular to its length..................... ....2. *Bugula* Oken (part.) (see p. 408).

11 (10). Zooids large and oblong, with proximal end unbifurcated, have

a margin that is straight or slightly bent on the basal side.

12 (13). Avicularia mobile, located on a short stem, separate from the very proximal part in the direction of their length.......... ....1. *Dendrobeania* Levinsen (part.) (see below).

13 (12). Avicularia sessile, lateral, usually located under a distal, outer, angular, unjointed, sharps pine.................. ....7. *Semibugula* Kluge (see p. 434).

14 (3). Zoaria consist of multi-rowed branches (from 3 to 24 rows of zooids to a branch); zooids oblong.

15 (16). Zooids bifurcated on the proximal side. Avicularia absent, or if present, very minute............................ ....2. *Bugula* Oken (part) (see p. 408).

16 (15). Zooids, proximal end unbifurcated, have a straight margin on the basal side. Avicularia present and large................ ....1. *Dendrobeania* Levinsen (part.) (see below).

1. Genus **Dendrobeania** Levinsen, 1909

Dendrobeania Levinsen, 1909 : 99; *Bugula* auctt. (part.).

The zoaria are free-growing, large, and dichotomously branched. The branches consist of 2 or a larger number of zooidal rows (sometimes 1 row, with 2 rows of zooids place intermittently, *cf.: D. fruticosa* var. *frigida* Waters). The zooids are large, thick, and oblong; the aperture occupies a considerable portion of the frontal surface. There is 1 spine on the distal margin of the aperture on the outer corner only, or 1 on each corner; spines are either not present, or present in varying numbers on the lateral margins of the aperture. The proximal end of the zooid is usually tubular, and its margin on the basal side is almost straight with no broadening or bifurcation. The distal part of the basal side of the zooid is covered with a strongly calcified layer, which continues in the distal direction in the form of a short tube that surrounds the base of the distal zooid. The distal septum has 1 large pore plate with many pores. Avicularia may be present or absent; in the majority of the species they are mobile, and the stalk of their attachment originates from the very proximal part, either in the direction of their length or almost perpendicular to it. The marginal and middle avicularia are distinct: the former are located on the zooids of the marginal row of branches, the latter on the zooids of the middle row of branches. Both may be in 1 row, differing only in size, or they may be in 2 rows, differing not only in size, but in shape as well. The ovicells are hyperstomial, and have an incompletely calcified outer layer; the calcareous frontal surface of the inner layer has a clear radial pattern, starting from the middle of the proximal margin.

The radicular fibers usually start from the second pore plate of the marginal zooids.

Genus type: *Flustra murrayana* (Bean, *mss.*) Johnston, 1847.

1 (2). Avicularia absent. Zoids long, with a small spinule on each distal corner........................7. *D. murmanica* (Kluge).

2 (1). Avicularia present.

3 (6). Branches consist of 1 to 2 rows of zooids. The 2 rows differ in size and shape.

4 (5). Branches are single-rowed; in some places, branching two-rowed with 1, rarely 2, spines in the corners..3b. *D. fruticosa* var. *frigida* Waters.

5 (4). Branches two-rowed; sometimes a new branch starts with 1 or 2 single-rowed zooids; usually there are 2 spines on each of the distal corners of the zooid..3a. *D. fruticosa* var. *quadridentata* Loven.

6 (3). Branches consist of 3 and more (up to 24) rows of zooids. Zooids large, oblong, and with spines; avicularia either of 1 genus, differing only in size, or of 2 genera, differing in size as well as shape.

7 (14). Avicularia of 1 or 2 types; in the latter case, the marginal differ from the central avicularia in size, but not in shape.

8 (9). Only marginal zooids have 1 spine on each of the outer distal corners; other zooids devoid of spines..6. *D. flustroides* (Levinsen).

9 (8). All zooids have spines.

10 (11). Marginal zooids have more than 2 spines (from 4 to 7) on the outer lateral margin of the aperture..1. *D. murrayana* (Johnston).

11 (10). Marginal zooids have no more than 2 spines on the outer, lateral margin of the aperture.

12 (13). Aperture of the marginal zooids occupies a large part of the frontal surface; gymnocysts poorly developed. Avicularia attached to one of the lateral margins on the proximal part of the zooid..........................4. *D. levinseni* (Kluge).

13 (12). Aperture of marginal zooids occupies from one-half to two-thirds of the frontal surface; gymnocysts well-developed. Avicularia attached to the frontal surface of the gymnocysts..............................5. *D. pseudolevinseni* Kluge.

14 (7). Avicularia of 2 types: marginal and central, which differ not only in size but in shape as well.

15 (20). Marginal zooids have one spine on the outer distal corner, under which more than one spine are located along the

lateral margin of the aperture.

16 (19). Marginal zooids have many (from 5 to 10) well-developed spines along the outer lateral margin of the aperture.

17 (18). Marginal zooids have 4 to 6 marginal spines along the outer margin of the aperture, which are directed upward and slightly bend toward the middle of the aperture .... 2. *D. pseudomurrayana* Kluge.

18 (17). Marginal zooids have 6 to 10 thin spines along the outer margin of the aperture, which are directed upward and bend more toward the base of the aperture .... 2a. *D. pseudomurrayana* var. *tenuis* Kluge.

19 (16). Marginal zooids have 2 to 3 poorly developed spines along the outer margin of the aperture, which become sharper toward the end, and strongly tilt toward the frontal surface .... 2b. *D. pseudomurrayana* var. *fessa* Kluge.

20 (15). Marginal zooids have a small spine in the outer distal corner, under which is located a weaker spine .... 3. *D. fruticosa* (Packard).

1. **Dendrobeania murrayana** (Johnston, 1847) (Figure 202)

Flustra murrayana Johnston, 1847 : 347, pl. LXIII, f. 5-6; *Bugula murrayana* Busk, 1852b : 46, pl. 59; Robertson, 1905-1906 : 266, pl. X, f. 48, pl. XVI, f. 98-99; Marcus, 1940 : 191 (part.), f. 100c; non *Bugula murrayana* Levinsen, 1887 : 310; *Dendrobeania orientalis* Kluge, 1952 : 144, fig. 2.

The zoaria consist of dichotomously branched, more or less short, broad, ribbon-like, spreading branches, which usually widen toward the distal end. The branches consist of 5 to 24 rather short, broad zooids (length 0.88 to 1.38 mm, width 0.28 to 0.38 mm). The aperture occupies from one-half to two-thirds of the length of the frontal surface in the marginal zooids, and about three-fourths of the length of the middle ones. The aperture is oval and broad, and has a thick margin. One spine is usually located on each of the distal corners, and points forward; the spine located in the outer distal corner of the marginal zooids is distinguished by a greater size and strength. In addition to these spines, there are a varying number of spines in the lateral margins of the aperture, usually in the distal half, which are directed upward and tilted toward the aperture; in the marginal zooids, there are 4 to 7 spines along the outer margin, 2 to 3 along the inner margin, and 2 to 4 on each side of the middle zooids.

Except for the marginal ones, all the middle zooids usually have a mobile, frontal avicularium, which is attached to the gymnocyst by a short

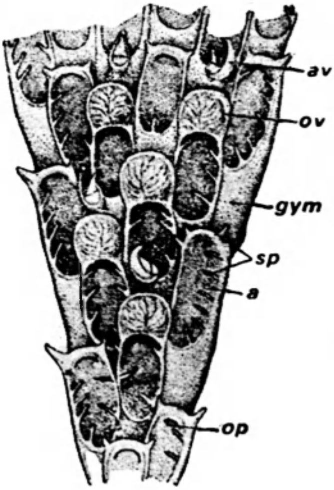


Figure 202. *Dendrobeania murrayana* (Johnston). Part of a zoarial branch. Barents Sea.

stalk, directly under the middle part of the proximal margin of the aperture, that is usually directed forward and to one side, with the mandibular side pointing upward, and the basal side pointing toward the aperture. Its height is almost 2 times less than its length (length 0.38 mm, height 0.18 mm), but the basal side is convex with no depression at the point of the transformation of the avicularian chamber into the maxilla, which is sharply bent and terminates in a long, pointed beak. The distal septum of the zooid is bent; its lower part is raised upward, and the upper part is slanted upward and forward. Its lateral and basal margins are strongly calcified; there is 1 pore plate with many (up to 20) pores located in the lower, triangular half. The lateral wall has 4 pore plates with 5 to 6 pores.

The ovicells are round; their outer layer is calcified on the sides and in the distal part; the frontal, calcareous wall of the inner layer has a radial pattern. Radicular tubes originate from the lateral wall of the distal part of the zooid in the proximal half.

The species lives on hydroids, Bryozoa, and shells, at a depth of 9 to 320 m, often from 50 to 200 m, on a bed of stone, shell, and silt, under temperatures ranging from −0.47 to 3°C, in the White Sea up to 10°C, in a salt concentration of 32.39 to 32.84‰.

Distribution. The species was located by me in the southeastern part of the Barents Sea, and in the Chukotsk and Bearing seas. *Reports in literature:* Barents Sea (Smitt, 1868a; Bidenkap, 1900a), White Sea (Gostilovskaya, 1957), Kara Sea (Levinsen, 1887), southern coast of Alaska (Robertson, 1900, 1905-1906), western Greenland (Levinsen, 1914), Finmark and Boguslen (Smitt, 1868a), German Sea (Kirchenpauer, 1875), and Great Britain (Busk, 1852b).

This is an Arctic-boreal species.

2. **Dendrobeania pseudomurrayana** Kluge, 1955 (Figure 203)

Dendrobeania pseudomurrayana Kluge, 1955a : 83, fig. 27 (1); *Bugula murrayana* forma *I*; *B. murrayana* s. s., *multispinosa* Smitt, 1868a : 291 (part.).

The free-growing zoaria consist of broad, dichotomously divided branches. The branches consist of 3 to 20, and more, rows of large zooids, whose tips are truncated. The zooids, arranged alternately in adjoining rows, are more or less large (length 1.25 mm, width 0.38 mm), broaden slightly in the distal part, and taper gently in the proximal. The aperture occupies about two-thirds of the frontal surface in the marginal zooids, and two-thirds to three-fourths in the central ones. The aperture is oval and its margin thickened. A strong, mildly conical spine is located in each distal corner, and directed toward the front and slightly upward. In addition to these spines, there are long, thick ones located along the margins of the aperture on both sides, which are directed upward and slightly toward the middle. Their number varies, but generally they total 8 to 10—5 to 6 on the outer margin, and 3 to 4 along the inner one. The avicularia are of 2 types—middle (central) and marginal. The former (length 0.38 mm, height 0.18 mm) are located on the frontal surface of the gymnocyst in the middle (central) zooids, and attached to it with a long, thin, tubular stalk directly under the proximal margin of the aperture; their mandibles are usually pointed upward and slightly to one side. For the most part, these avicularia are asymmetrical; the side tilted toward the frontal surface is slightly concave, while the opposite one is more convex. Due to a moderately raised avicularian chamber, the basal side is gradually transformed into the maxilla, the beak of which is bent at a right angle at the tip. The marginal avicularia (length 0.50 mm, height 0.33 mm), likewise mobile and articulate, are attached to the gymnocyst of the marginal zooids with a very short tube, at the border of the frontal and lateral surfaces, slightly below the proximal margin of the aperture. These avicularia are significantly larger than the central ones; they also differ in shape by their symmetrical structure, greater thickness, and a more raised avicularian chamber; as a result of the latter, the basal side, at the point of the transformation of the avicularian chamber into the maxilla, has a steeper slope and a little larger depression. The ovicells are large, roundish, and slightly broadened in the middle; the calcareous frontal surface of the inner layer is covered

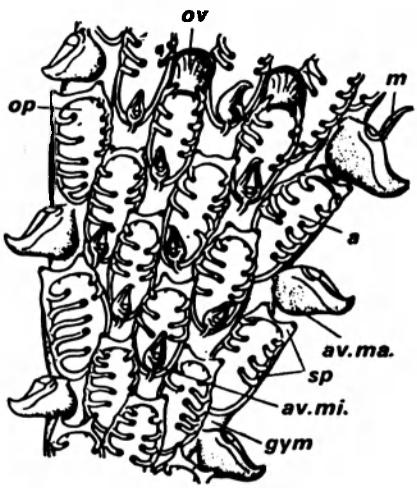


Figure 203. *Dendrobeania pseudomurrayana* Kluge. Part of a branch of a zoarium (from Kluge, 1955a).

with a radial pattern.

The radicular fibers are thick and start from one side of the distal part of the lateral margins in the proximal part of the zoarium. The branching is of the second type. The distal septum is bent, its lower part raised upward, and the upper part placed obliquely. Its upper and basal margins are strongly calcified; the lower, tunnel-shaped half has one pore plate with several pores. There are 4 pore plates with 4, 5, or 6 pores each in the lateral wall.

The species lives on hydroids, Bryozoa, shells, and stones, at a depth of 9 to 288 m, more often at 50 to 150 m, on a bed of stones, shells, and silt, under temperatures ranging from —1.61 to 3°C, in a salt concentration of 34.07 to 34.96‰.

Distribution. This species was found by me in the Barents Sea, Kara Gates, and Chukotsk Sea, as well as in Baffin Bay and eastern Greenland. *Reports in literature:* Barents Sea (M. Sars, 1851; Danielssen, 1861; Smitt, 1868a, 1879b; Nordgaard, 1896, 1900, 1907a, 1918; Bidenkap, 1900a; Waters, 1900; Andersson, 1902; Kluge in Deryugin, 1915), ?Chukotsk Sea (Osburn, 1923); Archipelago of the Canadian Islands (Nordgaard, 1906a), western Greenland (Smitt, 1868c), eastern Greenland (Andersson, 1902; Nordgaard, 1907a), and northwestern Norway (Nordgaard, 1918).

This is an Arctic-boreal species.

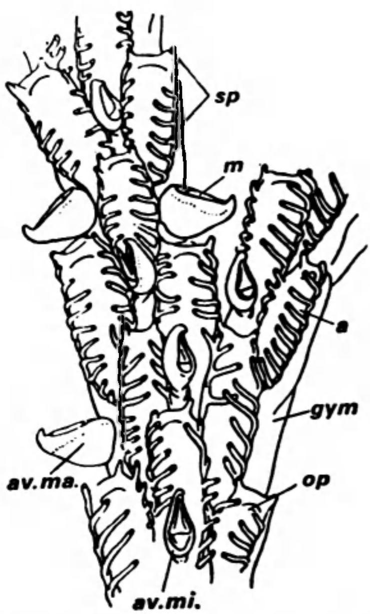


Figure 204. *Dendrobeania pseudomurrayana* var. *tenuis* Kluge. Part of a zoarium (from Kluge, 1955a).

2a. **Dendrobeania pseudomurrayana** var. **tenuis** Kluge, 1955 (Figure 204)

Dendrobeania pseudomurrayana var. *tenuis* Kluge, 1955a : 85, fig. 27 (2).

The zoaria, compared to those of *D. pseudomurrayana typica,* are distinguished by a smaller size and narrower branches. The zooids are thinner and narrower (length 1.12, width 0.30 mm). The aperture occupies from one-half to one-third of the frontal surface; many thin spines are arranged along its lateral margins, which bend toward the middle part. Their number fluctuates from 12 to 18—from 7 to 10 along the outer margin of the marginal and adjoining rows of middle zooids, and from 5 to 8 along the inner margin. Major distinguishing characteristic of this species is presented by the avicularia: in the middle, frontal, and marginal ones, the basal side is distinct in that there is an almost total absence of a depression in the place of the transformation of the avicularian chamber into the maxilla, i.e., it appears almost straight.

The dimensions of the middle avicularia (length 0.38 mm, height 0.18, thickness 0.15 mm), especially of the marginal ones (length 0.45, height 0.25, thickness 0.20), are correspondingly smaller than those of *D. pseudomurrayana typica.* The ovicells are hyperstomial, small, and round, and have an incompletely calcified outer layer.

The species lives on hydroids, Bryozoa, and shells, at a depth of 50 to 180 m, under temperatures ranging from below zero up to −1.61°C.

Distribution. This form was found by me in the Barents Sea, in Kola Bay, and near Franz Josef Land.

This is an Arctic species.

2b. **Dendrobeania pseudomurrayana** var. **fessa** Kluge, 1955 (Figure 205)

Dendrobeania pseudomurrayana var. *fessa* Kluge, 1955a : 85, fig. 27 (3); *Bugula murrayana* forma *I* : *B. murrayana* s. s., *multispinosa* Smitt, 1868a : 291 (part.), t. 18, f. 19-20; *B. murrayana* Hincks, 1880a : 92, pl. 14, f. 2, 4; Osburn, 1912 : 226, pl. 22.

The zoaria are free-growing, and consist of dichotomously divided, more or less broad, branches. The branches consist of 4 to 12 rows of oblong zooids (length 1.10 to 1.25 mm, width 0.38 mm), which are truncated at the distal margin and narrow in the proximal part. The aperture occupies about two-thirds to three-fourths of the frontal surface. In addition to the 2 small spines at the distal margin of the aperture, there are a small number, usually not more than 5 to 6, of weakly developed, thin spines that sharpen toward the tips, and strongly tilt toward the frontal surface from the lateral margins of the aperture. The avicularia are of 2 types—middle (central) and margi-

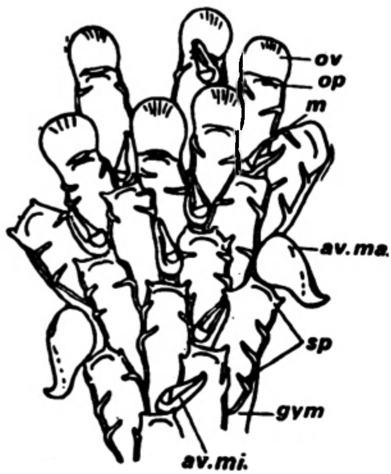


Figure 205. *Dendrobeania pseudomurrayana* var. *fessa* Kluge. Distal part of a branch of a zoarium, from the frontal side (from Kluge, 1955a).

nal. Unlike those in *D. pseudomurrayana typica,* the middle avicularia of this species (length 0.40 mm, height 0.20 mm) are attached with a short, thick, usually calcified stalk; consequently, these avicularia have little mobility and, being directed upward by their mandibles, appear closely pressed by their basal side to the frontal surface of the zooid. As a consequence of this, the convex, basal side is not well-formed, nor prominent, in the avicularian chamber, from which it rises almost straight, but forms a rather strong, backward bend in the place of transformation into the maxilla. Compared to those of *D. pseudomurrayana typica,* the marginal avicularia (length 0.60 mm, height 0.30 mm), are characterized by a larger size; the avicularian chamber is thicker in the proximal part, and the basal side is more convex, making the transformation into the maxilla more abrupt; the maxilla is relatively longer, more sharply bent, and terminates in a longer, sharp beak. All the other characters are the same as those in *D. pseudomurrayana typica.*

This species is more widely distributed than *typica,* and lives on hydroids, Bryozoa, shells, etc., at a depth ranging from 3 to 320 m, under temperatures varying from −1.9 to 3.5°C, in a salt concentration of 34.07 to 34.83‰.

Distribution. This species was found by me in the Barents, Kara, and Chukotsk seas, and in Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1868a; Vigelius, 1881-82; Kuznetsov and Matveeva, 1948), White Sea (Gostilovskaya, 1957), western Greenland (Smitt, 1868c; Vanhöffen, 1897; Levinsen, 1914), Labrador (Osburn, 1913), Island of Man and Woods Hole (Osburn, 1912, 1933), eastern Greenland (Andersson, 1902), Iceland (Smitt, 1868a), Great Britain (Hincks, 1880a), German Sea (Ortmann, 1894), and northern Norway (Nordgaard, 1918).

This is an Arctic-boreal species.

3. **Dendrobeania fruticosa** (Packard, 1863) (Figure 206)

Menipea fruticosa Packard, 1863 : 409, pl. I, f. 3; *Bugula murrayana* var. *a* Hincks, 1880a : 93, pl. 14, f. 3.

The zoarium is free-growing, and consists of dichotomously divided, more or less long, narrow branches. The branches consist of 3 to 4 rows of oblong zooids (length 0.75 to 1.00 mm, width 0.30 mm). The aperture occupies from one-half to two-thirds the length of the zooid. Usually a small unjointed spine, directed forward, is located at the distal, outer corner of the marginal zooids. Rarely, a second, weaker spine develops underneath the first. Two spines are located one after the other on both distal corners of the middle zooids. The avicularia are of 2 types—middle and marginal. Both are smaller than those in *D. pseudomurrayana*

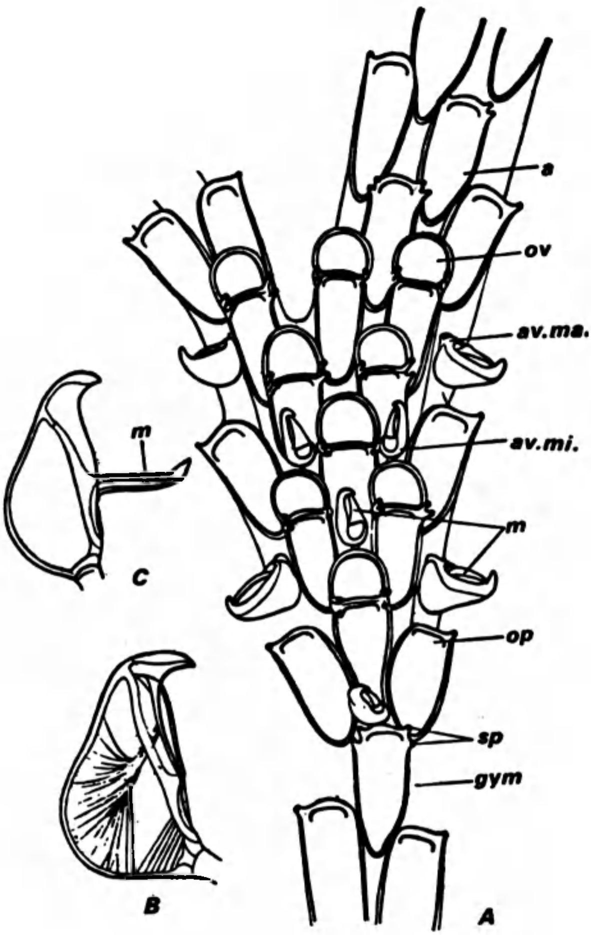


Figure 206. *Dendrobeania fruticosa* (Packard). *A*—part of a zoarial branch; *B*—marginal avicularium from the side; *C*—middle avicularium from the side. Barents Sea.

Kluge. On the basis of shape, the middle avicularia (length 0.42 mm, height 0.20 mm) are closer to those of *D. pseudomurrayana* forma *tenuis* Kluge. The marginal avicularia (length 0.50 mm, height 0.30 mm) differ markedly from those in *D. pseudomurrayana* Kluge by their shortened length, due to the replacement of the short, tubular stalk, by their attachment nearer to the proximal margin of the surface which follows after the mandible, and corresponds to a part of the aperture of the zooid, by a greater projection in the proximal direction which causes a weak depression at the place of transformation of the basal side of the avicularian chamber into the maxilla, and lastly, by a strong development of the distal end of the maxilla, which is bent at a right angle like a hook. A typical feature of these avicularia is that the angle formed by their basal and proximal sides is much more acute than that in *D. pseudomurrayana* Kluge. The ovicells are hyperstomial, semi-circular, and raised; their outer layer is incompletely calcified, and their inner layer has a smooth, calcareous surface.

The species lives on hydroids, Bryozoa, shells, and stones, at a depth of 1.5 to 330 m, on a bed of stone, shell, and silt, under temperatures varying from -1.9 to 3.7°C, in a salt concentration of 31.44 to 34.78‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, and Chukotsk seas, and the Bering and Davis Straits, as well as off eastern Greenland. *Reports in literature:* Barents Sea (Smitt, 1868a, 1879a; Ridley, 1881; Nordgaard, 1896, 1900, 1907a; Bidenkap, 1897, 1900a; Waters, 1900; Andersson, 1902; Norman, 1903a; Kluge, 1906; Kuznetsov, 1941), White Sea (Kluge, 1907, 1908a; Kluge in Deryugin, 1928; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Nordgaard, 1912b; Kluge, 1929), northern coast of North America and the Archipelago of the Canadian Islands (Busk, 1880; Nordgaard, 1906a; Osburn, 1923, 1932, 1936), Labrador (Packard, 1863; Osburn, 1913), Gulf of St. Lawrence (Whiteaves, 1901), western Greenland (Norman, 1876; Hincks, 1877a; Hennig, 1896; Vanhöffen, 1897; Kluge, 1908b; Osburn, 1919), eastern Greenland (Andersson, 1902), Yan-Maien Island (Lorenz, 1886), Iceland (Smitt, 1868a), western Norway (Smitt, 1868a; Nordgaard, 1918), German Sea (Ortmann, 1894), Great Britain (Hincks, 1880a), and the Island of Man (Osburn, 1933).

This is an Arctic-boreal species.

3a **Dendrobeania fruticosa** var. **quadridentata** (Loven, 1834) (Figure 207)

Cellularia quadridentata Loven, 1834 (*mss.*); *Bugula Murrayana* forma *I* : *B. quadridentata* Smitt, 1868a : 292 (part.).

The zoaria usually consist of double-rowed branches, but sometimes small, single-rowed branches are also found. The zooids (length 1.00 to 1.15 mm, width 0.28 mm) are comparatively small; they broaden in the region of the aperture, and narrow toward the proximal end. The aperture occupies two-thirds or more of the frontal surface. Usually 2 spines point forward and upward from each of the distal corners, but sometimes there is only 1 spine in the inner corner. The avicularia are of 2 types—middle and marginal. In shape and location they are close to *D. fruticosa,* but in size they are slightly smaller (length of the marginal

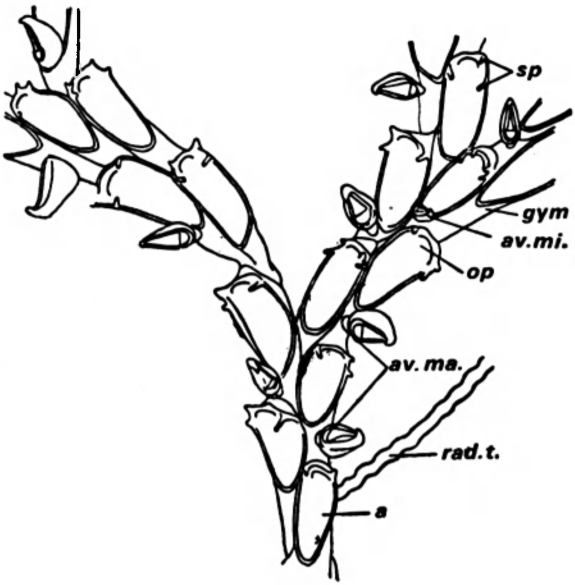


Figure 207. *Dendrobeania fruticosa* var. *quadridentata* (Loven). Part of a zoarium with a radicular tube.

avicularia 0.40 mm, width 0.23 mm). The ovicells are similar to those in *D. fruticosa.* Thick, radicular tubes, with a clearly formed interception (graduation), originate from the lateral surface of the distal part of the zooid. There are 2 pore plates with a few pores in the lateral wall, and 1 pore plate with 6 to 10 pores in the distal septum.

The species lives on hydroids, Bryozoa, ascidia, and shells, at a depth of 14.5 to 329 m, often from 50 to 150 m, on a bed of stone, shell, and silt, under temperatures ranging from −1.9 to 3.2°C in a salt concentration of 34.13 to 34.53‰.

Distribution. This species was found by me in the Barents, Kara, Laptev, Bering, and Okhotsk seas, and in the waters off Labrador, western Greenland, and the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1879b; Bidenkap, 1897; Nordgaard, 1900; Kuznetsov, 1941), ?Archipelago of the Canadian Islands and Hudson Bay (Osburn, 1923, 1932), western Greenland (Smitt, 1868c; Kluge, 1908b; Levinsen, 1914) eastern Greenland (Andersson, 1902), and Boguslen (Loven, 1834).

This is an Arctic species.

3b. **Dendrobeania fruticosa** var. **frigida** (Waters, 1900) (Figure 208)

Brettia frigida Waters, 1900 : 51, pl. 7, f. 1-3; *Bugula murrayana* forma *II*: *B. quadridentata* Smitt, 1868a : 292 (part.), t. 18, f. 27.

The zoaria usually consist of single-rowed branches, but at some places, prior to bifurcation, double-rowed branches are also found. Ramification takes place after 2 or 3 zooids. The first 2 zooids, forming new branches, usually do not separate at an angle in the base, but stretch and closely adjoin each other for a certain distance, after which they separate. Since these 2 zooids originate from the dorsal side of the preceding zooid, one below the other, their distal, terminal parts are also not on one level. The zooids are comparatively large (length 1.00 to 1.40 mm, width 0.30 mm), long, and slightly tapered in the proximal part. The aperture, narrowing toward the proximal end, is surrounded by a thick margin, and occupies half or more of the length of the zooid. There

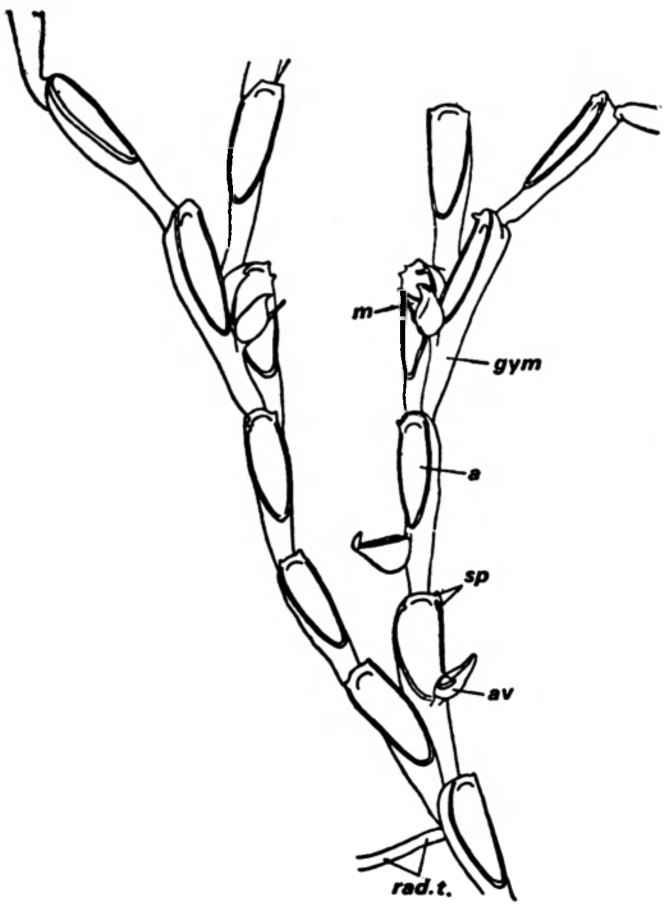


Figure 208. *Dendrobeania fruticosa* var. *frigida* (Waters). Part of a zoarium. Barents Sea.

is usually 1 weakly developed, angular spinule on each of the distal corners of the zooids; sometimes 2 weakly developed spinules appear one below the other in the outer, distal angles; rarely, these angles, or one of them, are mildly rounded. The avicularia are of 2 types—middle and marginal. In shape, both avicularia are close to those of *D. fruticosa,* except that in the marginal ones, the avicularian chamber is not so strongly extended in the proximal direction and, therefore, the corner formed by the basal and proximal sides is less acute than in *D. fruticosa.* Both types of avicularia are found in some zoaria, in which case the middle ones are located in the frontal side, under the proximal margin of the aperture, and the marginal ones, on the border between the frontal and lateral sides, slightly away from the proximal margin of the aperture; in other zoaria, only marginal avicularia are found. The ovicells are small and round, and have a radial pattern on the calcareous, frontal surface of the endooecium. There are 2 pore plates with 3 to 4 pores in the lateral wall, and 1 pore plate with 5 to 7 pores in the distal septum. The radicular fibers, shorter at different places on the lateral side of the distal part of the zooid, move into the sides and attach to the substrate, or to the neighboring branches of the zoarium.

The species lives on hydroids, Bryozoa, and shells, at a depth of 15 to 235 m, often from 100 to 150 m, on a bed of stone and shell, under temperatures ranging from −1.7 to 0.82°C, in a salt concentration of 34.07‰.

Distribution. The species was found by me in the Barents Sea near Spitsbergen and Franz Josef Land. *Reports in literature:* Barents Sea (Smitt, 1868a; Waters, 1900: Nordgaard, 1907a).

This is a high-Arctic species.

4. **Dendrobeania levinseni** (Kluge, 1929) (Figure 209)

Bugula levinseni Kluge, 1929 : 6; *B. murrayana* var. Levinsen, 1887 : 311, t. 26, f. 3-4.

The zoaria are free-growing and consist of dichotomously divided, ribbon-shaped branches. The branches consist of 6 to 22 longitudinal rows of oblong, rectangular zooids (length 0.90 to 1.30 mm, width 0.33 mm), arranged in such a regular manner that they form straight parallel rows which cross each other. The aperture occupies almost the entire frontal surface, leaving only a small, proximal part in the form of a gymnocyst. Two upwardly pointed spines are located near each of the distal corners, the lower of which develops more strongly. The avicularium (length 0.33 to 0.40 mm, height 0.15 to 0.20 mm) is attached to one of the lateral margins and the surface of the zoarium; but in marginal zooids, it is always attached to the inner margin of the most proximal part of the zooid, and the zoarial surface, by a thin, mobile

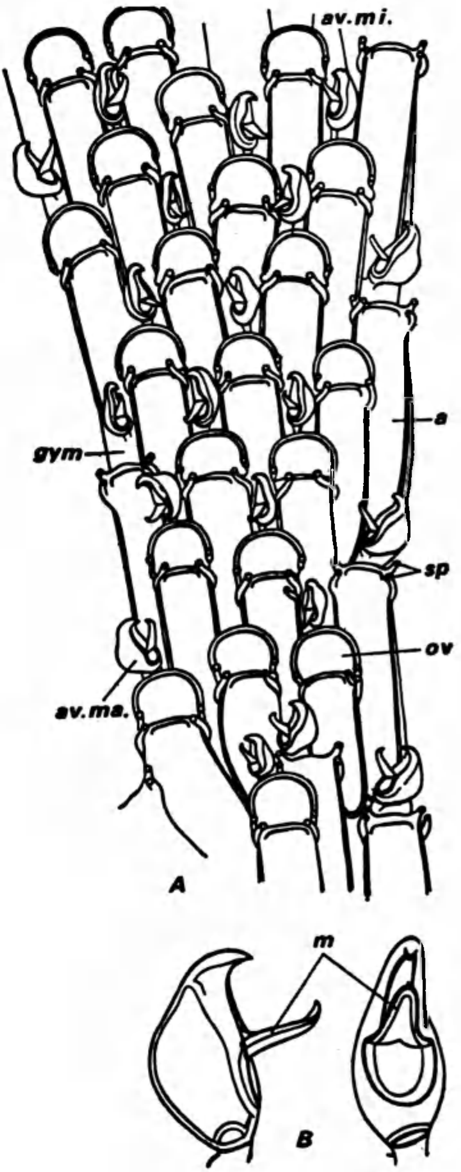


Figure 209. *Dendrobeania levinseni* (Kluge). *A*—part of a zoarium; *B*—middle avicularium, lateral and frontal views. Barents Sea.

stem, to one of the adjoining, lateral sides. The avicularium has an asymmetrical structure: the side adjoining the frontal surface of the zooid is slightly concave, while the side pointing outward is convex; its height is equal to half its length; the basal side is convex with a very small depression at the point where the avicularian chamber is transformed into the maxilla; the sharply bent rostrum has a sharp tip, and the mandible, a sharp, hook-like, bent tip. The ovicells are round and broad; the outer layer is calcified on the sides and the distal side; the frontal, calcareous wall of the inner layer is covered with a radial pattern on the proximal margin. There are 4 pore plates with 2 to 3 pores on the lateral wall, and 1 pore plate with 8 to 10 pores in the distal septum, 4 to 5 of these pores being arranged on each side of the broad, vertical, calcareous strip which divides them.

Thick, radicular fibers start from the lateral side of the distal part of the marginal zooids, and stretching in the proximal part of the zoarium along the basal side, form a thick bundle which helps attach the zoarium to the substrate.

The species lives on shells and stones, at a depth of 14.5 to 142 m, under temperatures ranging from −1.82 to 4.78°C, in a salt concentration of 29.96 to 33.32 ‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, and Bering seas. *Reports in literature:* Barents Sea (Kluge, 1929), Kara Sea (Levinsen, 1887), Laptev, East Siberian, and Chukotsk seas (Kluge, 1929).

This is an Arctic, Pacific species.

5. **Dendrobeania pseudolevinseni** Kluge, 1952 (Figure 210)

Dendrobeania pseudolevinseni Kluge, 1952 : 145, fig. 3; 1955a : 86, fig. 28.

The free-growing zoaria consist of dichotomously divided, narrow, ribbon-shaped branches. The branches consist of 3 to 14 longitudinal rows of long, narrow zooids (length 1.00 to 1.25 mm, width 0.25 to 0.30 mm). The aperture in the marginal zooids occupies from one-half to two-thirds of the frontal surface, but in the middle zooids, from four-fifths to five-sixths; the remaining frontal surface is a gymnocyst. The margin of the aperture is thick. There is 1 spine in each of the distal corners of the marginal zooids, the outer one being more developed and pointed forward; there are 2, sometimes even 3, small spines pointing upward in the middle zooids. All the zooids, marginal and middle, have 1 mobile, frontal avicularium, which is attached to the frontal surface of the gymnocyst by a small stalk, near the middle of the proximal margin of the aperture in the middle zooids, and almost in the middle between the lateral and distal margins of the underlying zooid in the marginal ones. As in *D. levinseni* (Kluge), this avicularium is asymmetrical, but its shape is closer to that of the avicularium of *D. murrayana* (Johnston). The marginal avicularia are larger than the middle ones (length of the marginal, 0.45 mm; the middle, 0.37 mm), but larger avicularia are also often found among the latter. The ovicells are large; the outer layer is calcified on the sides and on the distal side, and the calcareous, frontal surface of the inner layer is covered with a radial pattern. Radicular fibers originate from the lower pore plate of the outer lateral side, in the distal part of the

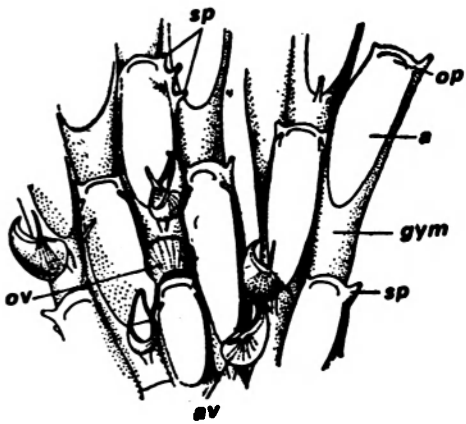


Figure 210. *Dendrobeania pseudolevinseni* Kluge. A small part of the ramified branch of a zoarium (from Kluge, 1952).

marginal zooids, in the proximal part of the zoarium.

The distal septum has a pore plate with many pores, and is similar to that in *D. murrayana* (Johnston) and *D. pseudomurrayana* Kluge; there are 4 pore plates with a few pores in the lateral wall.

The species lives on hydroids and shells, at a depth of 50 to 53 m, on a bed of sand and shells, under temperatures ranging from 0.63 to 4.78°C, in a salt concentration of 31.80 to 32.38‰.

Distribution. The species was found by me in the southern part of the Chukotsk Sea.

6. **Dendrobeania flustroides** (Levinsen, 1887) (Figure 211)

Bugula murrayana var. *A.* (*flustroides*) Levinsen, 1887 : 311, t. 26, f. 5; *Dendrobeania flustroides* Kluge, 1955b : 104, t. XXII, fig. 6.

The zoaria consist of more or less long, ribbon-like, dichotomously divided branches. The branches consist of 10 to 24 longitudinal rows of stretched-out, hexagonal zooids with a roundish, distal margin, which have their maximum width in the middle (length 1.40 mm, width 0.35 mm). The marginal zooids have an unjointed spine on the outer, distal corner which points forward; all the other zooids are devoid of spines. The aperture occupies the entire frontal surface, and the zooids are devoid of a gymnocyst; as a result, they appear, at first glance, to resemble *Flustra*. A comparatively short but thick avicularium is attached near one of the lateral margins of the most proximal part of the zooid, by a very short and broad stem (stalk), and the avicularium's long axis

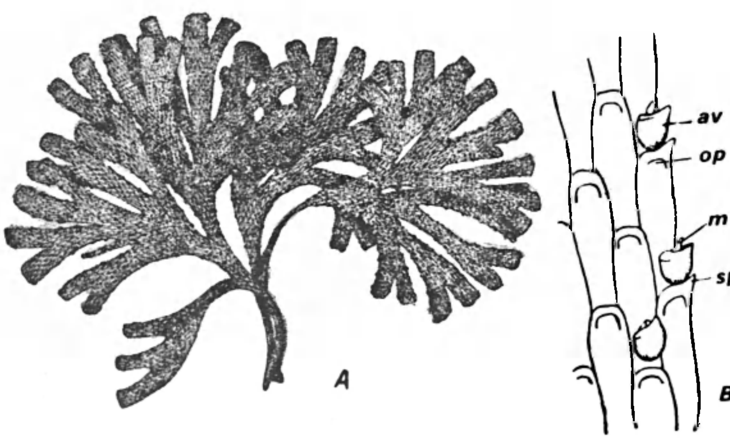


Figure 211. *Dendrobeania flustroides* (Levinsen). *A*—general view of a zoarium in natural size; *B*—a group of zooids, with and without avicularia (from Kluge, 1955b).

is perpendicular to the plane of the zoarium, i.e., it appears to stand erect. The height of the avicularium is a little less than its length (length 0.45 mm, height 0.35 mm, thickness 0.25 mm); its basal side is convex, and the avicularian chamber stretches backward slightly to the occiput; the upwardly directed rostrum is sharply bent and pointed. The ovicells are hyperstomial and round; their outer layer is incompletely calcified, and a radial pattern appears on the frontal surface of the inner layer.

There are 4 pore plates with 2 to 3 pores each in the lateral wall, and 1 large pore plate with several (up to 20) pores in the lower, vertical half of the distal septum. Thick, radicular fibers start from the lateral side of the distal part of the marginal zooids, in the proximal half of the zoarium.

The species lives on the shells of bivalved mollusks, acorn barnacles (*Balanus* sp.), and stones, at a depth of 7.2 to 70 m, under temperatures ranging from 1.7 to 3.2°C, in a salt concentration of 31.83‰.

Distribution. The species was found by me in the Kara, Chukotsk, Bering, and Okhotsk seas *Reports in literature:* Kara Sea (Levinsen, 1887), and the Chukotsk Sea (Kluge, 1929).

This is an Arctic-boreal, Pacific species.

7. **Dendrobeania murmanica** (Kluge, 1915) (Figure 212)

Dendrobeania murmanica Kluge, 1955a : 87, fig. 29; *Bugula murmanica* Kluge in Deryugin, 1915 : 378 (nom. nud.).

The zoarium is free-growing, and consists of dichotomously divided branches. The branches in the proximal part are narrow and two- or three-rowed, but gradually broaden toward the distal end, and reach up to 10 rows. The long zooids (length 0.88 to 1.13 mm, width 0.25 mm) broaden in the distal half, taper in the proximal, and change into a saddle-like widening under the distal margin of the underlying zooid. The aperture occupies almost the entire frontal surface, and only a small, proximal part of the zooid is occupied by the gymnocyst. Each distal corner has a small, unjointed spinule,

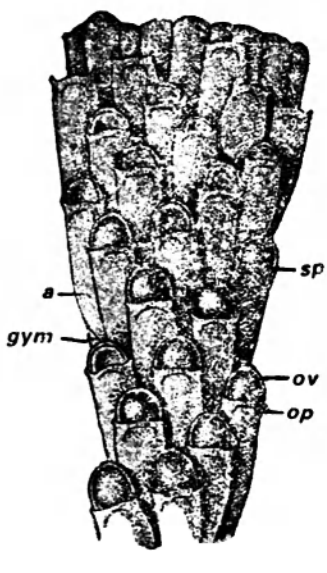


Figure 212. *Dendrobeania murmanica* (Kluge). Part of a zoarial branch (from Kluge, 1955a).

but sometimes these are absent. Avicularia are not present. The ovicells are hyperstomial and round; their height is slightly greater than their width; their outer layer is calcified only on the sides and the distal side, and the calcareous, frontal surface of their inner layer is covered with a radial pattern. There are 4 pore plates with 3 to 4 pores in the lateral wall, and 1 large pore plate with many pores in the distal septum.

The species lives on the shells of worms, mollusks, and stones, etc., at a depth of 44 to 292 m, more often from 50 to 150 m, on a bed of silt, stone, and shell.

Distribution. The species was found by me in the Barents Sea in Kola Bay, and the southeastern part of the open sea. *Reports in literature:* Barents Sea (Kluge in Deryugin, 1915).

Thus far, this species is endemic to the Barents Sea.

2. Genus **Bugula** Oken, 1815

Bugula Oken, 1815 : 89; Busk, 1852b : 43; Hincks, 1880a : 73.

The zoaria are free-growing and dichotomously branched. The branches are single-layered, and two- or multi-rowed. The zooids are oblong, and a large part of their frontal surface is occupied by the membrane-covered aperture in which a chitinous operculum does not exist. Spines are present. The zooids usually narrow toward the proximal end, and convert into a bifurcated, saddle-like widening under the distal margin of the underlying zooid. The distal septum has a series of uniporous plates. The avicularia, in the form of a bird's beak, are flexibly attached to the lateral side of the zooid by a stalk originating from the proximal end of the zooid's frontal surface, and are directed almost perpendicular to the length of the avicularia. The ovicells are hyperstomial, round, or semi-round, and often located on a narrow stalk on the distal margin of the frontal zooids.

Genus type: *Bugula* (*Sertularia*) *neritina* (Linnaeus, 1758).

1 (12). Branches always consist of 2 rows of zooids; all avicularia of the same size.
2 (5). Zooids long and narrow; there is one spine on the distal margin.
3 (4). Spine more or less long, cylindrical; avicularia long; ovicells semi-circular with a large, open orifice. Zoaria large and bushy............................3. *B. fastigiata* Dalyell.
4 (3). Spine short and pointed; avicularium short; ovicells large with an incompletely calcified ectooecium, and a radial pattern on the calcareous, frontal surface of the endooecium..........

..................................6. *B. elongata* Nordgaard.

5 (2). Zooids short; 2 or more spines on the distal end.

6 (7). There are usually 2 short spinules at the distal end of the zooid (one in each corner)........4. *B. tschukotkensis* Kluge.

7 (6). Not less than 3 spines in the distal end of the zooid.

8 (11). Three spines in the distal end of the zooid.

9 (10). Zoaria large, and assume a spiral shape.................. ....5. *B. avicularia* (L.).

10 (9). Zoaria, minute, flat, and widely spread.................. ....2. *B. tricuspis* Kluge.

11 (8). Three to 5 spines on the distal end. Zoarium shaped like a funnel............................1. *B. harmsworthi* Waters.

12 (1). Branches consist of a large number, and have 2 to 10 rows of zooids. Marginal avicularia larger than the central ones...... ....7. *B. calathus* Norman.

1. **Bugula harmsworthi** Waters, 1900 (Figure 213)

Bugula harmsworthi Waters, 1900 : 54, pl. 7, f. 13, pl. 8, f. 1; Nordgaard, 1906a : 8, pl. I, f. 1-5; 1912a : 16, f. 7-8; 1918 : 24 (part.); *B. avicularia* Smitt, 1868a : 289 (part.); Lorenz, 1886 : 84 (2); Bidenkap, 1900a : 507.

The zoaria are small, ramose, and shaped like a funnel. The branches are comparatively short and consist of 2 rows of long, narrow zooids (length 0.65 to 1.00 mm, width 0.18 mm). Branching is dense, and the branches appear to consist of internodes that are sometimes shorter, sometimes longer. The internodes consist of 2 to 6 zooids. The nodes in this form are smooth, uncalcified graduations, while the cuticular layer of the gymnocyst is more strongly chitinized, and acquires a yellow color. The formation of the internodes is the same as in *B. fastigiata*, but because the zooids are shorter in this species, the internodes seem more compact. The zooids are thin-walled, hyaline, and transparent. The aperture occupies two-thirds of the zooidal length. There are 2 to 1 articulated spines near the inner distal corner, and 2 to 3 articulated spines near the outer corner; the distal part of their branches is quite long. A relatively large avicularium (length 0.35 mm, height 0.17 mm) with a long and almost straight maxilla which is sharply bent and pointed at the tip, is flexibly attached by a short stalk to a small base, near the outer, lateral margin of the aperture. The primary zooid of the zoarium (ancestrula), and sometimes the one following it, is long and cylindrical, and terminates in a broad ochrea at the distal end, with 10 spines on each margin. The ovicells are hyperstomial and semi-circular; they have a semi-circular, proximal, frontal margin, rounded back somewhat by a wide, open

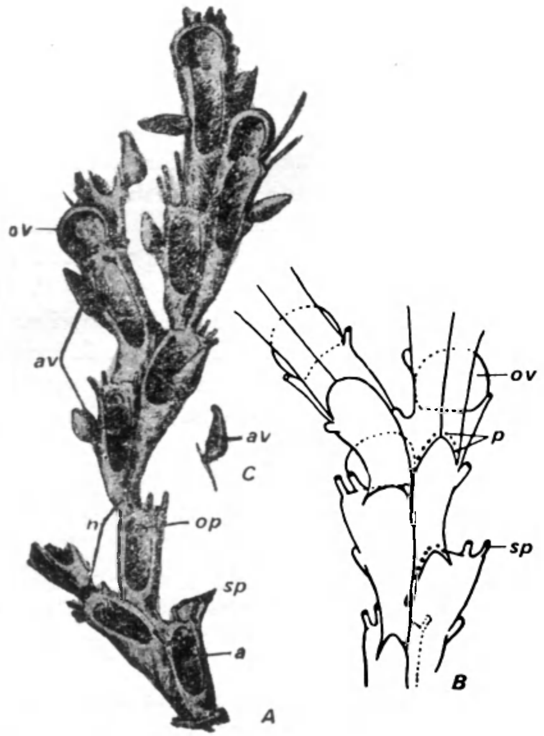


Figure 213. *Bugula harmsworthi* Waters. Part of a ramified branch from *A*—the frontal, and *B*—the basal side; *C*—avicularium, lateral view.

orifice at the inner cavity; the outer layer is only calcified along the distal and lateral sides of the inner layer. The radicular tubes start from the basal side of the proximal half of the zooid, and gathering together in the proximal part of the zoarium, sometimes form thick bundles of tubes which help attach the zoarium to the substrate.

The species lives on calcareous Bryozoa, primarily on *Retepora,* at a depth from 23.5 to 306 m, on a bed of stone, silt, and shell, under temperatures varying from —1.7 to 0.8°C, in a salt concentration of 34.35 to 34.81‰.

Distribution. The species was found by me in the Barents, Kara, and Laptev seas, and in the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1868a; Bidenkap, 1900a; Waters, 1900; Nordgaard, 1912a; Kluge in Deryugin, 1915), Laptev Sea (Kluge, 1929), Archipelago of the Canadian Islands (Nordgaard, 1906a), western Greenland (Kluge, 1908b), Yan-Maien Island (Lorenz, 1886), and the Lofoten Islands (Nordgaard, 1918).

This is an Arctic species.

2. **Bugula tricuspis** Kluge, 1915 (Figure 214)

Bugula tricuspis Kluge in Deryugin, 1915 : 379 (nom. nud.); 1955a : 87, f. 30.

The zoaria are small (up to 5 mm), dichotomously branched, and appear as flat, widely spread, and ramified structures. The branches consist of 2 rows of oblong and broad zooids (length 0.58 mm, width 0.23 mm). The aperture occupies almost the entire frontal surface. Three unjointed spines are located at the distal margin of the zooid, the first near the inner corner, the second at the outer, and the third rather near the second along the outer margin of the aperture. The avicularia are similar to those in *B. harmsworthi*, but smaller than the latter; they are located in most zooids at approximately one-third their length from the proximal end. Short, wide, and semi-circular ovicells are located under the distal end of the zooid between 2 angular spines; they have an almost straight proximal, frontal margin and a slightly open orifice in the inner cavity; their outer layer is membranous. Radicular tubes start from the basal side of the zooids in the proximal part of the zoarium, and help attach the zoarium to the substrate.

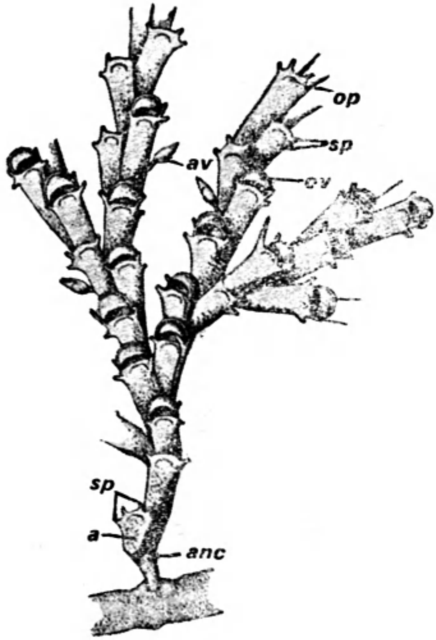


Figure 214. *Bugula tricuspis* Kluge. Proximal part of a zoarium (from Kluge, 1955a).

The primary zooid, or the ancestrula, has 5 spines. The daughter zooid has 3 spines and originates from the primary zooid; the daughter gives rise to another 2 daughters which serve as the initiation of the branches, and furthermore, are dichotomously branched.

The species lives almost exclusively on the calcareous Bryozoa *Retepora,* at a depth of 40 to 160 m, on a bed of stone, sand, and silt, under temperatures varying from —1.38 to 1.02°C, in a salt concentration of 34.63 to 34.72‰.

Distribution. The species was found by me in the Barents Sea, in the coastal waters of Murmansk, Spitsbergen, and Franz Josef Land, and in the Kara Gates.

The species is probably Arctic.

3. **Bugula fastigiata** Dalyell, 1847 (Figure 215)

Bugula purpurotincta **Norman, 1868 : 219; Hincks, 1880a : 89, pl. XII, f. 8-12;** ***B. fastigiata*** **var.** ***pallida*** **Kluge, 1929 : 7.**

The zoaria are comparatively large (up to 7 to 8 cm in height), branched, and bushy. The branches, consisting of 2 rows of long, narrow zooids (length 1.0 to 2.0 mm, width 0.18 mm), gradually broaden toward the distal end. Branching is very dense. The branches appear to consist of a row of internodes, which are sometimes shorter, sometimes longer. At the places of node formation, the proximal end of the internode forms a sort of uncalcified graduation, and the cuticular layer of the gymnocyst becomes more strongly chitinized, acquiring a yellow color. These node formations make the branches more flexible and elastic, which facilitates a stronger overgrowth in the zoarium. The internodes consist of 2 to 7, often 2 to 3, zooids. Of these, the first zooid is usually basal (main), longest, and without an avicularium. A new internode always starts from 2 zooids, and if one of them is the basal zooid, only 1 main row of internodes develops; new internodes form at the places of branching on the basal zooid, or next to it, i.e., at the daughter zooids and on the neighboring zooid of the other side. The zooids are thin-walled, hyaline, and transparent. The aperture occupies a large portion of the frontal surface. A spine is located slightly away from the outer, distal corner which is sometimes short, sometimes longer and cylindrical, and sometimes

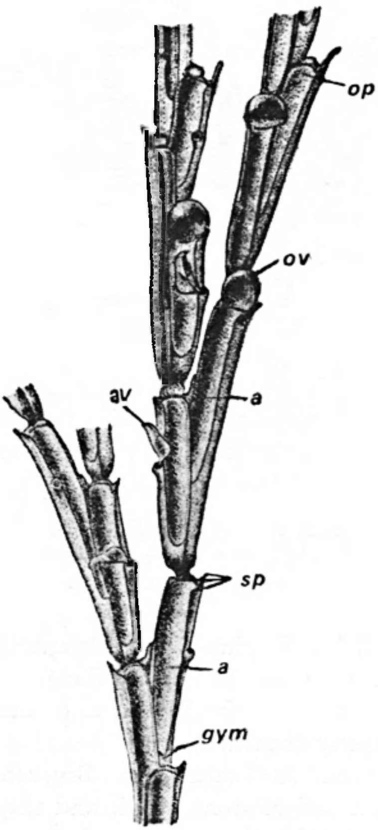


Figure 215. ***Bugula fastigiata*** **Dalyell. Part of a zoarium.**

articulated; sometimes the outer distal corner itself stretches slightly upward to form a small sharp spinule. A small avicularium (length 0.28, width 0.13 mm) with a straight jaw, sharpened and bent at the end, is flexibly attached to the prominent conical base near the outer margin of the aperture, at one-third to one-half its length from the distal end. The ovicells are hyperstomial and a continuation of the basal side of the distal part of the zooid; they look like a free hemisphere with a semi-circular, proximal margin that has been thrown slightly backwards; the orifice in the inner cavity is wide and open. Thin, radicular tubel originate from the lower part of the zooids in the proximal half of the zoarium; these fibers are branched, and fusing with each other, give rise to thicker bundles of tubes connected among themselves near the base of the zoarium, which form a single bundle (more or less) of tubes which help attach the zoarium to the substrate.

The species lives on tubes of worms, shells, and small stones, at a depth of 7 to 192 m, on a bed of silt, stone, and shells, under temperatures ranging from −1.28 to 2.4°C, in a salt concentration of 34.18‰.

Distribution. The species was found by me in the Barents, Kara, and Laptev seas. *Reports in literature:* Barents Sea (Nordgaard, 1896, 1918), Laptev Sea (Kluge, 1929), western Norway (M. Sars, 1863b; Smitt, 1868a; Nordgaard, 1896, 1918), Boguslen (Smitt, 1868a), Shetland Islands (Norman, 1869), British Isles (Hincks, 1880a), and Iceland (Nordgaard, 1924).

This is an Arctic-boreal, Atlantic species.

4. **Bugula tschukotkensis** Kluge, 1952 (Figure 216)

Bugula tschukotkensis Kluge, 1952 : 146, fig. 4; 1955a : 88, fig. 88.

The zoaria are free-growing, small, up to 6 to 7 mm in height, and consist of dichotomously divided branches. The branches consist of 2 rows of adjoining zooids. The zooids are medium in size (length 0.63 to 0.88 mm, width 0.29 to 0.30 mm) and slightly narrow at the proximal end. The aperture occupies from three-fourths the length of the longer zooids, up to the entire length of the shorter zooids, and is slightly tilted toward the middle line of the branch. A small, unjointed spine is located in each distal corner. However, on 2 zooids in a zoarium, 3 spines were recorded in each distal corner, 1 in the inner one and 2 on the outer. A small (length 0.28 mm, width 0.18 mm), strong avicularium, with a high avicularian chamber and a relatively short maxilla with a sharp, bent beak at the tip, is located on a fairly short peduncle, which is on a raised conical base near the outer margin of the aperture, a little below its middle

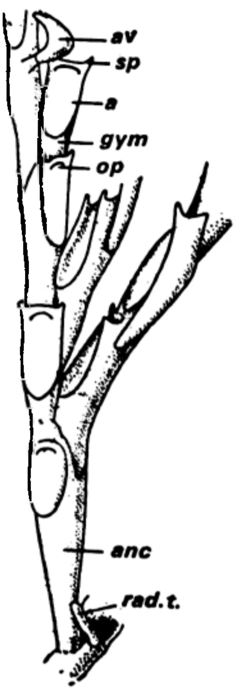


Figure 216. *Bugula tschukotkensis* Kluge. Proximal part of a zoarium (from Kluge, 1955a).

part. Ovicells are not known to exist. The first zooid near the base of the zoarium is quite long, almost twice the length of a usual zooid, and has a small (less than half the length of the zooid) aperture, which has no spines. The radicular tubes start on the lower side from its proximal half; these tubes facilitate the attachment of the zoarium to the substrate. Often the second, also equally long, zooid starts from this first zooid at an angle to its frontal side, which has a primordia of spines on its distal corners. Two zooids develop from the second zooid, each of which again give rise to 2 more zooids. These in turn produce another 2 zooids, and in each instance the branches ramify into 2 new branches. If branching takes place after a certain interval, each of the latter pair of zooids produces only 1 zooid, and so on, but as soon as new branching begins, every zooid immediately starts producing 2 zooids, which give rise to 2 branches.

The species lives on Bryozoa, shells, and stones, at a depth of 53 m, on a bed of sand and shells, under a temperature of 4.78°C, in a salt concentration of 31.80‰.

Distribution. The species was found by me in the southeastern part of the Chukotsk Sea.

*5. **Bugula avicularia** (Linnaeus, 1758) (Figure 217)

Bugula avicularia Hincks, 1880a : 75, pl. X, f. 1-4; Borg, 1930a : 78, f. 80.

The small (up to 2 cm in height) zoaria are free-growing and consist of dichotomously divided branches, arranged more or less spirally or in folds; the live zoaria are orange-brown in color. The branches consist of 2 rows of oblong, comparatively wide zooids (length 0.63 to 0.88 mm, width 0.25 mm), which slightly taper toward the proximal end. The branches appear to consist of internodes that are not very clearly expressed. The internodes consist of 2, 4, 5, and 6 zooids. The zooids are thin-walled, hyaline, and translucent. The aperture occupies three-fourths and more of the zooidal length. There are usually 2 spines at the outer distal corner, and 1 at the inner; they are often articulated. A small, conical protuberance is located on the outer lateral margin of the aperture, at one-third the length of the zooid from the distal end, to which a more or less long avicularium is flexibly attached through a short peduncle; this peduncle reaches more than one-third of the zooidal length (length 0.30 mm, width 0.12 mm). The avicularia are pressed on the sides, and their short jaw is bent downward, terminating in a sharp beak. In the distal margin of the zooid, the basal wall extends into a round, free, leading ovicell, which has a smooth, translucent surface, and a straight, proximal margin.

The species lives on hydroids, Bryozoa (mostly *Flustra foliacea*), and shells, at a depth varying from the belt of ebb and flow up to 100 m.

Distribution. In spite of repeated reports about its presence in the Barents Sea, I never found this species in our waters. An examination of the collections of Smitt and Bidenkap on which their reports referring to *Bugula avicularia* were based (Smitt, 1868a, for Spitsbergen; 1879b, for Kola Peninsula; and Bidenkap, 1900a, for Spitsbergen), revealed that the preparations from the aforementioned regions which were labeled *B. avicularia,* actually belonged to *B. harmsworthi* Waters. The same is true about the *B. avicularia* of Lorenz (1886) for Yan-Maien Island. Based on these findings, I have come to the conclusion that *B. avicularia* is a boreal species, which has not yet been located in the Arctic region.

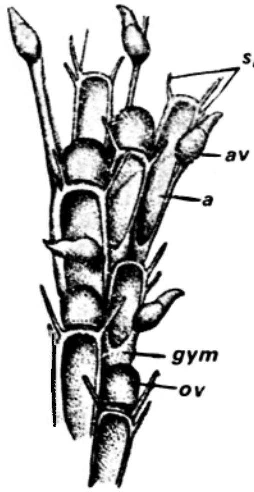


Figure 217. *Bugula avicularia* (L.). Part of a zoarial branch (from Hincks, 1880a).

6. **Bugula elongata** Nordgaard, 1906 (Figure 218)

Bugula elongata Nordgaard, 1906b : 80, t. 1, f. 1-6; *B. Murrayana* forma *II*: *quadridentata* Smitt, 1868a : 292 (part.). t. 18, f. 25-26; *Dendrobeania murrayana* var. *quadridentata* Nordgaard, 1918 : 25.

The zoarium is free-growing, dichotomously branched with flexible, narrow branches, and reaches up to 6 cm in height. The branches consist of 2 rows of stretched zooids (length 1.10 to 1.60 mm, width on the lower side 0.10 mm, on the upper side 0.25 mm), that narrow in the proximal part and gradually broaden toward the distal end where a straight,

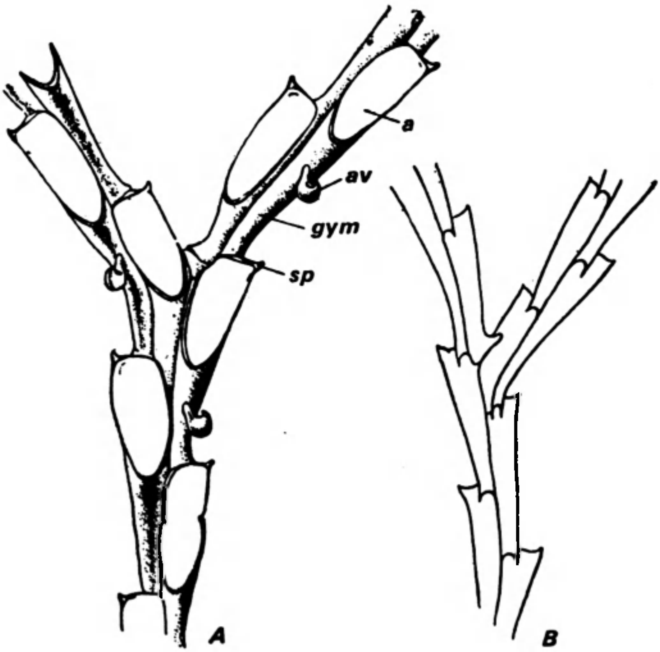


Figure 218. *Bugula elongata* Nordgaard. Part of a ramified branch, with *A*—frontal, and *B*—basal views. Barents Sea.

sharp spine, usually located on the outer corner, may sometimes be absent. The aperture occupies about half the length of the zooid, and its margin is unthickened. A very short and thick, frontal avicularium (length 0.13 mm, height 0.10 mm) is located approximately in the middle, between the proximal margin of the aperture and the distal margin of the preceding zooid; it is flexibly attached with a short, thick stem, and has a short, triangular mandible, and a strongly raised, basal side. This avicularium, far from occurring frequently, is found sporadically; there may be several in some zoaria, and none in others. The almost round, slightly broad, hyperstomial ovicell has a membranons other layer, and a radial pattern on the calcareous, frontal surface of the inner layer. There are 2 pore plates with 1 pore in the lateral wall, and 4 to 5 simple pores in the distal septum, arranged in a row parallel to the basal margin. The comparatively thicker tubes of the radicular fibers start from the laleral wall of the distal part of the zooid, in the proximal parts of the zoaria; these fibers are strongly branched, some overgrowing not only the basal side of the branches, but also the frontal one, and dropping down to the proximal margin of the zoarium, form thick bundles which help attach the zoarium to the substrate.

The species lives on shells and small stones, at a depth of 22 to 315 m, more often from 75 to 200 m, on a bed of shell, sand, and silt, under temperatures ranging from −1.66 to 3°C, in a salt concentration of 33.35 to 34.65‰.

Distribution. The species was found by me in the Barents, Kara, and Laptev seas, and in the Gulf of St. Lawrence. *Reports in literature:* Barents Sea (Smitt, 1868a; Norman, 1903a; Nordgaard, 1918), and western Norway (Nordgaard, 1905, 1906b).

This is an Arctic-boreal, Atlantic species.

*7. **Bugula calathus** Norman, 1868 (Figure 219)

Bugula calathus Norman, 1868 : 218, pl. VI, f. 3-8; Hincks, 1880a : 82, pl. XI, f. 4-6.

The zoaria are free-growing, small, and dichotomously branched. The zooids are long and narrow, and have an aperture which occupies a large part of the frontal surface. There are 2 spines, rarely 3, in the distal margin of the aperture, on the outer corner near the marginal zooids of the branch. An oblong avicularium is flexibly located on a short and thin stalk at one of the lateral margins of the aperture (in the marginal zooids, always near the outer margin), at approximately one-third the length from the proximal end; the avicularian chamber has a raised basal side, and the short jaw of the avicularium is sharply bent and pointed at the tip. The avicularia located on the marginal zooids, are markedly larger than those on the central zooids. The ovicells of the distal margin are round, somewhat stretched, and have a straight proximal margin; there is a small constriction between the border of the basal side of the ovicell and the distal margin of the zooid.

Radicular fibers originate from the basal side of the zooid in the proximal part of the zoarium, and gather into more or less thick bundles of tubes which help attach the zoarium to the substrate.

There are 4 pore plates with 3 to 5 pores in the lateral wall of the zooid, and many pores in the distal

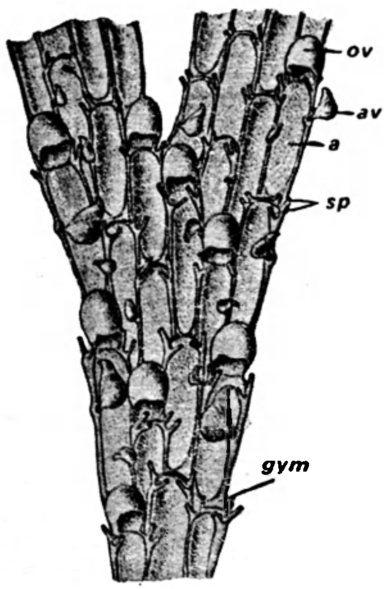


Figure 219. *Bugula calathus* Norman. Part of a ramified branch, frontal view (? White Sea).

septum, located in 2 rows.

The species lives on the tubes of worms, calcareous Bryozoa, etc., in the belt of ebb and flow, and at shallow depths.

Distribution. In my paper (Kluge 1908a: 518) this species was reported as found in the White Sea in the region of Solovetsky Bay. After an analysis by Gostilovskaya and myself of considerable material collected from different places in the White Sea, I came to the conclusion that my earlier report contained an error, arising most probably, from a colony of this species being inadvertently mixed with the Bryozoan collection of the Zoological Museum of the Berlin University, which I was simultaneously examining. I fully share the doubt expressed by Nordgaard (1918: 24) about the recovery of this boreal species in the White Sea, but Nordgaard and later Borg (1933a: 528), wrongly considered the form reported by me as *B. harmsworthi;* the latter has a zoarium consisting of 2 rows of zooids, while *B. calathus* consists of several zooidal rows. Moreover, *B. harmsworthi* has not yet been found in the White Sea. *Reports in literature:* British Isles (Norman, 1868; Hincks, 1880a), and the Mediterranean Sea (Calvet, 1902).

This is a boreal species.

3. Genus **Kinetoskias** Danielssen, 1868

Kinetoskias Danielssen, 1868 : 23, *et auctt., Bugula* Smitt, 1868a : 292; *Naresia* Thompson, 1873 : 388.

The zoarium consists of a crown of branches which has one more or less long, and a few short, transparent stems (stalks) supporting it; the lower ends of these stems help attach the zoarium to a silty, sandy substrate. The crown is a more or less wide funnel with an apparent radial disposition of branches, or it consists of branches situated in one plane, but forming 2 symmetrical lobes. The branches are interconnected for some distance from the base of the crown by a membrane, beyond which they become independent. The membrane is formed by the fusion of the common, radicular tubes of 2 adjoining branches from opposite sides. The common, radicular tubes originate through the fusion of individual, radicular tubes, which start from the outer lateral side of the proximal part of the zooids which follow one after the other. These, being thinly chitinized, fuse with each other and give rise to a thin, continuous, transparent, double-layered membrane in which the cavity fluid rests. The branches are single-layered and consist of 2 rows of adjoining zooids, whose frontal surface is directed to the outer side of the crown. The zooids are oblong and slightly narrow toward the proximal end, where they terminate with a straight, transverse wall. Each zooid has a strong muscle (*flexor zooecii*), which starts from the conical protuberance (apophysis) of the proximal, transverse wall, the given zooid, and the distal wall of the underlying zooid; it attaches by its distal end to the inner side of the basal and outer, lateral walls of the zooid. If 2 daughter zooids arise from the zooid, the latter develops 2 apophyses, one for each daughter zooid. Avicularia and ovicells are present.

Genus type: *Kinetoskias smitti* Danielssen, 1868.

1 (2). Zoarium attached to the substrate by many short, transparent, and cylindrical stems, which arise from the lower side of the flat, broad funnel. Avicularia are short, light, and similar to a bird's beak; they are flexibly attached to the outer, distal corner of the zooid..............1. *K. arborescens* Danielssen.

2 (1). Zoarium attached to the substrate by a more or less long, transparent, cylindrical stem.

3 (4). Zooids have an unarticulated spine at the outer, distal corner. Peduncle for attachment of avicularia to the outer, lateral margin of the aperture, absent..........2. *K. smitti* Danielssen.

4 (3). Zooids have no spine at the outer, distal corner; the latter is rounded. Peduncle present as a small, triangular protuberance on the outer, lateral margin of the aperture.

5 (6). Each symmetrical half of the crown consists of 2 main sectors of branches, whose formation takes place by unilateral branching in opposite directions......3. *K. mitsukurii* Yanagi and Okada.

6 (5). Each symmetrical half of the crown consists of 1 sector of branches, whose formation takes place by unilateral branching in one direction..............................4. *K. beringi* Kluge.

1. **Kinetoskias arborescens** Danielssen, 1868 (Figure 220)

Kinetoskias arborescens Danielssen, 1868 : 23; Koren and Danielssen, 1877 : 107, t. 12, f. 9-14, *et auctt.; Bugula umbella* Smitt, 1868a : 292, 353, t. 19, f. 28-31.

The zoarium is in the form of a more or less broad, flat funnel consisting of 2 main, successive, and dichotomously branched secondary branches, which fuse with each other over a small distance from the base of the membrane; the remaining part of the branches is free. The branches consist of a single layer of zooids arranged in 2 alternating rows; their frontal side is directed to the outer surface of the funnel, and their back to the inner side.

More or less short, transparent, cylindrical stems help attach the zoarium to the substrate. In addition to the main, short, and cylindrical stem originating from the first zooid of the zoarium, a larger or smaller number of similar stems arise from the lower (outer) surface of the zoarium, particularly from the axils of the branches; these stems have thin, radicular tubes at the proximal end, which help affix the zoarium to the substrate. The zooids which form the branches, are oblong, narrow in the proximal part, and broader in the distal. The oval aperture occupies the entire frontal surface of the zooid. A semi-circular, membranous operculum, which has a thin, chitinized margin, is situated in the distal part of the aperture. Directly under the middle part of the distal margin of the zooid, a solid, hard, conical protuberance (apophysis) rises under the frontal wall of the overlying daughter zooid in the cavity of the latter, from whose free, rounded end originates a bundle of muscular fibers, which stretch toward the outer, lateral and dorsal walls of the daughter zooid, and bend the zooid by their contraction. If 2 daughter zooids bud from the maternal zooid, 2 apophyses develop under the distal margin, one for each daughter zooid. The basal side of the zooid is slightly raised and has a pattern of parallel curves, which proceed in an oblique direction from below and outside, to the upper and inner side. A short, light, and thin avicularium, shaped like a bird's head, is located on the outer, distal corner; its short maxilla is strongly bent and pointed at the tip. The ovicells are semi-circular, shallow, and located a little obliquely to the distal margin. There are 2 monoporous plates in the lateral wall, and 1 plate with 6 to 7 pores in the distal septum. Because all the branches of the zoarium are uniformly connected by a membrane from the base over a certain distance, the zoarium has the shape of a funnel; this characteristic distinguishes the present species from others in which the zoarium is organized differently.

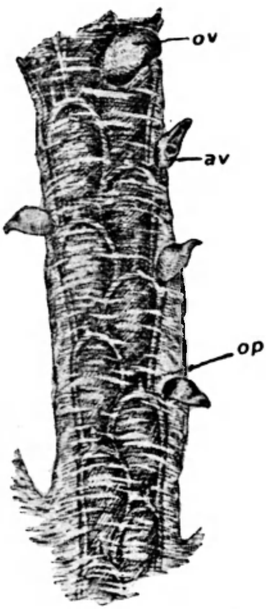


Figure 220. *Kinetoskias arborescens* Danielssen. Part of a branch of a zoarium, frontal view.

The species lives on a bed of silt and sand, at depths of 19 to 1,229 m, under temperatures varying from —1.60 to 4.25°C, in a salt concentration of 31.38 to 34.84‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, and East Siberian seas. *Reports in literature:* Barents Sea (Danielssen, 1868; Smitt, 1868a; Kluge in Deryugin, 1915; Nordgaard, 1918), Kara Sea (Levinsen, 1887), Laptev Sea (Kluge, 1929), East Siberian Sea (Kluge, 1929; Nordgaard, 1929), Gulf of St. Lawrence (Whiteaves, 1901), Gulf of Man and Sable Island (Verrill, 1879a, 1879b, 1880; Osburn, 1913), eastern Greenland (Andersson, 1902), Norwegian Sea (Nordgaard, 1900), and Sognefiord in Norway (Nordgaard, 1900).

This is an Arctic, Atlantic species.

2. **Kinetoskias smitti** Danielssen, 1868 (Figure 221)

Kinetoskias smitti Danielssen, 1868 : 23, Koren and Danielssen, 1877 : 104, t. 3, f. 12-14; t. 12, f. 4-8; Norman, 1893: 448, pl. 19, f. 2-5; Kluge, 1946 : 195, t. 2, f. 2; *Kinetoskias flexilis* Verrill, 1880 : 189; 1885 : 530.

The zoarium consists of a crown of branches located on a more or less stem. Although the crown appears to be a bundle of branches, in actuality it consists of branches arranged on one plane. The crown originates near the base in the form of 2 main branches, which dichotomously divide into the branches of the second tier. The branches consist of a single row of zooids arranged in 2 alternating rows. The common, radicular tubes stretch along the margins of the branches over a certain distance, from the base of the bifurcation between the neighboring branches; the radicular tubes develop through the fusion of individual, radicular tubes uprising from the outer side of 2 adjoining branches, which give rise to a comparatively narrower, double-layered membrane that connects the neighboring branches: these branches become independent after a short distance. Because the branches are arranged in one plane in the form of 2 lobes, it is possible to distinguish the inner or adjoining margins of both lobes, and the outer margins in the crown. Like the margins of the remaining branches, both of these are accompanied by common, radicular tubes. But their development differs from the other tubes, by the formation of a more or less stem which supports the crown. This stem arises, not from the base of the crown of the branches which is initiated by the first zooid, but at a certain distance from it; and the base of the first zooid, by which the zoarium is initially affixed to the substrate, now becomes free (independent). This stem is formed by the fusion of the radicular tubes and the continuation of the fused, common, radicular tubes, which are located either along the

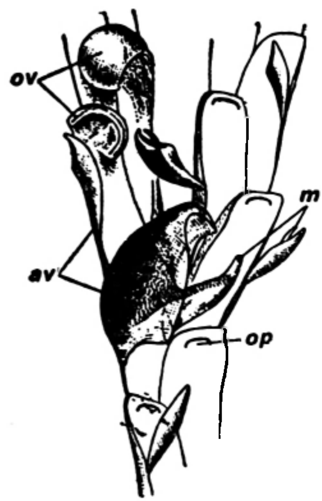


Figure 221. *Kinetoskias smitti* Danielssen. Part of a zoarial branch with ovicells showing outsized and normal avicularia. Polar Basin (to the north of Spitsbergen).

inner, or along the outer margins of the lobes of the crown. Usually a narrow graduation is found in the place of the transformation of the fused tubes into the stem; this graduation narrows down the cavity of the stem to a certain degree. Because of the fusion of the common, radicular tubes and the formation of the stem, a bending of the crown takes place in the middle in such a way that both the lobes come close together, and the frontal surface of the zooids is directed to the outer side, while their back is on the inner side of the bend. The stem is a more or less long (up to 4 cm), transparent, hollow, cylindrical tube with a thin, densely chitinized wall; it is filled with the cavity fluid. It is slightly broadened toward the proximal end, and many thin, radicular tubes develop at its terminal part, which help affix the zoarium to the silty, sandy substrate. The oblong zooids are slightly narrow in the proximal part and wider in the distal half (length 0.75 mm, width 0.38 mm); an unarticulated spine is located near the outer distal corner. The apophysis is located under the middle part of the distal margin of the zooid; there are 2 apophyses when a zooid buds 2 daughter zooids. The aperture occupies the entire frontal surface of the zooid. The proximal part of the basal side of the zooid has a slight transverse pattern. An oblong, narrow avicularium (length 0.55 mm, height 0.20 mm) is flexibly attached near the middle part of the outer, lateral margin of the aperture. The avicularium consists of 2, almost equal, halves: the distal half has a sharp mandible (length 0.18 mm, width at the base 0.13 mm), and the proximal one is slightly bent and stretched into a thin, pointed end. It must be mentioned here that we found 2 outsized avicularia in zoaria separated by a long distance (near Jilli Island in the Barents Sea, and near Ushakov Island in the Kara Sea) among ordinary avicularia typical to this species. The outsized avicularia had a totally different structure. In ordinary avicularia the body is oblong and seemingly consists of 2 equal halves—a distal one with a mobile mandible, and a proximal one which is sometimes even longer than the distal; in the outsized avicularia the distal part had a mandible that was 5 times longer than the proximal one. The ovicells are semi-circular with a smooth surface, and located obliquely in relation to the distal margin. The habitat of this species varies according to its branching: with closer branching, the interstices between the branches become shorter, the branches more closely placed, and the whole crown denser and bushier (compact); with sparser branching, the interstices between the branches lengthen, the branches are longer, the distance between them greater, and the whole crown acquires the appearance of long, sparse branches which are outwardly bent at the ends, departing almost from the very base of the crown; this has been depicted by Danielssen (Koren and Dannielssen, 1877) who first described this species.

As can be seen, this species has a different type of zoarial structure in the sense that the crown, although consisting of branches also arranged on one plane, is supported by a more or less long stem, the formation of which, by the continuation of the fused inner or outer common, radicular tubes, causes it to bend in the middle and its 2 halves to come closer together; this leads to the formation of an incomplete funnel. Such a structure is found in most species of this genus.

This species lives on a bed of silt and sand, at a depth of 65 to 1,210 m, under temperatures ranging from −1.62 to 0.71°C, in a salt concentration of 32.34 to 34.87‰.

Distribution. The species was found by me in the Barents, Kara, and East Siberian seas. *Reports in literature:* Western Norway from Malangenfiord to the south (Danielssen, 1868; M. Sars, 1869; Koren and Danielssen, 1877; Nordgaard, 1896, 1905, 1906b, 1912a, 1918; Norman, 1893), western Sweden (Silen, 1936), southwestern Ireland (Nichols, 1911), and along the eastern coast of North America in the region of the Island of Man and New Scotland (Verrill, 1875, 1880).

The "Sadko" expeditions in 1935 and 1937-38 demonstrated for the first time, that this is also an Arctic species, similar to *K. arborescens* Dan.

3. **Kinetoskias mitsukurii** Yanagi and Okada, 1918 (Figure 222)

Kinetoskias mitsukurii Yanagi and Okada, 1918 : 425, pl. VI, f. 11, Text f. 7.

The zoarium consists of a dense crown of branches located on a long, transparent stem. Although the crown has the appearance of a bundle, it actually consists of branches arranged on one plane. The crown starts growing near the base in the form of 2 main, short branches, which divide it into 2 symmetrical halves. Soon each of these main branches is divided into 2 secondary branches, which subsequently divide into a large number of tertiary branches, and these, taken together, form a bilobate crown. The branches consist of one layer of zooids arranged in 2 alternating rows.

I have deliberately made a distinction between the primary and secondary branches, and those formed by them, as further changes in the zoarial structure are associated with this. The secondary branches divide in turn, but this division is no longer dichotomous, but unilateral. However, not all the secondary branches divide unilaterally in one direction; the inner and outer secondary branches of each half unilaterally branch in the opposite direction, i.e., from the left secondary, inner branch, all branches, including those directly arising from it as well as all the successive ones, are produced from the left side or in a left direction; while in the outer, secondary branch, all branches arising from it as well as those which follow, originate from the right side or in a right direction. Branching in the right half mirrors that of the left half. To understand the method of branching in this species, let us examine the ramification of the left, inner, secondary branch.

This branch consists of 2 generations of double-rowed zooids, one following the other. The second pair of zooids do not produce a pair of daughter zooids, but 3 zooids; the zooid located at the inner margin of the branch produces 1 daughter zooid directed toward the maternal zooid, and 1 more lateral daughter zooid, located between the former and the daughter zooid of a neighboring zooid of the second pair of the secondary branch. This new, third, middle zooid serves as the start of a new branch, and its surrounding lateral zooids give rise to daughter zooids in a straight line with the maternal zooids; the middle zooid produces 2 zooids, 1 in a lateral direction, which connects both the branches, and forms paired zooids for both the 2 newly-formed branches. In this manner, the secondary branch divides into 2 subsequent branches, 1 of which continues to grow along the inner margin of the second, main (basal) branch, and the other 1 along its outer margin. These 2 rows form the marginal rows of the entire sector of branches, which were formed by the sequential, unilateral branching within a given sector. The next 2 pairs of zooids from the inner margin of the secondary branch repeat by themselves the preceding 2 pairs, giving rise to a similar new branch from the left side. Thus, along with the growth of the marginal inner branch, a new branch is produced from it after every 2 zooids. The branches of the first order formed during their further growth, in turn give rise to the lateral branches of the second order in the same manner, but not after every

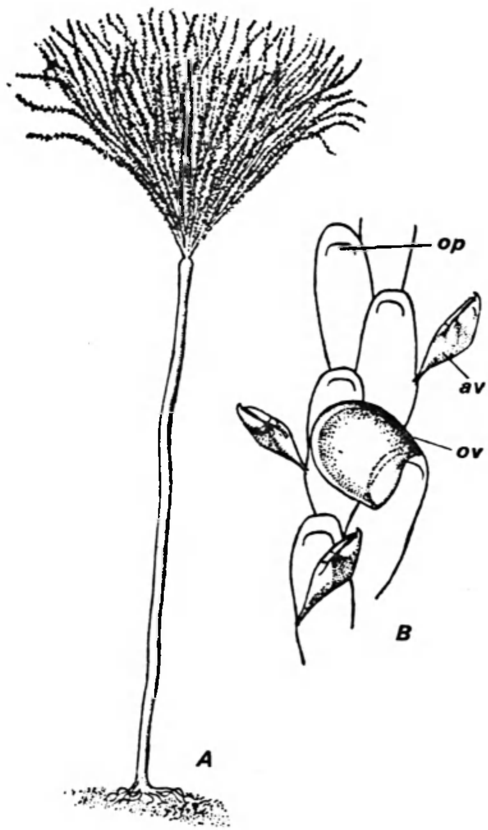


Figure 222. *Kinetoskias mitsukurii* Yanagi and Okada. *A*—a general view of the zoarium; *B*—zooids with avicularia and ovicells.

one to 2 pairs of zooids, but rather after every 3 to 4 and more pairs; as a result, a sector of those branches is formed which were produced by unilateral branching. The common, radicular tubes stretch for a certain distance along the margins of these branches, from the base of the bifurcation between the branches. These tubes originate through the fusion of individual radicular tubes (kenozooids), arising from the outer side of the proximal part of the zooids following each other. The common, radicular tubes on one side of the bifurcation fuse with those of the other side of the fork, from the base of the branch up to the height of one-third the row of zooids; this forms a high, double-layered membrane, which connects the neighboring branches with each other up to this height, after which the latter grow independently in a distal direction, usually turning to the outside at the tips. Due to the arrangement of the branches on one plane in the form of 2 lobes, it is possible to differentiate between the inner or adjoining margins of both lobes, and the outer margins in the crown. Like the other branches, both of these are accompanied by common, radicular tubes. But unlike the other branches, their development is associated with the formation of the long stem which supports the crown of the branches. This stem arises, not from the base of the crown of branches formed by the first zooids, but, as was observed by Busk (1880) from it, after a certain distance, and the base of the first zooid which, formerly attached to the ground, now becomes independent. This stem is formed by the fusion and continuation of the fused, common, radicular tubes located along the inner margins of the lobes of the crown. A narrow graduation is found at the place of the transformation of the fused tubes into the stem, which causes a slight narrowing in the stem. This narrowing reduces the cavity in the beginning of the stem, and it is that aperture, visible through the transparent membrane of the widened part of the fused radicular tubes, which was taken by Yanagi and Okada as an orifice through which the stem, as it were, opened out, connecting its cavity with the external environment; this is the same orifice about which Harmer (1926) expressed doubt. Because of the fusion of these common, radicular tubes, and the formation of the stem, a bend occurs at the middle of the crown in such a manner that the symmetrical lobes are brought closer to each other, and thus the zooids have their frontal surface facing the outer side and their back toward the inner side of the coronal bend. The stem is a long (from 5.25 to 7.8 cm, or half the length of the crown), transparent, hollow, cylindrical tube with a thin and densely chitinized wall; it contains the cavity fluid. It is slightly broader toward the proximal end, and numerous thin, radicular tubes develop at its terminal part which help affix the zoarium to the substrate of silt and sand. The zooids have an oblong form (length 1.00 mm, width 0.33 mm) and a rounded, outer, distal corner; they broaden very little in the middle part, and narrow slightly in the proximal one. The aperture occupies the entire frontal surface. A solid, conical spine (apophysis) is located under the middle part of the distal margin of the zooid, on the proximal, transverse wall of the daughter zooid, from the top of which a flabellate bundle of muscles (*flexor zooecii*) starts toward the inner wall of the outer, lateral and dorsal walls of the daughter zooid. This bundle, reaching up to half or a little more of the length of the zooid, bends it. A zooid has 2 apophyses if it produces 2 daughter zooids, one for each daughter. These apophyses are strongly developed in the lower, proximal part of the zoarium. The basal side of the zooid is convex with a smooth surface. A relatively large and oblong avicularium is located on a small, conical stalk, slightly below the middle part of the outer lateral margin of the aperture; the avicularium consists of 2 almost equal halves—the distal half with a slightly bent beak, and a mobile, sharpened jaw (the mandible), and the proximal part, which stretches out into a thin, sharp end by which the avicularium is attached to the peduncle (stalk). The ovicells, tall, roundish, and miter-like, have a smooth surface, and are located slightly obliquely to the distal margin of the zooid.

The species lives on a bed of silt and sand, at a depth of 3,400 m.

Distribution. The species was found by me in the southern part of the Okhotsk Sea.

This is a Pacific, boreal species.

4. **Kinetoskias beringi** Kluge, 1953 (Figure 223)

Kinetoskias beringi Kluge, 1953 : 212, fig. 1.

The zoarium consists of a bilaterally symmetrical crown of branches located on a long, transparent, cylindrical stem. The branches of the crown are arranged on one plane and form 2 symmetrical lobes. In each lobe, the branches uprise by unilateral branching; all the branches of the left lobe originate from the ramifying branch on the left side, and the branches of the right lobe originate from the branching twig on the right side. The primary zooid, or the ancestrula, is located near the base of the crown; 2 branches rise from it at an angle; these branches consist of 2 to 4 single-rowed zooids from each side, which then transform into double-rowed zooids. The first double-rowed pair of zooids gives rise to the branch in such a manner that the zooid adjoining the inner margin of the lobe produces 2 daughter zooids, one of which uprises in a straight direction with the maternal zooid, and the other, lateral zooid, gives rise to the branch. In its turn, this lateral zooid produces 2 daughter zooids, one of which uprises in a straight direction with the maternal zooid, and the other, lateral zooid gives rise to the branch. This lateral zooid, in its turn, produces 2 zooids: one daughter zooid in a straight line with the maternal zooid or a reformed branch, and the other, lateral zooid, which connects the new branch with the main, inner, marginal branch. The next pair of zooids in the latter branch itself, repeats the process of ramification in the same manner as happened in the first pair of zooids, with the formation of the first lateral branch, giving rise to the second lateral branch in this manner. Thus, as the main, inner, marginal branch grows by a sequential branching of each successive zooidal pair in the manner described above, primary lateral branches form. The number of such branches reached up to 11 in the specimens investigated by me. These branches in their turn produced secondary branches in the same way, only the branching was not so close. Closer to the distal end of the basic (main), inner, marginal branch, the more distant branches are younger and less branched, while the number of secondary, lateral branches gradually

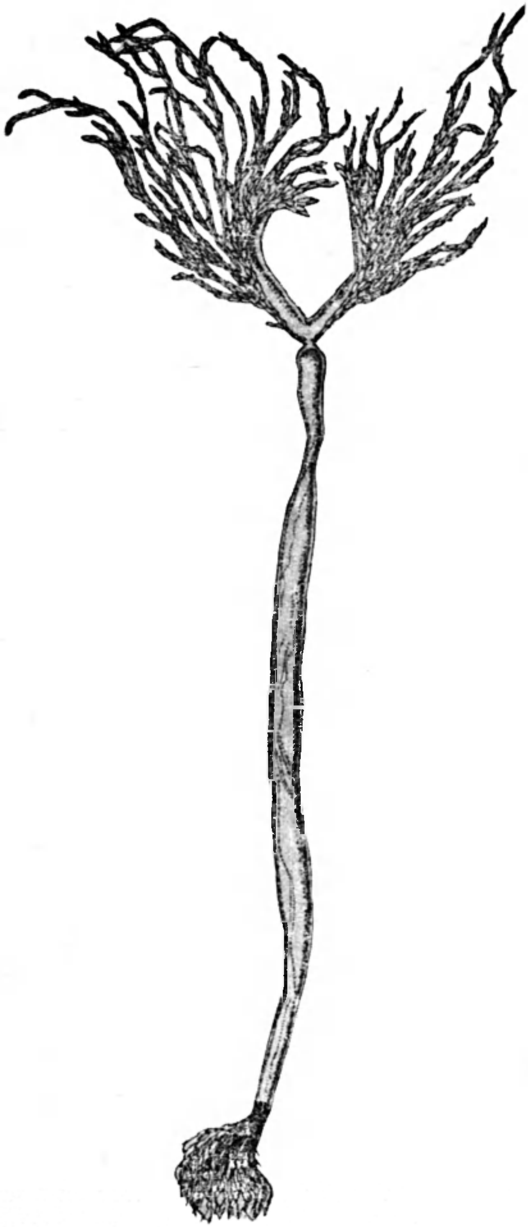


Figure 223. *Kinetoskias beringi* Kluge. General view of a zoarium (from Kluge, 1953).

increases in a proximal direction, reaching up to 7 tertiary branches. Thin, chitinous membranes are located between the neighboring branches of the lobe. These membranes form by the fusion of individual radicular tubes arising from the outer side of the proximal part of the zooids of both opposite sides of 2 adjoining branches. The membranes are double-layered and the cavity located between them is filled with the cavity fluid. They occupy a relatively large surface, reaching up to the height of 3 to 4 rows of zooids from the base of the fork, after which the branches continue independently. Thick, common, radicular tubes, quite distinct from the flat, interbranch membranes, stretch along the inner margin of each lobe toward the base of the crown where, fusing with each other, they are transformed into the stem of the zoarium; a graduation forms at the place of this transformation into the stem. This graduation narrows the stem cavity to a small orifice. The cavities of both the common, radicular tubes communicate with the cavity of the stem through this orifice. All these cavities are filled with a common cavity fluid which, apparently, gives elasticity to the stem as well as to the lobes of the zoarium in a living state. The stem is a more or less long (from 5.8 to 9.5 cm, or one-half to one-third the length of the crown), transparent, hollow, cylindrical tube with a thin and densely chitinized wall. It slightly broadens toward the proximal end, and numerous, thin, radicular tubes develop at its terminal part, which help affix the zoarium to the silty substrate. The branches of the crown are single-layered and consist of 2 rows of adjoining zooids whose frontal surface is directed toward the outer side of the crown. The oblong zooids, slightly broadened in the middle part and slightly narrowed in the proximal, have a rounded, outer, distal corner. The aperture occupies the entire frontal surface of the zooid. A dense (solid), conical spine (apophysis) is located under the middle part of the distal margin of the zooid on the proximal, transverse wall of the daughter zooid. A flabellate bundle of muscles (*flexor zooecii*) arise from the top of this apophysis toward the inner side of the outer, lateral and dorsal walls of the daughter zooid. This bundle, reaching up to one-half, or a little more than half, the length of the zooid, bends it. When 2 daughter zooids bud from 1 zooid, the latter has 2 apophyses, 1 for each daughter zooid. These apophyses are more strongly developed in the lower proximal part of the zoarium. The basal side of the zooid is convex with a smooth surface. A relatively large, oblong avicularium is located in the middle of the outer lateral margin of the aperture on a small, triangular protuberance (stalk), which consists of 2 almost equal halves, the distal one with a slightly bent beak and a mobile mandible, and the proximal one which stretches out into a thin, sharp end by which the avicularium is attached to the stalk.

The ovicells, high, roundish, and cap-shaped, have a smooth surface, and are located obliquely to the distal margin of the zooid. On the basis of the zoarial characters, this form is particularly identifiable with *Kinetoskias mitsukurii* Yanagi and Okada, but in the structure of the zoarium, i.e., in the zoarial characters, it differs distinctly from the latter. This difference includes the fact that the number of zooids forming the outer margin of the primary branch drop out in *K. beringi,* and along with them the whole sector of branches formed by unilateral branching falls. In reality, contrary to the formation of the crown of branches in *K. mitsukurii* and other species, where there are double-rowed main branches, in *K. beringi* the primary zooid branches out into 2 main branches of single-rowed zooids, each of which, after a few generations, develops into a double-rowed branch, which corresponds to the branch of *K. mitsukurii,* growing along the inner margin of the secondary branch. Because the outer sectors of the crown in *K. mitsukurii* fall off, the branching of the inner sectors in *K. beringi* and the crown of the branches, acquire a distinctly bilateral, symmetrical structure with a strongly expressed regular branching by unilateral ramification. Because of the stronger development of the inner margins of the lobes of the crown and their branches in *K. beringi,* the membranes are also more strongly developed between the branches, and in the main, common, radicular tubes along the inner margins of the lobes of the crown, which fuse together and continue into a strongly developed stem. The whole development of the zoarium in *K. beringi* suggests that in this form, the genus *Kinetoskias* attained a high degree of colonial individuality.

The species lives on a bed of silt and sand, at a depth of 3,400 to 3,812 m.

Distribution. The species was found by me in the Bering and Okhotsk seas.

This is a boreal, Pacific species.

4. Genus **Bicellariella** Levinsen, 1909

Bicellaria Blainville, 1830 : 423; 1834 : 459; Smitt, 1868a : 288; Hincks, 1880a : 68; Levinsen, 1909 : 99; *Bicellariella* Levinsen, 1909 : 431; Borg, 1930a : 77.

The zooids appear divided into 2 parts by transverse graduations—a lower or proximal part which is narrow and cylindrical, and a distal one which is broad; the independent distal ends of the zooids are bent outward. There are many long, thin, bent spines on the distal margin of the aperture. The ovicells are located near the inner margin of the aperture in its broadest part. The avicularia are mobile. The radicular fibers originate from the basal side of the zooid.

Genus type: *Sertularia ciliata* Linnaeus, 1758.

Bicellariella ciliata (Linnaeus, 1758) (Figure 224)

Bicellaria ciliata Smitt, 1868a : 288, 333, t. XVIII, f. 1-3; Hincks, 1880a : 68, pl. VIII, f. 1-5; Osburn, 1912 : 224, pl. XXI, f. 21; 1923 : 7; Borg, 1930 : 77, f. 19; Marcus, 1940 : 178, f. 93.

The zoaria are thin, dichotomously branched, white, hyaline, and transparent; they reach up to a height of 1½ cm. The branches seem pinnate (plumose) and are bent inward at the ends. The zooids are medium in size (length 0.75 mm, width 0.15 mm) and arranged in 2 alternating rows. The zooids broaden in the distal half, sharply narrow in the middle, and become narrow and cylindrical in the proximal half. The oval aperture, located in the distal half, is obliquely directed to the outer side. The spines (from 4 to 7) on the distal margin of the aperture, attain a length that is significantly greater than the length of the zooids; there is 1 longer spine near the proximal margin of the aperture; 1 or 2 spines are located on the basal side of the zooid. The proximal end of the zooid

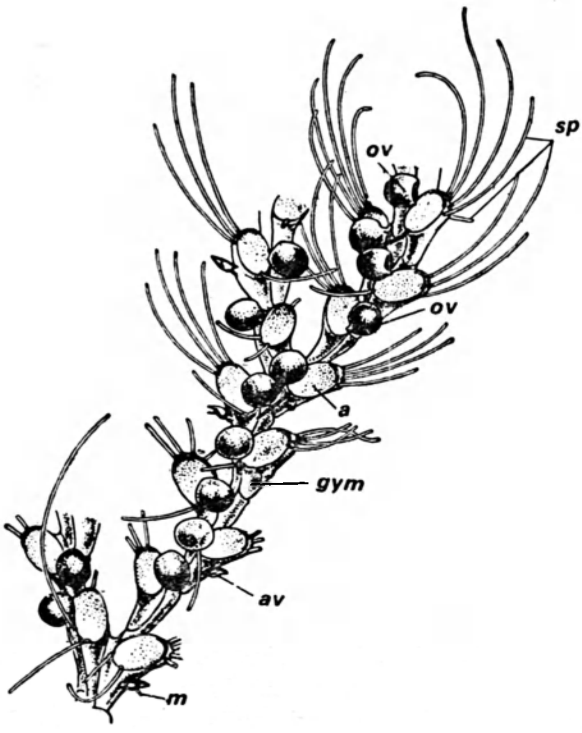


Figure 224. *Bicellariella ciliata* (L.). Part of a zoarial branch (from the collection of Smitt).

is bifurcated, and situated like a saddle on the basal side of the maternal zooid, at the point where the distal half is deflected (tilted) outward. The neighboring zooid forms a graduation in this place. A small, lateral, and oblong avicularium (length 0.15 mm) with a lightly denticulated jaw (mandible), is situated in mobile manner below the aperture in most zooids. The ovicells are almost spherical (width 0.20 mm, height 0.15 mm) and convex, with a smooth, glassy surface; they are obliquely located on a short stem, on the former part of the aperture's inner margin.

This species is found on algae, hydroids, tubes of worms, shells, and small stones, at a depth ranging from the upper sublittoral to 100 m, on a bed of stone and sand.

Distribution. Reports in literature: Northern coast of Canada in the Dolphin Strait and Weton (Osburn, 1923), and the Gulf of St. Lawrence (Whiteaves, 1901). Although this is a boreal species distributed along the eastern coast of the Atlantic Ocean from Bode on the northwestern coast of Norway (G. Sars, 1872 in Nordgaard, 1918: 27) down to the southern coast of France (Smitt, 1868a; Fischer, 1870; Jolliet, 1877; Hincks, 1880a; Nordgaard, 1896, 1906b, 1918; Borg, 1930a; Marcus, 1940), and was not found in the Barents Sea, its recovery by Osburn and Whiteaves in the cold waters off the northern coast of North America, and in the Gulf of St. Lawrence, does not exclude its penetration to the higher latitudes of the eastern hemisphere.

This is a boreal species.

5. Genus **Bicellarina** Levinsen, 1909

Bicellaria Blainville, 1830 : 423 (part.); *et auctt.; Bicellarina* Levinsen, 1909 : 99.

The zooids are not divided by transverse graduations (interceptions); the neighboring zooids adjoin each other along their entire length. The oblong zooids are strongly broadened in the distal half, and stretch into a narrow cylinder in the proximal part. The aperture has a triangular shape. Each outer distal corner has 1 to 2 long, bent spines. The ovicells are located on the distal margin. The avicularia are mobile. The radicular fibers start from the basal wall of the zooid.

Genus type: *Bicellaria alderi* Busk.

Bicellarina alderi (Busk, 1859) (Figure 225)

Bicellaria alderi Smitt, 1868a : 289, t. 18, f. 4-8; Hincks, 1880a : 70, pl. IX, f. 3-7 ; Nordgaard, 1918 : 26; *Bicellarina alderi* Levinsen, 1914 : 564.

The zoaria are large (up to 3 to 4 cm in height), and dichotomously branched. The branches consist of 2 rows of adjoining zooids. The zooids are large (length 0.88 to 1.25 mm, width at the distal end 0.34 mm, at the proximal end of 0.08 mm), thin-walled, transparent, and oblong; they have a broader distal, and a stretched, strongly narrowed, cylindrical, proximal part. The roundish-triangular aperture has an almost straight, distal margin, and occupies less than half the length of the zooid. The zooids, adjoining in rows, are not always tightly fused with each other. There is usually 1, but sometimes 2, fairly long and bent spine near the outer distal corner of the aperture. The avicularium is small (length 0.18 mm, height 0.15 mm, thickness 0.13 mm), capitate, thick, and with the help of a small peduncle, flexibly attached to the lateral margin of the proximal side of the zooid, in the corner between the lateral and distal margins of the maternal zooid. The ovicells are hyperstomial and semicircular; they have an uncalcified outer layer, and a radial pattern on the calcareous, frontal surface of the inner layer.

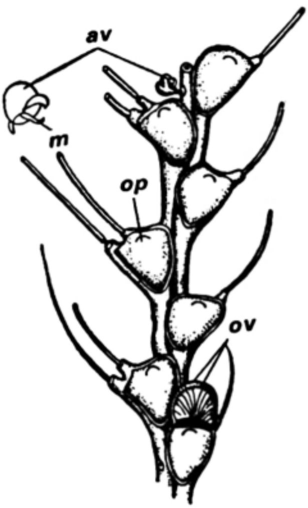


Figure 225. *Bicellarina alderi* (Busk). Part of a zoarial branch (from Hincks, 1880b).

The radicular tubes originate from the lateral wall of the proximal part of many zooids; these tubes are stretched along the basal side of the underlying zooids and, fusing with each other, form more or less thick bundles supporting the thin branches; near the base of the zoarium they fuse together to give rise to still thicker bundles which support the entire zoarium, and simultaneously serve to attach the zoarium to the substrate.

The species lives on hydroids, especially *Gorgonaria,* shells, and stones, at a depth of 100 to 1,130 m, on a bed of stone, silt, and sand, under temperatures varying from −0.69 to 6.7°C.

Distribution. Reports in literature: Barents Sea (Nordgaard, 1900), western Norway (M. Sars, 1863b; Nordgaard, 1896, 1905, 1918), Shetland Islands (Norman, 1868), eastern Greenland (Levinsen, 1914), and the northern Atlantic Ocean (Nordgaard, 1900, 1907b, 1918).

This is a boreal, Atlantic species.

6. Genus **Corynoporella** Hincks, 1888

Corynoporella Hincks, 1888 : 215; Robertson, 1905 : 284; *Brettia* Waters, 1900 : 52 (part.).

The zoarium is free-growing, and consists of zooids arranged in a single row with their frontal surface directed to one side. The branches are dichotomously divided.

The zooids are oblong; the aperture occupies up to half the length of the zooid, and its lower, tube-like part narrows toward the proximal end. Each daughter zooid starts from the middle of the distal wall of the maternal zooid; when branching occurs, the second daughter zooid originates from the neighboring pore plate, and the newly formed branches separate at a right angle from the base of the zooid. The flexibly articulated avicularia are attached to the lateral margin of the aperture. The ovicells are hyperstomial.

Genus type: *Corynoporella tenuis* Hincks, 1888.

Corynoporella tenuis Hincks, 1888 (Figure 226)

Corynoporella tenuis Hincks, 1888 : 215, pl. XX, f. 1; *Brettia minima* Waters, 1900 : 52 (part.), pl. 7, f. 5-7; *Corynoporella spinosa* Robertson, 1905 : 284, pl. XIV, f. 81-83.

The zoaria are free-growing and small, and consist of thin, translucent, dichotomously divided branches. The branches consist of one row of long (length 1.00 to 1.25 mm, width 0.20 mm), thin, translucent zooids, which gradually broaden toward the distal end. The oval aperture slightly narrows toward the proximal end, and is surrounded by a slightly thickened margin; it occupies from one-third to one-half of the zooidal length. One small spine is often present in each distal corner. The proximal end of the zooid is usually chitinized and uncalcified, giving great elasticity to the branches. The avicularium is flexibly attached by a short, thin stalk to a place slightly above the middle part of one of the lateral margins of the aperture. It is short, semi-circular from the side, and fairly thick, although its structure is subject to a certain amount of variation, both in form and in thickness. The daughter zooid originates from the middle part of the distal wall of the maternal zooid, and the septum which divides them in a pore plate with 2 to 4 pores. One or 2 pore plates of varying size are located along both sides of the latter. On branching, another daughter individual originates from one of the lower plates and 2 branches form, which diverge from the base of the zooid at an angle. Radicular fibers, originating from one of the lower plates, or from the basal wall in the proximal part of the zooid, help attach the zoarium to the substrate. The ovicells are hyperstomial and almost round; their height is somewhat more than their width, and they have a radial pattern on the calcified frontal surface of the inner layer, while the ectooecium is membranous and transparent.

The species lives on calcareous Bryozoa and crabs, at a depth varying

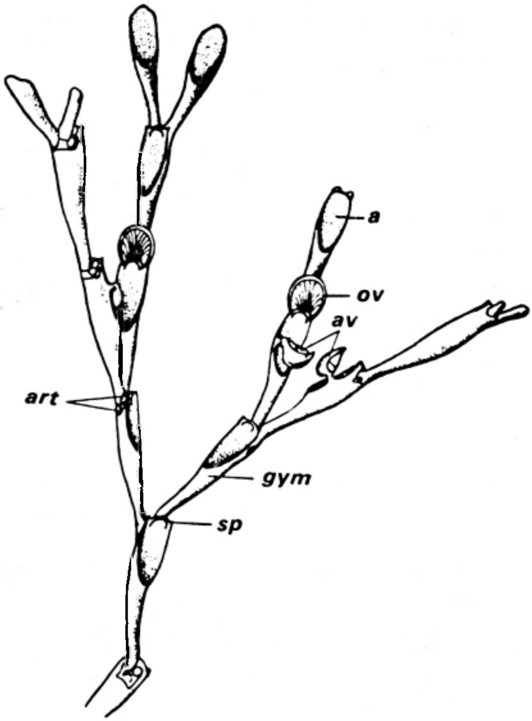


Figure 226. *Corynoporella tenuis* Hincks. Part of a zoarium.

from 80 to 170 m, on a bed of stone, under a temperature of 3.2°C.

Distribution. The species was found by me in the Barents, Bering, and Okhotsk seas. *Reports in literature:* Barents Sea (Waters, 1900), Gulf of St. Lawrence (Hincks, 1888), and the northern coast of Alaska (Robertson, 1905).

This is an Arctic-boreal species.

7. Genus **Semibugula** Kluge, 1929

Semibugula Kluge, 1929 : 5.

The zoarium is free-growing, dichotomously branched, and unjointed. The zooids are arranged in 2 rows on one side. There is an unjointed, pointed spine at the upper, outer corner of the zooid. A sessile, lateral avicularium with a triangular mandible is sometimes frequently, sometimes rarely, found underneath the spine. Jointed, mobile avicularia are absent. Ovicells are hyperstomial.

This genus occupies an intermediate position between the families *Bicellariidae* and *Scrupocellariidae.*

Genus type: *Semibugula birulai* Kluge, 1929.

Semibugula birulai Kluge, 1929 (Figure 227)

Semibugula birulai Kluge, 1929 : 5; 1955a : 89, fig. 32; 1955b : 105, t. 22, fig. 3.

The zoaria are free-growing, dichotomously branched, and unjointed. The branches consist of 2 closely lying rows of zooids. The zooids are

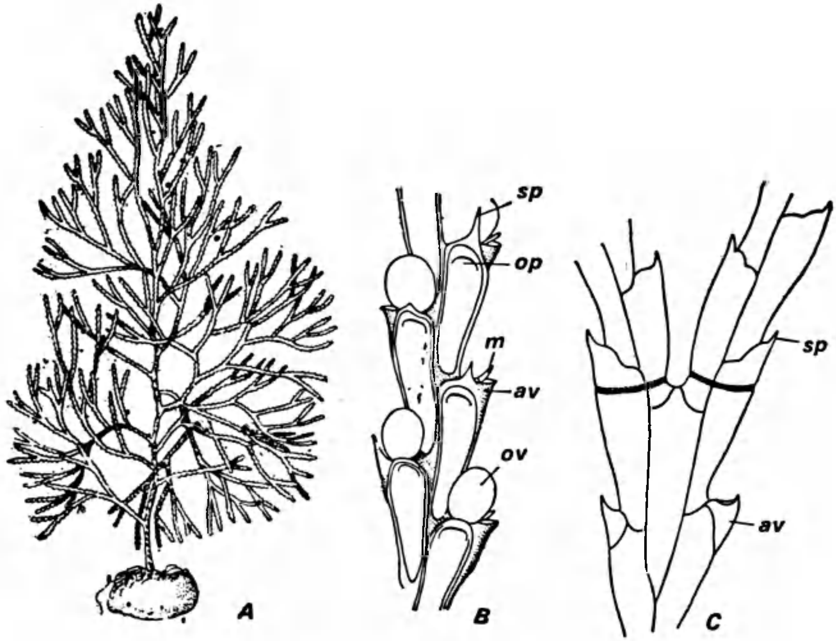


Figure 227. *Semibugula birulai* Kluge. *A*—general view of a zoarium; *B*—part of a zoarial branch, frontal side; *C*—part of a branch, lateral side, showing the method of branching. (Figures *A* and *B*—from Kluge, 1955b).

oblong (length 0.85 mm, width 0.28 mm), slightly narrow in the proximal part, and gradually widen in the distal direction. The aperture, occupying a larger part of the frontal surface, is surrounded by a thick margin. An unjointed spine, located on the outer distal corner, points forward and narrows toward its tip. The lateral, immobile avicularium with its pointed mandible, is located under the spine. The avicularium, found very rarely, varies in its development from almost unobservable to a goodly size. The hyperstomial ovicells are round and somewhat stretched, and have a slightly raised, frontal surface. The lateral wall has 2 pore plates with 3 to 4 pores, and the distal septum has 1 large pore plate with 10 pores. Numerous radicular fibers stretch throughout the proximal part of the zoarium, which originate from the outer, lateral wall of the proximal part of the zooid. Although the zoaria in this species are unjointed, the development of future joints is more or less clearly marked on them in the form of a weakly chitinized strip (belt), which passes transversely to the newly formed branches at the level of the angle of bifurcation; because of this, the branches are better protected against breakage by bending.

The species lives on hydroids, tubes of worms, annelids, shells, and stones, at a depth of 9 to 170 m, on a bed of silt and silt mixed with stone, under temperatures ranging from −1.7 to 4.78°C, in a salt concentration of 31.80‰.

Distribution. The species was found by me in the Barents (Yugorsk Shar Strait), Kara, Laptev, Okhotsk, and Chukotsk seas, and in the Bering Strait. *Reports in literature:* Laptev and Chukotsk seas (Kluge, 1929).

This is an Arctic-boreal, Pacific species.

II. Family **Sadkoidae** Kluge fam. n.

The zoaria are free-growing, ramified, and unjointed. The branches consist of zooids, usually arranged in pairs and fused by their basal sides; each overlying pair is located at a right angle to the underlying one. The aperture occupies a large part of the frontal surface. Spines may be absent or present. A long, pedunculate avicularium is located under the proximal margin of the aperture. Ovicells are not known to occur. The zoaria are fixed to the ground by radicular fibers which arise from the sides of the zooids, near the base of the zoarium.

Key for Identification of the Genera of the Family Sadkoidae

1 (2). Zoaria not uniform in the structure of zooids in the proximal and distal halves. Zooids in the distal half have long, aculeate and pilose protuberances .... 1. *Uschakovia* Kluge (see p. 437).

2 (1). Zoaria uniform in the structure of zooids in the proximal and distal halves. Zooids devoid of aculeate and pilose protuberances. .... 2. *Nordgaardia* Kluge gen. n.

Genus type: *Synnotum pusillum* Nordgaard.[6]
Northern Atlantic Ocean, depth 1,100 m.

Genus **Uschakovia** Kluge, 1946

Uschakovia Kluge, 1946 : 196.

The zoaria are free-growing and branched. The branches consist of a series of paired zooids, which fuse with each other by their basal sides; each succeeding pair is located at an angle of 90° to the preceding one, i.e., they are arranged in a crisscross manner. The zooids in both the lower and upper parts of the zoarium are arranged in pairs with their dorsal sides to each other, and each overlying pair is located at a right angle to the underlying one. The oblong zooids narrow and become tubular in the lower half, while gradually broadening toward the distal end up to the point of origin of the tubular protuberances, which rest on wide, round bases at the middle line of the frontal wall. It is at this point that the difference in the structure of the zooids in the lower and upper parts of the zoarium begins. Beyond the first tubular protuberances on the frontal surface, the distal end of the zooids in the lower part of the zoarium, slightly narrows and forms a roundish, distal surface behind, and a small, semi-circular protuberance ahead on the frontal side, which appears conical on the lateral side. The distal end of the zooids in the upper part of the zoarium appears as a forward, continuous, semi-circular surface; the more chitinized margin of the semi-circular operculum is located near the distal margin of this surface. The aforementioned paired, tubular protüberances remain short in the lower part of the zoarium, but strongly overgrow and form long, thin, hairy tubes that are 6 times, or more, longer than the length of the zooid, in the upper part of the zoarium. Initially, they are pointed forward, because of which (together with the similarity of structure in the other zooids), the core (axis) of the upper part of the zoarium appears, at first glance, to be covered with a hairy coat. While the zooids of the lower part of the zoarium are uncalcified, though covered with a thick layer of cuticle which gives a typical yellow color to this section, the zooids in the upper part of the zoarium are calcified, thin-walled, hyaline, transparent, and whitish in color. The frontal wall of the zooids in the lower part of the zoarium, gradually broa-

[6] Nordgaard (1907b: 5) described a form taken from the Atlantic Ocean at a depth of 1,100 m, under the name of *Synnotum pusillum* which, according to the structure and location of its zoarium, closely resembles the *Uschakovia gorbunovi* described by me. He included the form in the genus *Synnotum* Hincks, but the latter markedly differs in the structure and arrangement of its avicularia, and is closer to the genus *Notamia* Hincks. Therefore, I am including Nordgaard's form in the new genus, *Nordgaardia*, as *Synnotum pusillum* Nordgaard.

dens toward the distal end. The zoaria consist of 2 parts—the lower in which the zooids are covered with a more or less thick, yellowish cuticle, are devoid of polypides, and have no avicularia, and the upper in which the zooids are calcified, thin-walled, and transparent, and have polypides, long, tubular, hairy protuberances on the frontal side, and long, straight, pedunculate avicularia. Ovicells are not known to exist.

Genus type: *Uschakovia gorbunovi* Kluge, 1946.

Uschakovia gorbunovi Kluge, 1946 (Figure 228)

Uschakovia gorbunovi Kluge, 1946 : 196, t. 1, fig. 1-4.

The zoarium usually appears to consist of 2 parts—the lower or proximal, and the upper or distal. The lower is usually short and sparsely branched, while the upper is usually dichotomously branched. Since branching takes place in the proximal part, closely, one after the other, and the branches do not diverge, the zoarium gives the impression of being fascicularly branched. A sort of interstice is usually found between the two parts of the zoarium, throughout the growth of its core (axis), caused by the fact that further growth of the zooids in pairs stops in the axis of the lower part of the zoarium or its branches, and one of the distal zooids buds a longer zooid (up to 1.40 mm) from the basal side which, in turn, sometimes produces by budding a similar daughter zooid (perhaps 2), whose walls are bent toward each other. From this (or these) zooid starts the further growth of the upper part of the zoarium. But sometimes such an interstice in the structure of the zoarium, i.e., a wedging of one-rowed zooids between the upper and lower parts, does not form; then the lower part is gradually covered by a solid, yellow cuticle, while the upper part becomes membranous, with the aperture of the zooids occupying almost the entire frontal surface. While the zooids in the lower part of the zoarium are devoid of avicularia, those in the upper part have long, straight, pedunculate avicularia on the side of the frontal surface, below the aperture. The avicularium is pressed on the sides and bent on the distal end like a tube; it has a narrow, oblong, and pointed mandible. Thin, paired, weakly chitinized, and translucent radicular tubes originate from many zooids in the lower part of the zoarium, and sometimes even from the aforementioned zooids, which are intermediate between the lower and upper parts of the zoaria. These radicular tubes originate at the basal side of the zooids and help attach the zoarium to the substrate. The zooids in the lower part of the zoarium are almost always filled with a white, granular mass; there is no trace of the polypides that are always found in the zooids of the upper part. Ovicells have not been reported. The structural differences in the zooids

Figure 228. *Uschakovia gorbunovi* Kluge. *A*—general view of a complete zoarium; *B*—lower part of a zoarium with radicular tubes, and paired, short, tubular protuberances; *C*—beginning of the upper part of a zoarium with long tubular protuberances and avicularia; *D*—an avicularium, lateral view (all sketches from Kluge, 1946).

of the lower and upper parts notwithstanding, their formation is the same. The semi-circular protuberance of the frontal side on the distal, roundish surface in the zooids of the lower part of the zoarium, is the operculum; it bends backward when the zooidal orifice opens and, at this stage, the zooids are covered by a thicker, chitinous coating. I once observed an instance in which the operculum with an open orifice was bent backward, and the distal end of the zooid in the upper part of the zoarium, assumed a shape similar to that of a zooid in the lower part. It is difficult to comment on the origin of the zooids in the lower part of the zoarium in this species, due to the absence of material on the earliest stages of development, starting from the aperture. To me it would seem that initially these zooids had polypides, but later these were converted into a folded place for the storage of nutritional substances required for the growth of such a complex zoarium.

The species lives on small stones, at a depth of 64 to 698 m, under temperatures ranging from −0.90 to −1.40°C, in a salt concentration of 34.65 to 34.92‰.

Distribution. The species was found by me in the Kara and East Siberian seas.

This is a high Arctic species.

III. Family **Scrupocellariidae** Levinsen, 1909

Scrupocellariidae Levinsen, 1909 : 89, 130; Harmer, 1926 : 348; *Cellulariidae* Smitt, 1868a : 281 (part.); *Cellulariidae* Hincks, 1880a: 30 ; *et auctt.*

The zoaria are free-growing, branched, and single-layered. The branches consist of 2, or 2 to 4 zooidal rows, whose frontal sides are pointed in one direction; they are either jointed with well-developed, chitinous articulations, or unjointed. The aperture varies in size; the cryptocyst likewise varies in development. Spines are usually present near the distal margin of the aperture. In some genera, the scutum or fornix is present in the form of a continuous or ramose plate which stretches horizontally above the aperture; it is attached to the middle of the margin of the aperture by a stem. Heterozooids are of the following types: lateral avicularia in the outer, distal corner of the zooid; frontal avicularia, paired or single, on the frontal side, usually near the proximal margin of the aperture; basal avicularia in the distal part of the basal side of the zooid (in *Notoplites normani* Nordgaard); and lastly, vibracula on the basal side near the proximal margin of the zooid, usually in contact with the lateral avicularium of the preceding zooid, or occupying almost the entire basal side of the zooid. The mandibles of the vibracula are either narrow pointed plates or resemble more or less long flagella. The distal septum of the zooid originates vertically from the basal side initially, and then, coming closer to the frontal side, bends in the distal direction; as a result, the proximal part of each zooid partly covers its predecessor at its basal side. The ovicells are hyperstomial.

Key for Identification of the Genera of the Family Scrupocellariidae

1 (14). Vibracula absent. Zoaria jointed.

2 (3). Lateral avicularia absent. Branches consist of 2 rows of zooids; internodes have a large number of zooids; spine may or may not be present on the outer, distal corner; frontal avicularia present or absent. Ovicells hyperstomial...1. *Bugulopsis* Verrill (see p. 442).

3 (2). Lateral avicularia present.

4 (11). Scutum present.

5 (6). Radicular fibers, strongly developed, stretch along the basal side of the branches, and surround the lateral margins of the latter on both sides, as well as the margin of the fork of ramification, and almost continuously over the basal side of the branches in the proximal part of the zoarium................................2. *Notoplites* Harmer (part.) (see p. 444).

6 (5). Radicular fibers not strongly developed, and do not cover the basal side of the branches with a continuous row of tubes.

7 (8). Scutum completely covers the aperture and a part of the ovicell; its cavity divided into a large number of lobes...................4. *Scrupocellaria* Van Beneden (part.) (see p. 455).

8 (7). Scutum does not fully cover the aperture; its cavity not divided into lobes.

9 (10). Scutum fully developed in the form of a roundish, triangular, complete lobes............3. *Tricellaria* Fleming (see p. 450).

10 (9). Scutum either weakly developed (and bifurcated on the free end or in the form of a simple, narrow rod), or totally absent. ....4. *Scrupocellaria* Van Beneden (see p. 455).

11 (4). Scutum absent.

12 (13). Frontal avicularium present..2. *Notoplites* Harmer (see p. 444).

13 (12). Frontal avicularium usually absent; if present, very rarely. ....3. *Tricellaria* Fleming (part.) (see p. 450).

14 (1). Vibracula present.

15 (16). Zoaria unjointed. Large vibracula arranged in double rows along the basal side of the branches, almost fully cover it.

Flagella denticulate.......5. *Caberea* Lamouroux (see p. 463).

16 (15). Zoaria jointed. Small, triangular vibracula located in the proximal part of the basal side of the zooid. Mandibles, sharp and not denticulate...4. *Scrupocellaria* Van Beneden (see p. 455).

1. Genus **Bugulopsis** Verrill, 1879

Cellularia Busk, 1851 : 82; *et auctt.*; *Bugulopsis* Verrill, 1879a : 53.

The zoaria are free-growing and branched. The branches are jointed and consist of 2 to 3 rows of adjoining zooids. A row of pores (3 to 5) stretches along the outer margin of the distal part of the zooid on the basal side. Frontal avicularia either present or absent. Vibracula are absent. Ovicells are hyperstomial. Radicular fibers are present.

Genus type: *Cellularia peachi* Busk, 1851.

1 (2). Frontal avicularia absent.................1. *B. peachi* (Busk).
2 (1). Frontal avicularia present.....1a. *B. peachi* var. *beringia* Kluge.

1. **Bugulopsis peachi** (Busk, 1851) (Figure 229)

Cellularia peachi Busk, 1851 : 81, pl. VIII, f. 1-4; 1825b : 20, pl. XXVII, f. 3-5; Smitt, 1868a : 285, 322, t. 17, f. 51-53; Hincks, 1880a : 34, pl. V, f. 2-5.

The zoaria are free-growing white, glassy, dichotomously branched, and jointed. The branches consist of 2 rows of alternating zooids. The internode usually consists of 7 to 9 zooids. The oblong zooids (length 0.65 to 0.85 mm, width 0.18 mm) narrow in the proximal part, and have an oval aperture, which occupies from one-half to two-thirds of the zooidal length. The margin of the aperture is raised in the distal half; a narrow cryptocyst that is slightly granular is located in the proximal part. A small, unjointed spine is situated on the outer distal margin, but it is often absent. A row of 3 to 5 small pores stretches on the basal side of the distal half along the outer margin. Avicularia are absent. The ovicells are round and have a reticular surface. The radicular fibers originate from the lateral side of the proximal part of the zooid; these tubes stretch along the basal and lateral sides toward the proximal part of the zoarium, where they fuse into bundles fixed to the substrate.

The species lives on hydroids, shells, and stones, at a depth of 5.5 to 450 m, often from 40 to 200 m, on a bed of stone, shells, and silt, under temperatures varying from −1.9 to 4.78°C, in a salt concentration of 31.80 to 34.78‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and in the coastal waters of Labrador, and western and eastern Greenland. *Reports in literature:* Barents Sea (Smitt, 1868a; Urban, 1880; Vigelius, 1881-82; Bidenkap, 1897, 1900a, 1900b; Waters, 1900; Kluge, 1906; Kluge in Deryugin, 1915), White Sea (Bidenkap, 1900b; Kluge, 1907, 1908a, 1928; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Nordgaard, 1912b), Archipelago of the Canadian Islands (Osburn, 1936), Hudson Bay (Osburn, 1932), Labrador (Packard, 1863, 1866-69, 1877a), western Greenland (Levinsen, 1914; Osburn, 1936), eastern Greenland (Levinsen, 1916), Gulf of St. Lawrence (Hincks, 1888; Whiteaves, 1901), near Cape Cod (Verrill, 1879b), Iceland (Nordgaard, 1924), Shetland Islands and Great Britain (Hincks, 1880a), northern part of the Atlantic Ocean (Nordgaard, 1918), Boguslen (Smitt, 1868a), Finmark (Nordgaard, 1918), and Vancouver Island near the western coast of North America.

This is an Arctic-boreal, circumpolar species.

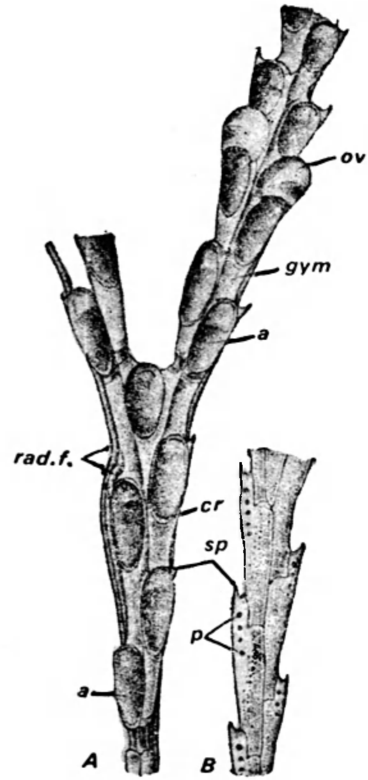


Figure 229. *Bugulopsis peachi* (Busk). *A*—part of a branch from the frontal side; *B*—part of an internode from the basal side. Barents Sea (Kola Bay).

1a. **Bugulopsis peachi** var. **beringia** Kluge, 1952 (Figure 230)

Cellularia peachi Osburn, 1912 : 223, pl. XXI, f. 20 bis ; *Bugulopsis peachi* var. *beringia* Kluge, 1952 : 142 ; 1955b : 105, t. XXII, fig. 2.

The zoaria have a structure similar to that of *B. peachi* (Busk), but the zooids usually differ in that they have a strongly developed, unjointed, sharp spine at the outer, distal corner, and this spine gives them a peculiar, distinct appearance. However, this spine varies in development, and is sometimes absent. Another difference between the two species is the stronger development of the cryptocyst along the lateral and proximal margins of the aperture. The third and most important difference is the presence of a sessile, frontal, oval avicularium with a semi-circular mandible under the proximal margin of the aperture in the present species; the free end of the mandible is pointed downward. The avicularium is usually present near the distal middle zooid of the internode, located near its fork, and often even in other zooids.

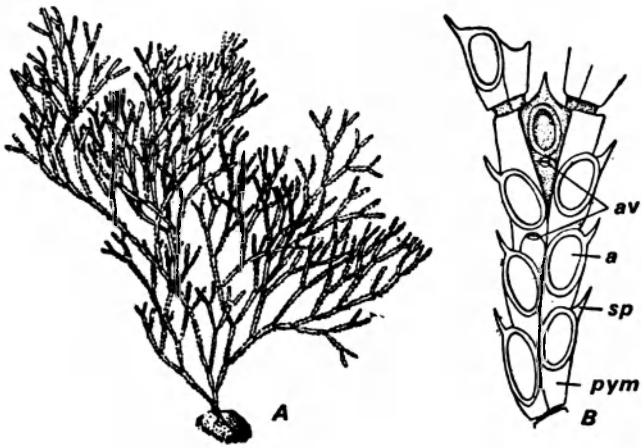


Figure 230. *Bugulopsis peachi* var. *beringia* Kluge. *A*—general view of a zoarium; *B*—a simple internode near the fork of bifurcation, frontal side (from Kluge, 1955b).

The species lives on hydroids, Bryozoa, and shells of bivalved mollusks, at a depth of 15 to 72 m, on a bed of stone, shells, and sand, under temperatures ranging from 7.5 to 16.4°C, in the White Sea.

Distribution. The species was found by me in the Chukotsk and Okhotsk seas. *Reports in literature:* White Sea (Gostilovskaya, 1957), and the eastern coast of North America in the region of Woods Hole (Osburn, 1912).

This is an Arctic-boreal, Pacific species.

2. Genus **Notoplites** Harmer, 1923

Menipea Lamouroux, 1816 (part.); *Scrupocellaria* Van Beneden, 1845 : 26; Harmer, 1923 : 348; 1926 : 351.

The zoaria are free-growing and ramified. The branches consist of 2 rows of adjoining zooids. The zooids are oblong with a comparatively short aperture. The scutum and frontal and lateral avicularia are either present or absent. The basal avicularia, close to a vibraculoid form, may or may not be present; if present, they border the fork of bifurcation. The radicular fibers arising from these and other parts of the zooid, lie close to the margins of the branches and strengthen the fork. These strongly developed fibers stretch along the basal side of the branches, surround the lateral margins of the latter from both sides, as well as the margins of the fork, and almost fully cover the basal side of the branches in the proximal part of the zoarium.

The ovicells are hyperstomial and large, with an orifice in the middle of the frontal surface of the ectooecium.

Genus type: *Notoplites rostratus* Harmer, 1923.

1 (2). Scutum present.................... 1. *N. jeffreysii* (Norman).
2 (1). Scutum absent.
3 (6). Frontal avicularium small and sessile. Spines near the distal margin are either present and number from 1 to 4, or absent.
4 (5). When present, spines number 1 on the inner margin, and 2 to 3 on the outer margin of the aperture. Ovicells long with a roundish, uncalcified surface on the outer layer.................. ....2. *N. sibirica* (Kluge).
5 (4). When present, spines number 1 on the inner margin and 1 to 2 on the outer margin of the aperture. Ovicells roundish and slightly narrow in the proximal part; there is an oval surface on the frontal side of their outer layer.......3. *N. smitti* (Norman).
6 (3). Frontal avicularium pedunculate and markedly raised above the aperture. Spines present near the distal margin, numbering from 3 to 6......................4. *N. normani* (Nordgaard).

1. **Notoplites jeffreysii** (Norman, 1868) (Figure 231)

Menipea jeffreysii Norman, 1868 : 213, pl. V, f. 4-8; 1893 : 446, pl. XIX, f. 1; 1903a : 579; Hincks, 1880a : 42, pl. IX, f. 1-2; Nordgaard, 1905 : 164; 1906b : 77; 1918 : 35.

The zoarium is free-growing, transparent, hyaline, dichotomously branched, and jointed. There are 6 to 9, and sometimes even more, zooids in an internode. The zooids are oblong but narrow toward the proximal end; the oval aperture with its slightly raised margin, occupies half the length of the zooid. Three long spines are usually located in the distal margin of the young zooids, but in the more adult zooids the middle spine drops and only 2 remain in the form of shorter cylindrical spokes.

The scutum, attached to the upper part of the inner margin of the aperture, is large and convex, and its margins rather closely adjoin the margins of the aperture; its almost straight, distal margin stretches transversely to the aperture, and leaves the semi-circular orifice open, as it were, in the calcareous, frontal surface which, at first glance, appears to

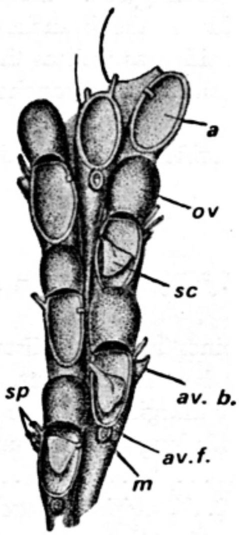


Figure 231. *Notoplites jeffreysii* (Norman). Part of an internode, frontal side (from Hincks, 1880a).

be continuous. A raised, frontal avicularium is located under the proximal margin of the aperture, with its mandible's sharp end pointed downward. The lateral avicularium, located directly under the angular spine, is small. The ovicells are round and oblong, and have a slightly raised, smooth surface. Numerous radicular fibers stretch along the basal side of the branches, often surrounding the lateral margins of the branches from both sides, as well as the fork of bifurcation; in the proximal part of the zoarium, they almost continuously over the basal side of the branches, gathering into a thick bundle near the zoarial base, which helps attach the zoarium to the substrate.

The species lives on small stones and shells, at a depth of 63 to 753 m, under temperatures ranging from −1 to 6°C.

Distribution. Barents Sea. *Reports in literature:* Begfiord in Varangerfiord (Norman, 1893, 1903a), western Norway (Norman, 1893; Nordgaard, 1918), Shetland Islands (Norman, 1868), Ireland (Nichols, 1911), and the northern part of the Atlantic Ocean (Nordgaard, 1900).

This is a boreal species.

2. **Notoplites sibirica** (Kluge, 1929) (Figure 232).

Scrupocellaria sibirica Kluge, 1929 : 4; 1946 : 194, fig. 1; *Cellularia scabra* forma *elongata* Smitt, 1868a : 284 (part.).

The zoarium is free-growing, dichotomously branched, and jointed. There are 6 to 8, rarely 10, zooids in an internode, which are arranged in 2 rows. The zooids are oblong (length 0.63 to 1.25 mm, width 0.25 mm) and gradually narrow toward the proximal end. The aperture usually occupies more than one-half of the zooidal length, and is surrounded by a slightly thicker margin. The cryptocyst is absent. Spines near the distal margin of the aperture are sometimes absent, sometimes present; when present, they are frequently located near the end of the branches, 1 on the inner, and 2 to 3 on the outer, and sometimes 1 in the middle of the distal margin, near the zooid, in the fork. A small, lateral avicularium with a pointed mandible is located on the outer, distal corner. A small frontal avicularium, located under the proximal margin of the aperture, has a raised, sharp apex which points toward the proximal side; the entire avicularium tilts in a direction opposite to the neighboring one in the zooid bordering it. Vibracula are absent. The ovicells are oblong and their outer layer has a roundish, uncalcified surface.

There are 2 pore plates with 4 to 5 pores in the lateral wall, and many (up to 10) simple pores in the lower half of the distal septum. Radicular fibers originate from the lateral side of the proximal part, and drop down along the basal side, often even along the lateral margins of both sides of the branches, toward the proximal part of the zoarium, where they fuse, sometimes forming thick bundles which help attach the colony to the substrate.

The species lives on Bryozoa, shells, and stones, at a depth of 40 to 598 m, more often 80 to 400 m, on a bed of stone and silty sand, under temperatures ranging from −1.9 to 1.53°C, in a salt concentration of 34.29 to 34.92‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, and Chukotsk seas. *Reports in literature:* Laptev Sea (Kluge, 1929).

This is a high Arctic species.

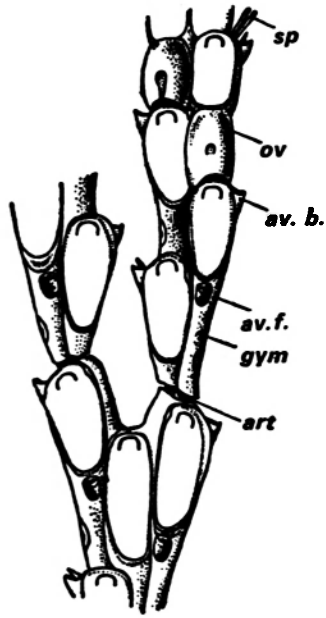


Figure 232. *Notoplites sibirica* (Kluge). Part of a branch, frontal view. Polar Basin.

3. **Notoplites smitti** (Norman, 1868) (Figure 233)

Cellularia ternata forma *duplex* Smitt, 1868a: 283, t. 16, f. 25-26; *Menipea duplex* Levinsen, 1887: 309, pl. 26, f. 1-2; *Membranipora smitti* Norman, 1868 : 241; *Scrupocellaria smitti* Waters, 1900 ; 57, pl. 7, f. 8-11.

The zoaria are free-growing, dichotomously branched, and jointed. The internode has 6 to 18 zooids arranged in 2 rows. The zooids are oblong (length 0.75 mm, width 0.18 mm) and slightly taper toward the proximal end. The aperture is oval and has a raised margin in the distal half, and a narrow cryptocyst in the proximal part. One articulated spine is usually located near the outer, distal corner, although the number of spines on the distal margin varies; sometimes there are 1 to 2 spines on the outer corner, and 1 on the inner, and sometimes there are no spines at all. A lateral avicularium with a sharp mandible is located directly under the angular spine; a frontal avicularium with a strongly raised, sharp end is located under the proximal margin of the aperture, and is mandible's sharp tip points downward. The scutum is absent. A small cavity juts out from the outer lateral side of the proximal part of the zooid into the cavity of the latter. This is the chamber from which the radicular fibers originate, often running transversely until they meet the neighboring branch. These chambers are found in all the zooids, regardless of whether the radicular fibers are present or absent. The ovicells are roundish, tall, and slightly narrow in the proximal part; their oval orifice is situated in the middle of the frontal surface of the outer layer.

The species lives mostly on various, calcareous Bryozoa and shells, at a depth from 1.5 to 698 m, on a bed of stone and silt, under temperatures ranging between −1.4 to 2.2°C, in a salt concentration of 31.44 to 34.94‰.

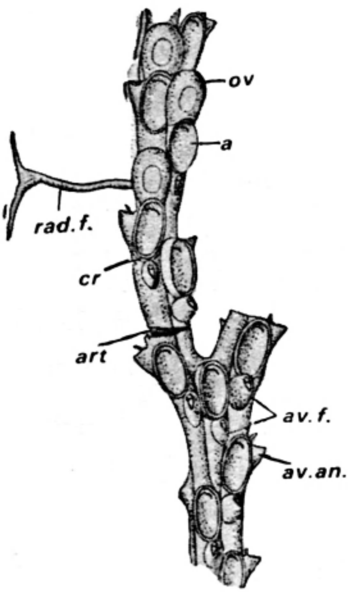


Figure 233. *Notoplites smitti* (Norman). Part of a branch, frontal view. Polar Basin (north of Franz Josef Land).

Distribution. This species was found by me in the Barents, Kara, and Laptev seas, and in the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1868a; Marenzeller, 1877; Bidenkap, 1897, 1900a; Waters, 1900; Andersson, 1902), Kara Sea (Smitt, 1879a; Levinsen, 1887; Nordgaard, 1912b; Kluge, 1929), Laptev Sea (Kluge, 1929), northern coast of North America (Osburn, 1923), Davis Strait (Norman, 1906), and eastern Greenland (Kirchenpauer, 1874; Andersson, 1902).

This is a high Arctic species.

4. **Notoplites normani** (Nordgaard, 1900) (Figure 234)

Menipea normani Nordgaard, 1900 : 4, pl. I, f. 2-8; *Notoplites normani* Kluge, 1946 : 195.

The zoarium is free-growing, dichotomously branched, and jointed. The internode usually has 5 to 7 zooids arranged in 2 adjoining rows. The zooids are oblong (length 0.75 mm, width 0.20 mm), taper in the proximal half, and broaden in the distal part, which is slightly tilted outward. The aperture is oval and occupies about one-third of the length of the zooid. The margin of the aperture is raised, and the inner side surrounded by a narrow cryptocyst. There are 3 to 6 spines along the distal margin of the aperture. The avicularia are of 2 types. The lateral avicularium is small with a raised rostrum, and located more on the basal than the lateral side of the distal part of the zooid; therefore it is often unnoticeable when observing the zooid from the frontal side. The frontal avicularium, located directly under the proximal margin of the aperture, is strongly raised above the latter in the form of an initially tapering and flattened stem, which then broadens toward the end; on this "stem" is located a raised stem whose mandible's sharp tip points downward.

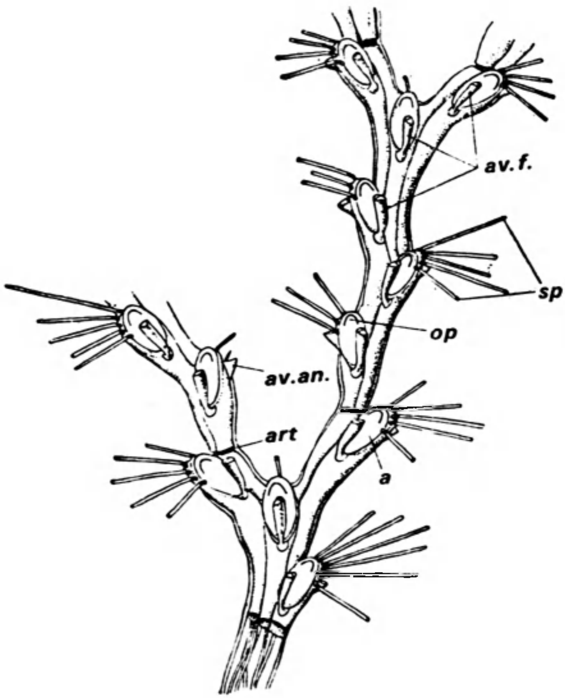


Figure 234. *Notoplites normani* (Nordgaard). Part of a zoarium.

The ovicells are round and tall; they are broader in the distal half and narrower near the proximal margin; a reticulate sculpture is seen on the frontal surface. The radicular fibers, arising from the lateral side of the proximal part of the zooid, stretch along the basal wall, as well as the lateral margins of both sides, to the proximal end of the zoarium, where they gather into thick bundles which help attach the zoarium to the substrate.

The species lives on Bryozoa, shells, and stones, at a depth of 184 to

698 m, on a bed of stone, silt, and sand, under temperatures ranging from -1.48 to 1.5°C, in a salt concentration of 34.63 to 34.92‰.

Distribution. The species was found by me in the higher latitudes of the Barents and Kara seas. *Reports in literature:* Norwegian Sea (Nordgaard, 1900, 1905, 1907c, 1918).

This is a high Arctic species which dwells in deep water.

3. Genus **Tricellaria** Fleming, 1828

Tricellaria Fleming, 1828 : 540; Harmer, 1923 : 317; *Cellularia* Smitt, 1868a : 382 (part.); *Menipea* Busk, 1852b : 20 (part.); Hincks, 1880a : 36.

The zoaria are free-growing, dichotomously branched, and jointed. The branches consist of 2 rows of zooids arranged in a single layer, and their frontal side is directed toward one side. The internodes usually consist of 3 to 5 to 7 zooids. The zooids are oblong, the aperture occupies a small part of the frontal surface, and the cryptocyst is weakly developed in the proximal part. The scutum and the lateral and frontal avicularia may or may not be present. The basal avicularia or vibracula appear absent, but they might possibly be present in the form of pore chambers on the radicular fibers.

Genus type: *Cellularia ternata* Ellis and Solander, 1786.

1 (2). Internodes consist of 3 zooids. Two spines usually visible from the basal side, in the middle of the distal margin of the middle, distal zooid in short internodes. In longer internodes, only 1 spine is present, but there are 4 or 3 corresponding spines on the frontal side.............. 1. *T. ternata* (Ellis and Solander).

2 (1). Most internodes in the zoarium consist of 5 to 6 zooids. One spine usually visible from the basal side, in the middle of the distal margin of the middle distal zooid, and there are 3 corresponding spines on the frontal side.

3 (4). Oval aperture usually covered with a roundish, triangular scutum. Lateral and frontal avicularia sometimes present, sometimes absent......................... 2. *T. gracilis* (Van Beneden).

4 (3). Oval aperture not covered with the scutum. Lateral avicularium rarely found; frontal one absent......................... .... 2a. *T. gracilis* var. *inermis* Kluge.

1. **Tricellaria ternata** (Ellis and Solander, 1786) (Figure 235)

Cellularia ternata forma *ternata* Smitt, 1868a : 282, 305, t. 16, f. 10-14; *Menipea ternata* Busk, 1852b : 21, pl. XX, f. 3-5; Hincks, 1880a : 38, pl. 6, f. 1-4; *Tricellaria ternata* Borg, 1930a : 73, f. 71; Marcus, 1940 : 161, f. 85.

The zoaria, in the form of small, tender bushes, consist of closely dichotomous, divided, and jointed branches, which usually bend inward at the tips. The internodes usually consist of 3 zooids. The zooids are oblong and vary significantly in length—from 0.83 to 1.00 mm in the short internodes, and from 1.13 to 1.5 mm in the longer ones; they narrow in the proximal part and broaden in the distal. The distal part has an oval aperture which occupies about one-third of the zooidal length. The aperture is partially covered with a roundish, triangular scutum. There are 3 to 4 jointed spines on the distal margin of the aperture, and 4 near the fork of the middle, distal zooid, of which the 2 middle ones

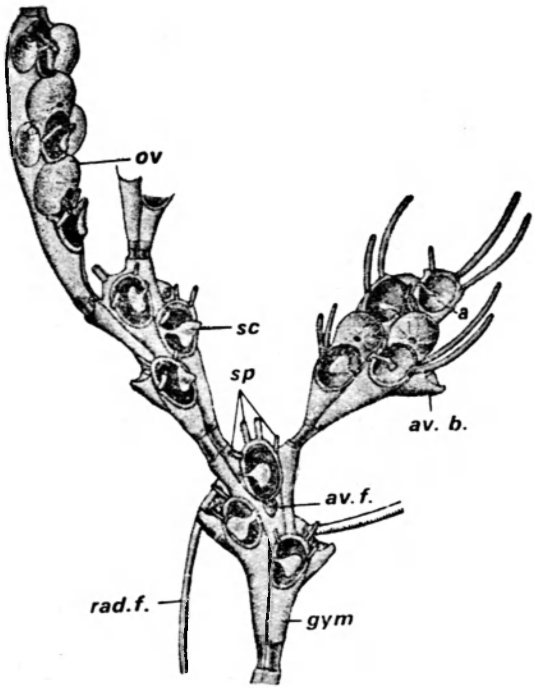


Figure 235. *Tricellaria ternata* (Ellis and Solander). Part of a zoarium from the frontal side. Barents Sea.

are located closer to each other, and are always visible from the basal side. The 2 proximal zooids usually have 3 spines, 1 near the inner corner, and 2 near the outer; often one of them, either the upper but more often the lower one, attains a great length. The lateral avicularia are large, raised, and usually present on the 2 proximal zooids in the internode; their frontal surface is markedly broadened in the comparatively shorter internodes. A very small frontal avicularium, located directly under the proximal margin of the aperture, is usually found only in the distal zooid, but sometimes it is present in all the zooids of the internode. The ovicells are large and stretched, and have a smooth frontal surface.

The species lives on algae, hydroids, Bryozoa, and shells, at a depth of 1.8 to 243 m, more often from 20 to 100 m, on a bed of stone, shells, and sandy silt, under temperatures ranging from −1.61 to 5.6°C, in the White Sea up to 14°C, in a salt concentration of 34.23 to 43.00‰, in the White Sea 26.09 to 33.80‰.

Distribution. The species was found by me in the Barents, Kara, Bering, and Okhotsk seas, and in the waters off Labrador and western Greenland. *Reports in literature:* Barents Sea (M. Sars, 1851; Smitt, 1868a, 1879b; Urban, 1880; Vigelius, 1881-82; Nordgaard, 1896, 1900, 1907a, 1912a, 1923; Bidenkap, 1897, 1900a, 1900b; Andersson, 1902; Norman, 1903a; Kluge, 1906; Kluge in Deryugin, 1915), White Sea (Bidenkap, 1900a; Kluge, 1907, 1908a; Kluge in Deryugin, 1928; Guerin-Ganivet, 1911; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Levinsen, 1887), northern coast of North America and the Archipelago of the Canadian Islands (Osburn, 1932, 1936), Labrador (Packard, 1863, 1866-69; Hincks, 1877a), western Greenland (Smitt, 1868c; Hincks, 1877a; Norman, 1906; Kluge, 1908b; Levinsen, 1914; Osburn, 1919, 1936), Gulf of St. Lawrence (Whiteaves, 1901), eastern Greenland (Levinsen, 1914), Yan-Maien Island (Lorenz, 1886), Iceland (Smitt, 1868a; Nordgaard, 1924), western Norway (Smitt, 1868a; Nordgaard, 1918), Skagerrack (Smitt, 1868a), North Sea (Ortmann, 1894), British Isles (Hincks, 1880a), Belgium (Van Beneden, 1848), along the eastern coast of North America from Woods Hole to Labrador (Osburn, 1912, 1913, 1933), and the Pacific coast of North America (Hincks, 1882; Robertson, 1900, 1905-1906).

This is an Arctic-boreal, circumpolar species.

2. **Tricellaria gracilis** (Van Beneden, 1848) (Figure 236)

Cellularia ternata forma *gracilis* Smitt, 1868a : 283, 308, t. 16, f. 17-23; *Menipea ternata* Osburn, 1912 : 222, pl. 21, f. 19.

The zoaria consist of more or less long, straight, dichotomously divided, and jointed branches. The internodes usually consist of 5 to 9 zooids, but the ovicell-carrying internodes reach up to 16 zooids. The zooids are oblong (length 1.25 mm, width 0.20 mm) and have an almost uniform width throughout their length. The oval aperture occupies from one-third to one-fourth of the zooidal length, and is covered, except for the distal part, by a roundish, triangular scutum. The distal margin usually has 3 spines, 1 at the inner corner and 2 at the outer; 1 of the latter, usually the lower one, is sometimes very long. There are 3 spines at the distal margin of the middle, distal zooid near the fork; of these, 2 are lateral and the other, stronger one in the middle, is always visible from the basal side. But the number of spines varies rather greatly; often they are not present at the inner angle, and at the outer corner, there may be 3, 2, 1, or none. The lateral avicularia have a triangular form, a straight outer margin, and no bend in the rostrum. The small, frontal avicularium, directly under the proximal margin of the aperture of the middle, distal zooid at the fork, is not present in all internodes.

The ovicells are round, raised, and oblong, and have a transverse oval orifice in the middle of the frontal surface.

The species varies considerably with regard to the number of zooids in the internodes (particularly in the regions which are transitional to the boreal region, where internodes with 3 zooids are often found), as well as with regard to the presence or absence of spines, avicularia, and the scutum in many zooids of the zoarium.

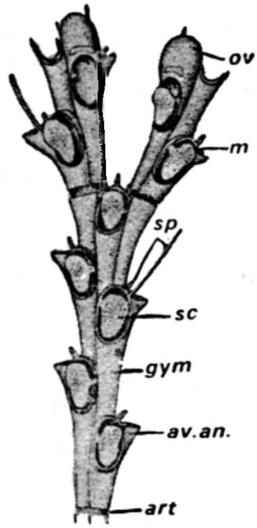


Figure 236. *Tricellaria gracilis* (Van Beneden). Part of a branch from the frontal side. Polar basin (north of Franz Josef Land).

It lives on calcareous Bryozoa, shells, and stones, at a depth of 0 to 869 m, more often from 50 to 150 m, on a bed of stone, shells, and silt, under temperatures ranging from —1.96 to 4.75°C, in the Barents Sea up to 10°C, in a salt concentration of 29.96 to 35.00‰, in the White Sea up to 26.09 to 29.47‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and in the waters off Labrador, eastern and western Greenland, and the Gulf of St. Lawrence. *Reports in literature:* Barents Sea (M. Sars, 1851; Smitt, 1868a, 1879b; Marenzeller, 1877; Urban, 1880; Vigelius, 1881-82; Nordgaard, 1896, 1905, 1907a, 1923; Bidenkap, 1897, 1900a, 1900b; Norman, 1903a; Kluge in Deryugin, 1915; Grieg, 1925; Kuznetsov, 1941), White Sea (Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Levinsen, 1887; Nordgaard, 1923; Kluge, 1929), East Siberian Sea (Kluge, 1929; Nordgaard, 1929), Archipelago of the Canadian Islands (Busk, 1880; Nordgaard, 1906a), Hudson Bay (Osburn, 1932), western Greenland (Smitt, 1868c; Hennig, 1896; Norman, 1906; Kluge, 1908b; Levinsen, 1914; Osburn, 1919), Gulf of St. Lawrence (Hincks, 1880a), eastern Greenland (Kirchenpauer, 1874; Levinsen, 1914, 1916), Yan-Maien Island (Lorenz, 1886), Iceland (Nordgaard, 1924), western Norway (Smitt,

1968a; Nordgaard, 1918), and Skagerrack (Smitt, 1868a).
This is an Arctic, circumpolar species.

2a. **Tricellaria gracilis** var. **inermis** Kluge var. n. (Figure 237)

Menipea arctica Busk, 1855 : 254 (part.), pl. I, f. 4-5; *Cellularia ternata* forma *gracilis* Smitt, 1868a : 283 (part.), t. 16, f. 16; *Scrupocellaria ternata* var. *gracilis* Waters, 1900 : 55 (part.), pl. VII, f. 12.

Structurally, the zoarium resembles the species *T. gracilis,* but it differs more or less strongly from the latter in the structure of its zooids. The occurrence of internodes with 3 zooids is frequent in the zoaria. The zooids are usually strongly stretched, and, in the majority of cases, their oval aperture is devoid of even traces of a scutum. Even spines are sometimes absent, but 1 (rarely 2) articulated spine is usually present in the outer, distal corner. The lateral avicularium is almost absent, and if present (very rarely), occurs in the form of a very small, barely noticeable, angular avicularium. The frontal avicularium is absent.

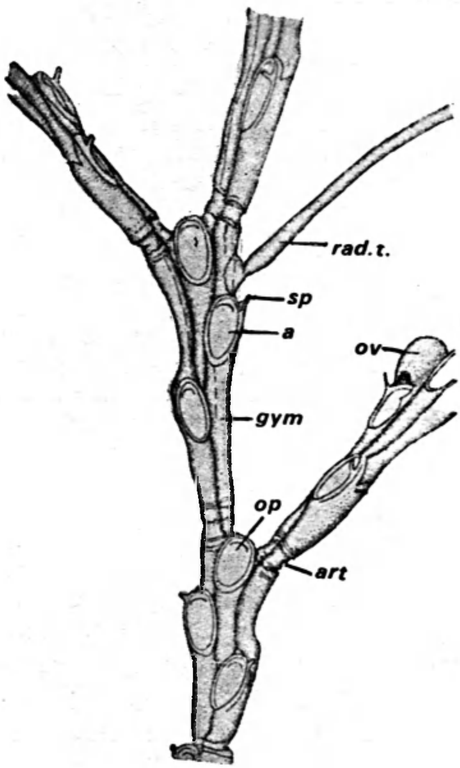


Figure 237. *Tricellaria gracilis* var. *inermis* Kluge var. n. Part of a zoarium from the frontal side. Kara Sea.

The species lives on algae, hydroids, Bryozoa, and shells, at a depth from 4 to 108 m, on a bed of stone, silt, and sand, under a temperature of -1.61°C.

Distribution. The species was found by me in the Barents, Kara, and Chukotsk seas. *Reports in literature:* Barents Sea (Ridley, 1881; Waters, 1900), Yan-Maien Island (Lorenz, 1886), and western Greenland (Busk, 1855).

This is an Arctic species.

4. Genus **Scrupocellaria** Van Beneden, 1845

Scrupocellaria Van Beneden, 1845 : 26; Busk, 1852b : 23; Hincks, 1880a : 43; *Cellularia* Smitt, 1868a : 282 (part.).

The zoaria are free-growing and dichotomously branched. The branches are jointed and consist of 2 rows of mutually adjoining zooids. The internode consists of 5 to 13 zooids. The zooids are often equipped with spines and a scutum. Lateral (angular) and frontal avicularia are either present or absent. Vibracula are either present or absent. If present, they are located on the basal side of the proximal part of the zooids, and their cavity consists of 2 parts separated by a septum: the larger, having muscles which cause the movement of the flagella, and the smaller, opening through a round orifice from which radicular tubes originate in the proximal part of the zoarium. The flagella are simple and non-denticulate. The ovicells are hyperstomial.

The members of the genus *Scrupocellaria* tend to underdevelop, and hence lose some important parts like the scutum, frontal and lateral avicularia, and vibracula. This is particularly significant with regard to the latter part, and therefore the presence of vibracula on the basal side, considered up to now as a main character for distinguishing the genus *Scrupocellaria,* loses strength. Nevertheless, certain species which have no vibracula, such as *S. arctica* Busk and *S. minor* Kluge, must be included in this genus because in all other characteristics they exhibit closer similarity to *S. scabra* Van Beneden and *S. minor* which, it is true, rarely have a vibraculum in the proximal part of the zoarium, but this must be considered a phenomenon of atavistic nature.

Genus type: *Sertularia scruposa* Linnaeus, 1758.

1 (8). Vibracula present (if not in all, in some of the zoaria) on the basal side of the zooids.

2 (3). Scutum oval, sometimes almost reniform; its cavity is not divided into lobes. Vibracular chamber corresponds to the long axis of the zooid; the hair-like flagella of the vibraculum is several times longer than the chamber...1. *S. intermedia* Norman.

3 (2). Scutum roundish and triangular or elliptical; its cavity is divided into lobes by the narrow protuberances of the outer margin growing into it. Vibraculum perpendicular to the long axis of the zooid; pointed flagellum of the vibraculum short, only fractionally longer than the chamber.

4 (5). Scutum small, roundish, and triangular, incompletely covers the aperture.....................2. *S. scabra* (Van Beneden).

5 (4). Scutum large and oval.
6 (7). Scutum narrow and oval, also covers a part of the ovicell; it is slightly concave in the middle, with sparse and short vibracula ....2a. *S. scabra* var. *paenulata* Norman.
7 (6). Scutum broad and oval, completely covers the aperture; it is convex with denser and more strongly developed vibracula........2b. *S. scabra* var. *paenulata* forma *orientalis* Kluge forma n.
8 (1). Vibracula not present on the basal side of the zooid.
9 (10). Scutum large, completely covers not only the aperture, but a part of the ovicell as well................3. *S. minor* Kluge.
10 (9). Scutum either very small, often like a rod, or totally absent. ....4. *S. arctica* (Busk).

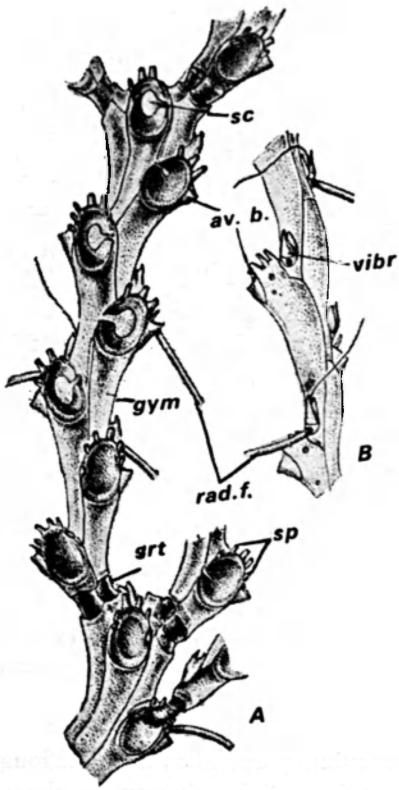


Figure 238. *Scrupocellaria intermedia* Norman. *A*—part of a branch from the frontal side; *B*—part of an internode from the basal side. Norwegian Sea.

1. **Scrupocellaria intermedia** Norman, 1893 (Figure 238)

Scrupocellaria intermedia Norman, 1893 : 450, pl. XIX, f. 9, 10.

The zoaria are free-growing and dichotomously branched. The internodes have from 5 to 7 long zooids (length 0.58 mm, width 0.15 mm) arranged in 2 adjoining rows. The zooids are slightly narrow on the proximal end. The aperture occupies from one-third to a little less than one-half the zooidal length; it has a raised margin and a ring arranged in the form of a cryptocyst. There are 4 to 6 short, strong spines on the distal margin. The scutum, weakly developed and oval, has a continuous margin, and is absent from many zooids. Frontal avicularia are absent. Lateral or angular (corner) avicularia are present on all zooids, though only slightly developed. Small vibracula, arranged on the basal side of the proximal part of the zooid, occupy from one-fourth to one-fifth of the zooidal length. The vibracular chamber corresponds to the long axis of the zooid; the hair-like flagella are several times longer than this chamber. The radicular fibers often arise from the lower chamber of the vibraculum. The ovicells are round, but a little more stretched and flat in the middle.

The species lives on stones, at a depth of 278 m, under a temperature of 5°C; in boreal regions it settles down up to 1,270 m.

Distribution. The species was found by me in the southwestern part of the Barents Sea on the border of the continental steppe. *Reports in literature:* Fiords off the western coast of Norway (Norman, 1893; Nordgaard, 1912a, 1918), and along the northern coast of Iceland (Nichols, 1911).

This is a boreal species.

2. **Scrupocellaria scabra** (Van Beneden, 1848) (Figure 239)

Scrupocellaria scabra Hincks, 1880a : 48, pl. VI, f. 7-11; Levinsen, 1894 : 44, pl. I, f. 19-25; Borg, 1930a : 75, f. 75-76; Marcus, 1940 : 169, f. 89.

The zoaria, free-growing and strongly ramified in the form of grayish-white bushes, reach up to 1 to 2 cm in height. The branches are jointed and consist of 2 rows of adjoining zooids. The internodes are comparatively long and contain from 5 to 12 zooids. The zooids are small (length 0.75 mm, width 0.20 mm) and slightly narrow toward the proximal end. The aperture occupies almost half of the zooidal length; the scutum is small and does not fully cover the aperture. One spine is usually located on each side of the distal margin of the aperture, but sometimes there are 2 spines on the outer side. The lateral (corner) avicularia are small, and their mandibles are slightly bent at the tips. The frontal avicularia are well-developed, but small in size in the sterile zooids. The vibracula are few. The ovicells are hyperstomial,

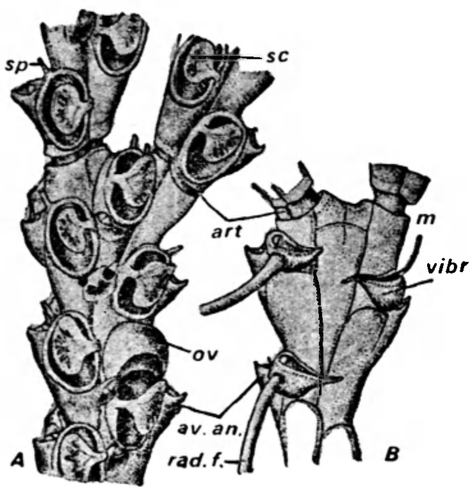


Figure 239. *Scrupocellaria scabra* (Van Beneden). Part of the branches near the bifurcation from the frontal side (*A*), and the basal (*B*). Barents Sea (entrance to the Vaida Inlet).

round, and broad; the proximal margin of the outer layer is not calcified, due to which a sort of broad, transverse orifice forms on the proximal part of the frontal surface.

The species lives on algae, hydroids, Bryozoa, and shells, at a depth of 0 to 228 m, more often from 10 to 150 m, under temperatures ranging from −1.54 to 0.74°C, in a salt concentration of 31.80 to 34.35‰.

Distribution. The species was found by me in the Barents, Kara, Chukotsk, Bering, and Okhotsk seas, and in the waters off western Greenland. *Reports in literature:* Barents Sea (M. Sars, 1851; Smitt, 1868a, 1879b; Nordgaard, 1896, 1912a, 1923; Bidenkap, 1897, 1900b; Norman, 1903a; Kluge, 1906; Kluge in Deryugin, 1915; Guerin-Ganivet, 1911; Kuznetsov, 1941), White Sea (Smitt, 1879b; Kluge, 1908a; Kluge in Deryugin, 1928; Gostilovskaya, 1957), Chukotsk Sea (Osburn, 1923), Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1936), Labrador (Busk, 1880; Osburn, 1913), western Greenland (Fabricius, 1780; Smitt, 1868c; Hincks, 1877a; Busk, 1880; Levinsen, 1914; Osburn, 1936), eastern Greenland (Levinsen, 1916), Yan-Maien Island (Lorenz, 1886), Iceland (Smitt, 1868a; Nordgaard, 1924), western Norway (Smitt, 1868a; Nordgaard, 1905, 1918), Skagerrack (Borg, 1929), Kattegat (Levinsen, 1894; Marcus, 1940), North Sea (Ortmann, 1894), British Isles (Hincks, 1880a), and the region of Woods Hole and the Gulf of Man on the eastern coast of North America (Osburn, 1912, 1933).

This is an Arctic-boreal, circumpolar species.

2a. **Scrupocellaria scabra** var. **paenulata** Norman, 1903 (Figure 240)

Scrupocellaria scabra Hincks, 1889 : 427, pl. 21, f. 1; Waters, 1900 : 54, pl. 7, f. 14-16.

The zoaria are branched and jointed. There are from 5 to 12 thick and oblong zooids (length 0.75 mm, width 0.28 mm) in an internode. The aperture is almost completely covered by a scutum so strongly developed that it also covers half of the ovicell by its upwardly bent, distal end. Its cavity is divided into a large number of narrow lobes. Two spines are usually located on the distal margin of the aperture, 1 near the inner corner, and 1 (sometimes 2) at the outer corner. The lateral avicularium is more or less raised with a bent rostrum. Although the frontal avicularium may develop, it is often absent. The vibracula are of the same type as in *S. scabra* but more strongly developed. Vibracula vary strongly in their development: sometimes they are present in almost all of the zooids of the internode; sometimes only in 1 or 2 zooids of an internode and, in such cases, mostly in the distal part; and sometimes they are absent from all the internodes. The ovicells are round and miter-like, and have an incompletely calcified outer layer in the proximal part of the frontal surface. Radicular fibers arise from the outer, lateral side of the proximal part of the zooid, and continue toward the proximal part of the zoarium.

The species lives on shells, hydroids, Bryozoa, and tubes of worms, at a depth of 1.5 to 454 m, more often from 50 to 150 m, on a bed of stone, shells, and silt, under temperatures ranging from −1.9 to 2.67°C, in a salt concentration of 31.60 to 34.92‰, in the White Sea 26.65‰.

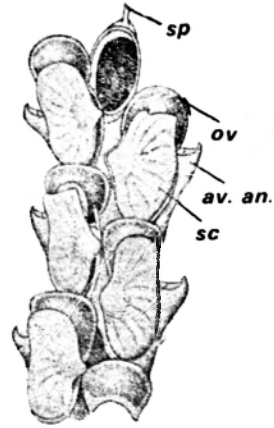


Figure 240. *Scrupocellaria scabra* var. *paenulata* Norman. Part of a branch from the frontal side (from Hincks, 1889).

Distribution. The species was found by me in the Barents, Kara, Laptev, Chukotsk, Bering, and Okhotsk seas, and in the waters off western and eastern Greenland. *Reports in literature:* Barents Sea (Smitt, 1868a; Ridley, 1881; Bidenkap, 1897, 1900a; Waters, 1900; Andersson, 1902; Norman, 1903a; Kluge, 1906; Nordgaard, 1907a, 1918), White Sea (Kluge, 1908a; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Levinsen, 1887; Nordgaard, 1912b, 1923), Archipelago of the Canadian Islands and the northern coast of North America (Busk, 1880; Nordgaard, 1906a; Osburn, 1923, 1932), western Greenland (Smitt, 1868c; Hennig, 1896; Vanhöffen, 1897; Kluge, 1908b; Marcus, 1919; Osburn, 1919), eastern Greenland (Andersson, 1902), Gulf of St. Lawrence (Hincks, 1889; Whiteaves, 1901), and northern Norway (Smitt, 1868a; Nordgaard, 1918).

This is an Arctic, circumpolar species.

2b. **Scrupocellaria scabra** var. **paenulata** forma **orientalis** Kluge, 1955 (Figure 241)

Scrupocellaria scabra var. *paenulata* forma *orientalis* Kluge, 1955b : 106, t. XXII, f. 4.

This form is distinguished first by the almost permanent presence of a large frontal avicularium; second, the almost certain presence of a vibraculum; third, a longer vibraculum, located not only on the entire zooid, but also on not less than half of the neighboring zooid; fourth, a larger and broader fornix, which completely covers the aperture, while in var. *paenulata* the proximal part is in the form of a more or less narrow slit which remains uncovered; and fifth, a weaker development of angular avicularia.

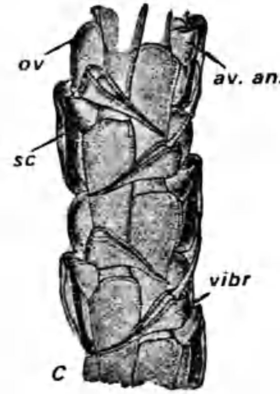
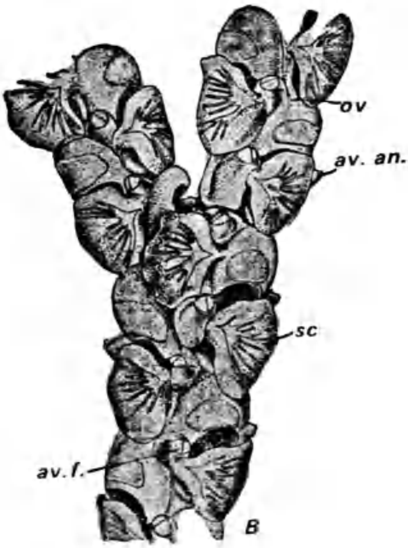


Figure 241. *Scrupocellaria scabra* var. *paenulata* forma *orientalis* Kluge. *A*—general view of a zoarium in natural size; *B*—part of a branch from the frontal side; *C*—part of an internode from the basal side with vibracula (Figure *A* from Kluge, 1955b; Figures *B* and *C*—Polar Basin).



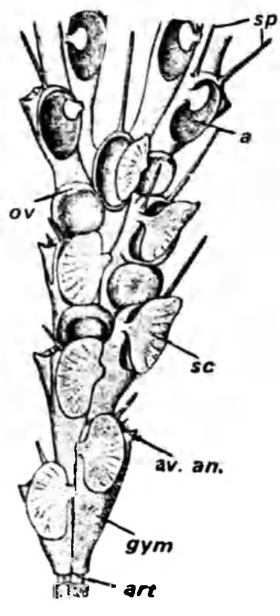


Figure 242. *Scrupocellaria minor* → Kluge. Part of a branch.

Distribution. This form was found by me in the East Siberian Sea north and northeast of Novaya Sibirsk Island, and in our Far East seas, at a depth of 65 to 91 m.

3. **Scrupocellaria minor** Kluge, 1915 (Figure 242)

Scrupocellaria scabra var. *paenulata* forma *minor* Kluge, in Deryugin, 1915 : 378 (nom. nud.); *S. minor* Kluge, 1946 : 194, t. II, f. 1.

The zoaria are small, thin, dichotomously branched, and jointed. The zooids are oblong (length 0.55 mm, width 0.20 mm), thinner in the proximal part and broader in the distal one. The aperture occupies one-half of the zooidal length, and is covered with a scutum similar to that in *S. scabra* var. *paenulata*. There is 1 spine in each distal corner of the zooids. The lateral avicularia are present, but the frontal ones are absent. Vibracula are also absent. The ovicells are round, slightly broadened, and weakly raised. The calcareous layer of the ectooecium is developed only on the sides and the distal side, leaving its entire frontal surface uncovered, and occupied by the smooth surface of the calcareous endooecium.

The species lives on shells of mollusks and calcareous Bryozoa, at a depth of 20 to 315 m, mostly from 100 to 150 m, on a bed of stone, silt, and shells, under temperatures ranging from −1.23 to 2.54°C, in a salt concentration of 34.00 to 35.00‰, in the White Sea 23.63‰.

Distribution. The species was found by me in the Barents and East Siberian seas, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Kluge in Deryugin, 1915), and the White Sea (Kluge in Deryugin, 1928; Gostilovskaya, 1957).

This is an Arctic species.

4. **Scrupocellaria arctica** (Busk, 1855) (Figure 243)

Menipea arctica Busk, 1855 : 254; *Cellularia scabra* forma *elongata* Smitt, 1868a : 284 (part.), t. 17, f. 35-36.

The zoaria are free-growing, dichotomously branched, and jointed. The internodes usually consist of 5 to 7, but sometimes 11 to 13 zooids. The zooids are oblong (length 0.75 to 1.00 mm, width 0.25 mm) and thick, gradually broadening toward the distal end. The aperture, with a weakly margin, occupying one-half to two-thirds the length of the zooid, is oval and often narrows toward the proximal end. The scutum is fixed slightly above the middle part of the inner margin of the aperture which, in its most complete development, has the appearance of a narrow plate that widens toward the free end, where it usually divides into 2 small lobes; but often the scutum has the appearance of a narrow, slightly bent rod, and sometimes it is totally absent. There is usually 1, but sometimes 2, short and jointed spine located on the outer distal corner, but often it is absent. Three spines are usually present in the middle, distal zooid of the internode; of these spines, the middle, larger, unjointed, and broad one is pointed toward the end and always visible from the basal side. A small, lateral avicularium is located directly behind the distal spine in the marginal zooid, while a frontal avicularium is often located on the frontal side under the proximal margin of the aperture, slightly to one side near the base of the scutum of the neighboring zooid. Both of these are poorly developed and are sometimes absent. The vibraculum is absent. The ovicells are round, broad, and miter-like; there is a weak sculpturing on the surface and a large, transverse slit between the outer and inner layers at the proximal margin. Fairly large radicular fibers originate from the lateral side of the proximal part of the zooid, which narrow toward the proximal end of the zoarium where they form thick bundles, which help attach the zoaria to the substrate.

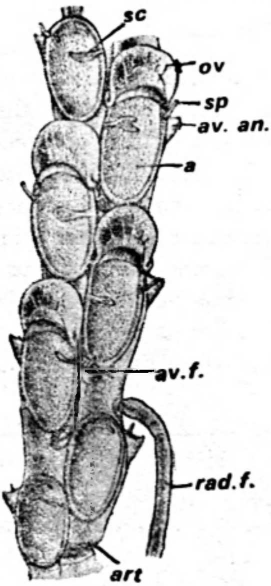


Figure 243. *Scrupocellaria arctica* (Busk). An internode from the frontal side. Barents Sea (Katherine Harbor).

This species tends to vary greatly; it has only one permanent characteristic—the absence of vibracula; other characters such as zooidal length, scutum, lateral and frontal avicularia, and corner spines vary strongly in their development which, under different conditions, could lead to the formation of various forms.

The species lives on algae, hydroids, Bryozoa, and shells, at a depth of 0 to 308 m, more often from 50 to 100 m, on a bed of stone, shells, and silt, under temperatures ranging from −1.61 to 3.2°C, in a salt concentration of 34.27‰.

Distribution. The species was found by me in the Barents, Kara, Bering, and Okhotsk seas, and near the western coast of Greenland. *Reports in literature:* Barents Sea (Smitt, 1868a, 1879b; Bidenkap, 1897; Waters, 1900; Norman, 1903a; Kluge, 1906; Kluge in Deryugin, 1915; Nordgaard, 1918; Kuznetsov, 1941), White Sea (Kluge, 1907, 1908a; Gotilovskaya, 1957), Archipelago of the Canadian Islands (Nordgaard, 1906a), western Greenland (Busk, 1855; Smith, 1868c; Norman, 1876, 1906; Hincks, 1877; Kluge, 1908b; Levinsen, 1914), and along the southern coast of Alaska (Robertson, 1900, 1905-1906).

This is an Arctic, circumpolar species.

5. Genus **Caberea** Lamouroux, 1816

Caberea Lamouroux, 1816: 128; Busk, 1852b : 37; Smitt, 1868a : 326; Hincks, 1880a : 57.

The zoaria are free-growing, unjointed, and irregularly branched. The branches consist of 2 to many rows of zooids. The zooids are relatively small, and the aperture occupies a large part of the frontal surface. Small spines are present on the distal corners. The scutum is either present or absent. The lateral avicularia are small, and the frontal are either paired or single. A strongly developed vibraculum, present on the basal side of the zooids, occupies a large part of the surface; its flagella are strongly developed and may be denticulate or smooth. The radicular fibers arising from the vibracular chamber are strongly developed. The ovicells are hyperstomial.

Genus type: *Caberea boryi* Audouin, 1826.

Caberea ellisi (Fleming, 1818) (Figure 244)

Caberea ellisi Smitt, 1868a : 287, 327, t. 17, f. 55-56; Hincks, 1880a : 59, pl. VIII, f. 6-8; Osburn, 1912 : 222, pl. 21, f. 18, 18a, pl. 31, f. 93; Marcus, 1940 : 164, f. 87.

The zoarium is yellow-brown in color and irregularly branched with thick branches that gradually broaden toward the distal end. The zooids are short and broad (length 0.55 mm, width 0.30 mm) and arranged in 2 to 4 rows; they have a roundish-rectangular form, and an oval aperture which, occupying almost the entire frontal surface, is surrounded by a broad calcareous margin that, sloping toward the outer side, is slightly granulated. The marginal zooids have 2 strong spines on the outer distal corner and 1 on the inner; the middle zooids have 1 spine on each corner. The scutum is absent. The very small lateral avicularia, located a little below the distal corner, have a rounded mandible; the slightly larger, frontal avicularia are located under the proximal margin of the aperture, 1 on each side, although sometimes only 1 avicularium is present. The mandible is bordered and directed downward. Strongly developed vibracula are located on the basal side of the zooid. The vibracular chambers are stretched obliquely from the middle line toward the outer distal margin; their flagella are very long and strong, and originate from the distal margin of the chamber. The radicular fibers are strongly developed. They originate from the lateral side of the proximal part of the vibracular chamber toward the medial line of the basal side and, fusing with one of the underlying zooids, form thick bundles along the branch which fuse with similar bundles of neighboring branches, to form a dense, radicular structure at the proximal end of the zoarium, which helps affix it to the substrate.

The ovicells are hyperstomial, semi-circular, and slightly stretched;

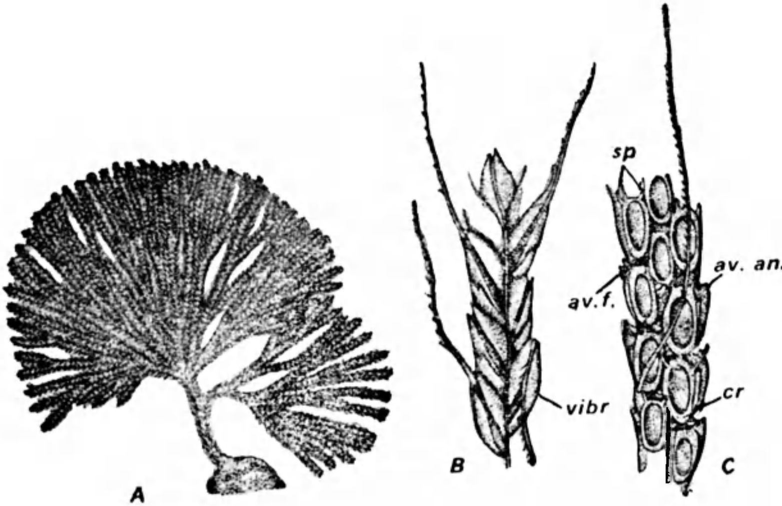


Figure 244. *Caberea ellisi* (Fleming). *A*—general view of a zoarium; *B*—part of a branch from the frontal side; *C*—part of a branch from the basal side (Figure *A*—from Kluge, 1955b; Figures *B* and *C*—from Hincks, 1880a).

they have a flat frontal surface on which the outer layer is not fully calcified; they form a semi-circular orifice from whose margins a thin, radial pattern spreads out toward the periphery.

The species lives on hydroids and Bryozoa, on a bed of stone, sand, and silt, at a depth of 9 to 432 m, more often from 75 to 200 m, under temperatures ranging from -1.23 to 4.95°C, in a salt concentration of 34.50 to 34.79‰.

Distribution. The species was found by me in the Barents and Bering seas, and near the western coast of Greenland. *Reports in literature:* Barents Sea (Danielssen, 1861; Smitt, 1868a, 1879b; Nordgaard, 1896, 1907b, 1918; Bidenkap, 1900a, 1900b; Norman, 1903a; Kluge, 1906; Kluge in Deryugin, 1915; Guerin-Ganivet, 1911; Kuznetsov, 1941), White Sea (Bidenkap, 1900a; Kluge, 1907, 1908a; Kluge in Deryugin, 1928; Gostilovskaya, 1957), Chukotsk Sea (Osburn, 1923), Hudson Bay (Osburn, 1932), Labrador (Packard, 1863), western Greenland (Smitt, 1868c; Hincks, 1877a; Norman, 1906; Levinsen, 1914; Osburn, 1919), Gulf of St. Lawrence (Whiteaves, 1901), Iceland (Smitt, 1868a), western Norway (Smitt, 1868a; Nordgaard, 1918), North Sea (Ortmann, 1894), British Isles (Hincks, 1880a), northwestern coast of France (Joliet, 1877), and along the western coast of North America (Hincks, 1882; Robertson, 1900, 1905-1906; O'Donoghue, 1923, 1926).

This is an Arctic-boreal, Pacific species.

IV. Section *CRIBRIMORPHA* Harmer, 1926

Cribrimorpha Harmer, 1926 : 191.

This section includes all the living and fossil species in which the frontal wall is formed by the fusion of so-called rebra, that originate from the lateral and proximal margins of the zooid, and cover the initial frontal membrane like a canopy. These rebra are nothing more than adjoining hollow spines which arise from the margins of the former aperture. These rebra are initially connected or fused by their ends along the medial line with slit-like interstices between them. When these rebra fuse with each other along the sides at specific intervals, the slit-like interstices divide into a number of inter-rebral pores. The transformation (conversion) of the spines and their fusion with each other can be studied in many species at the time of ontogenetic development in the zooids, such as in *Membraniporella nitida* and *Cribrilina punctata*. The hypostegy or cavity formed between the frontal slit, formed by the fused rebra and the initial frontal membrane, corresponds to the compensatory sac of *Ascophora*. The rebra do not always arise from the very margins of the frontal surface; in some species they originate at a certain distance from the margins and then are encircled by the gymnocyst. Sometimes the rebral surface is strongly reduced due to the gymnocyst, which in such instances, takes up almost the entire frontal surface. But the hypostegy is not reduced in such instances, even though the rebral surface is; rather it lies under the gymnocyst and the rebral surface and, in these instances, plays the same role as the compensatory sac.

Thus, *Cribrimorpha* occupy an intermediate position between *Anasca* and *Ascophora*, having originated from the *Membranipora*-like forms.

The only family in this division is *Cribrilinidae* Hincks.

Family **Cribrilinidae** Hincks, 1880

Celleporidae Johnston, 1847 : 295 (part.); *Eschariporidae* Smitt, 1868b : 3 (part.); *Cribrilinidae* Hincks, 1880a : 182.

The zoaria are prostrate. The frontal wall of the zooid consists of hollow adjoining rebra stretched either transversely, or transversely in the distal half and radially in the proximal. The rebra adjoin or fuse by their inner ends along the medial line, causing interstices to form between them, or they fuse at specific points, giving rise to a series of pores between them. The interstices or pores between the rebra are arranged in the same manner as the rebra themselves. The pores may differ in size and form, but often they are small and large. The rebra either occupy the entire frontal surface of the zooid, or the larger or smaller part not occupied by the gymnocyst. Spines are present at the distal end. Avicularia are either present or absent. The ovicells are peristomial and have either a completely or partially calcified outer layer. A majority of cribrilinids have pore chambers, but there are species which have pore plates as well.

Key for Identification of the Genera of the Family Cribrilinidae

1 (2). Frontal wall consists of rebra which fuse along the medial line and in other places along their length; they are separated by more or less small pores..........3. *Cribrilina* Gray (see p. 469).
2 (1). Frontal wall consists of rebra which fuse but are separated by smaller sized slits or openings.
3 (4). Frontal wall consists of rebra which adjoin or fuse only along the medial line, and are separated by transverse slits.................................1. *Membraniporella* Smitt (see below).
4 (3). Frontal wall consists of short rebra directed toward the central calcareous surface; they are covered with small orifices. Broad openings can be seen between the rebra...2. *Gephyrotes* Norman (see p. 467).

1. Genus **Membraniporella** Smitt, 1873

Lepralia (part.) Johnston, 1847 : 319; *Membranipora* Smitt, 1868a : 366 (part.); *Membraniporella* Smitt, 1873 : 10 (part.); *et auctt.*

The frontal wall of the zooid consists of rebra which arise from the margin of the zooid, or at some distance from it, in the form of continuous plates that either adjoin or fuse with their inner ends along the medial line, and are separated by slits. These slits may differ in that some may stretch transversely, in relation to the frontal surface, in more or less parallel rows, while others arise at an angle to the medial line. Avicularia and ovicells may or may not be present.

Genus type: *Lepralia nitida* Johnston.

Membraniporella nitida (Johnston, 1838) (Figure 245)

Membranipora nitida Smitt, 1868a : 366, 401, t. 20, f. 50-51; *Membraniporella nitida* Hincks, 1880a : 200, pl. XXVII, f. 1-8.

The zoarium, in the form of a silver-bright crust, consists of oval, convex zooids arranged in regular rows. The frontal wall of the zooid consists of a varying number (from 4 to 9 and more on each side) of transverse, parallel rebra separated by slits. The orifice of the zooid is semi-circular; a sharp protuberance is often located in the middle of its proximal margin; this protuberance is formed by the fusion of the first pair of frontal rebra. There are usually 4 (rarely 6) oral spines around the orifice, of which the distal pair is often covered by the ovicell. Sometimes 1 (rarely 2) raised avicularium is located at the proximal end of the zooid with a pointed mandible directed down and out. The ovicells, oblong-roundish in shape, have a smooth or finely granulated surface, and are usually found at the distal ends of the zooids. Two pairs of large, lateral pore chambers, and one distal chamber which is divided into two parts, are located at the margin of the basal side of the zooid.

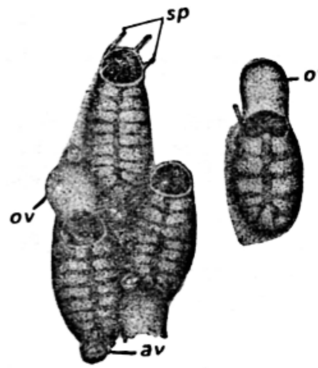


Figure 245. *Membraniporella nitida* (Johnston). Zooids, frontal view (from Hincks, 1880a).

The species lives on shells, stones, ascidia, and other such objects, in the sublittoral zone, at depths of 0 to 150 m, but mostly in shallow water (from 5 to 25 m).

Distribution. Reports in literature: Barents Sea in the region of Nordkin, Finmark (Nordgaard, 1896, 1918), coastal waters off western Norway (Nordgaard, 1906b, 1918), Skagerrack (Smitt, 1868a), southwestern part of the Baltic Sea (Möbius, 1873; Borg, 1930a), western Denmark (Marcus, 1940), North Sea (Borg, 1930a), British Isles (Hincks, 1880a), and northwestern France (Joliet, 1877).

This is an Atlantic, boreal species.

2. Genus **Gephyrotes** Norman, 1903

Escharipora (part.) Smitt, 1868b : 3; *Cribrilina* (part.) Smitt, 1873 : 24; *Gephyrotes* Norman, 1903b : 100.

The frontal wall of the zooid consists of rebra which arise at a certain distance from its margin, and rest against the central, calcareous surface by their inner ends; the central surface is covered with small orifices. Broad openings are apparent between the rebra. The first distal pair of rebra is more strongly developed than the others, and forms the proximal margin of the zooidal orifice; in combination with the second branch of the outspreading, second pair, it is sharply raised upward and forms the distal half of the frontal surface, which is separated from the proximal half by a large, central orifice located between the branches of the second pair of rebra, and a large, lateral opening between the first and second pair. Avicularia and ovicells are present.

Genus type: *Escharipora figularis* forma *nitido-punctata* Smitt, 1868.

Gephyrotes nitido-punctata (Smitt, 1868) (Figure 246)

Escharipora figularis forma *nitido-punctata* Smitt, 1868b : 4, 49, t. XXIV, f. 2-3; *Cribrilina nitido-punctata* Nordgaard, 1896 : 19, pl. II, f. 3; 1906b : 84, t. I, f. 7; *Gephyrotes nitido-punctata* Norman, 1903b : 101, pl. VIII, f. 12-13.

The zoarium, prostrate in the form of a crust, consists of more or less regularly arranged zooids. The zooids are oval with a raised surface. In a young zoarium or in the marginal parts of an older one, the zooids are less sharply separated from each other by deep margins; nearer to the middle of the zoarium, these margins are eradicated under the influence of further calcification of the depression, and the surface of the zoarium seems to consist of the closely adjoined, oval, frontal surfaces of the zooids. The zooids are mildly raised in the proximal half, and abruptly raised toward the orifice of the zooid in the distal half. The frontal wall of the zooid consists of a few short rebra (5 to 6 on each side), which arise at a certain distance from its margin, with their inner ends resting against the common, central, calcareous surface. There are relatively broad openings between the rebra, and the central surface is covered with a few small pores. The first distal pair of rebra is fused by its inner ends along the central line, and forms, together with the upper branches of the second pair of

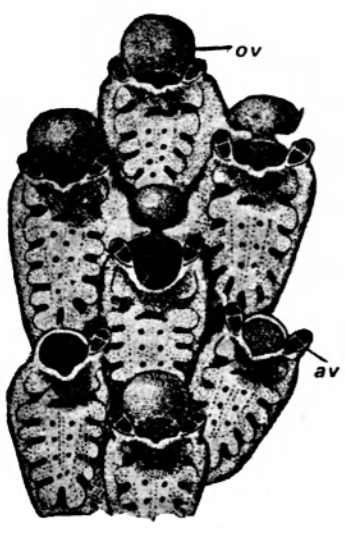


Figure 246. *Gephyrotes nitido-punctata* (Smitt). Part of a zoarium. Finmark (from the collections of Smitt).

rebra, the sharply raised, distal half of the frontal surface; its upper fore-margin constitutes the proximal margin of the semi-circular zooidal orifice. The inner ends of the rebra of the next second pair are bifurcated, and a large, transverse orifice of triangular shape is formed between the fused ends of the upper and lower branches. The lateral openings between the first and second pair of rebra are usually larger than the successive lateral openings, but not less in size than the aforementioned, central, triangular orifice. One avicularium with a roundish-triangular mandible is often found on the sides of the distal margin of the zooidal orifice. The avicularium has a mandible whose sharp apex is pointed to the proximal side. A round, peristomial ovicell with a smooth, non-porous surface, is located on the distal end of the zooid. There are 4 pore plates with a few pores in the lateral wall, and 1 pore plate with many pores in the distal septum.

The species lives on shells, tubes of *Polychaeta*, stones, etc., at a depth of 60 to 100 m.

Distribution. Reports in literature: Barents Sea in the region of Nordkin and Nordkap, Finmark (Nordgaard, 1896, 1918), coastal waters off the western coast of Norway (Smitt, 1868b; Nordgaard, 1895, 1906b, 1918), and the western coast of Greenland (Norman, 1903b; Levinsen, 1914).

This is an Atlantic, boreal species.

3. Genus **Cribrilina** Gray, 1848

Lepralia (part.) Johnston, 1847 : 312; *Cribrilina* Gray, 1848 : 147; Hincks, 1880a : 184; *Escharipora* Smitt, 1868b : 3.

The zoaria are prostrate. The frontal surface of the zooid consists of rebra which arise from either the margin itself, or at a certain distance from the margin. The rebra fuse on the medial line and at many places along their length; they are separated by more or less small pores. There are 2 to 4 spines on the distal margin of the orifice. Avicularia are either present or absent. The ovicells are peristomial and round, and have either a completely or partially calcified outer layer that may or may not have pores on the surface. Most of the species have pore chambers and a few have pore plates.

Genus type: *Cribrilina punctata* Hassall, 1841.

1 (4). Avicularia absent.

2 (3). Zooids small and convex; their frontal wall consists of rebra which fuse along the medial line, and are separated by small, round pores. Ovicells small. There are 2, rarely 3, large pore chambers along the lateral margins of the basal side, and

1 chamber in the distal septum........1. *C. annulata* (Fabricius).

3 (2). Zooids large and flat. Margin of the zooidal orifice has 3 flattened spines. Rebra broad and flat. Ovicells large, slightly raised; 1 terminally broadened spine located on each side of their orifice. There are 2 large pore plates in the lateral wall, and 1 in the distal septum..........2. *C. spitzbergensis* Norman.

4 (1). Avicularia present.

5 (6). Avicularia small with a mandible whose sharp tip is directed perpendicular to the longitudinal axis of the zooid. Ovicells have a fully calcified ectooecium with a smooth surface laden with calcareous spines similar to those in other parts of the zooid..............................6. *C. spiculifera* Kluge.

6 (5). Avicularia large with a mandible whose sharp apex is pointed forward and slightly outward. Ovicells have an incompletely calcified ectooecium that has no spines on the surface.

7 (8). Zooids small. Frontal wall consists of 3 to 4 pairs of rebra, between which large pores are arranged in transverse rows, each row having 4 pores. Pores often appear scattered over the zooidal surface because the rebra are unevenly distributed. There is a triangular incision in the ectooecium of the ovicells, which often have a keel that stretches from the tip of the triangle over the surface in a distal direction......................
..................................4. *C. cryptooecium* Norman.

8 (9). Zooids relatively large. Frontal wall consists of 6 to 8 pairs of rebra, between which are located transverse rows of small pores, each row having 5 to 7 pores. There is a rectangular incision in the ectooecium of the ovicells..................
..................................5. *C. watersi* Andersson.

9 (8). Frontal wall covered with more or less irregularly arranged pores of different size and shape, which are sometimes round, sometimes rectangular. Ovicells round and slightly stretched, have a smooth surface that is covered with a few small pores....
..................................3. *C. punctata* (Hassall).

1. **Cribrilina annulata** (Fabricius, 1780) (Figure 247)

Escharipora annulata Smitt, 1868b : 4, 53, t. 24, f. 8-10; *Cribrilina annulata* Hincks, 1880a : 193, pl. 25, f. 11, 12; Osburn, 1912 : 232, pl. 24, f. 42; *et auctt.*

The zoaria, prostrate in the form of a small, round crust, are reddish or brownish in color. The zooids are oval or roundish-hexagonal, and have a strongly raised surface, due to which the individual zooids are sharply separated by deep margins. The frontal wall consists of closely adjoined rebra which originate at the medial line, and are separated by small pores arranged in transverse rows in the distal half, and in radial rows in the proximal. There are usually 5 to 7 such rows. The proximal margin of the secondary orifice, formed by the first distal pair of rebra, is slightly thickened and stretched forward in the middle in the form of a short and sharply pointed protuberance. The orifice of the zooid is semi-circular. There are 2 to 4, often 3, spines located on the distal margin of the zooid, but only 2 spines in the zooids carrying ovicells. There are small, round, peristomial ovicells in the distal end of the zooids that appear to be bent backward; spines develop on the sides of their orifices, which often fuse by their ends and form a rebra, as it were, on their proximal margin. The surface of the ovicells is covered with pores. Avicularia are absent. There are 2 large pore chambers along the lateral margin of the basal side, arranged in regular rows. The distal septum has 2 chambers usually, but quite often only 1 because the 2 chambers fuse. The ancestrula has a structure which is absolutely identical with that of mature zooids.

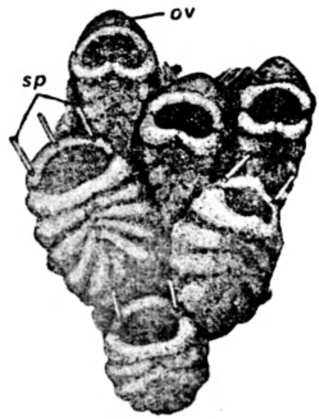


Figure 247. *Cribrilina annulata* (Fabricius). Part of a zoarium.

The species lives on stones, shells, and algae, at a depth ranging between the littoral up to 112 m, on a bed of stone and sand, under temperatures ranging from 1.82 to 1.95°C, in a salt concentration of 31.87 to 33.77‰; but in the White Sea, under temperatures ranging from 4 to 14.4°C, in a salt concentration of 26.60 to 26.87‰.

Distribution. The species was found by me in the Barents, Kara, Chukotsk, and Bering seas, and off western Greenland. *Reports in literature:* Barents sea (Smitt, 1868b; Nordgaard, 1896, 1918, 1923; Bidenkap, 1897; Norman, 1903a; Kuznetsov, 1941), White Sea (Kluge, 1907, 1908a; Gostilovskaya, 1957), Kara Sea (Levinsen, 1887), Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1923, 1932, 1936), Labrador (Packard, 1863, 1866-69; Hincks, 1877a), Gulf of St. Lawrence (Whiteaves, 1901), western Greenland (Fabricius, 1780; Vanhöffen, 1897; Norman, 1903b; Kluge, 1908b; Levinsen, 1914; Osburn, 1919, 1936), eastern Greenland (Levinsen, 1916), Yan-Maien Island (Lorenz, 1886), western Norway (Nordgaard, 1896, 1905, 1918), Skagerrack (Smitt, 1868b), Kattegat (Levinsen, 1894; Marcus, 1940), North Sea (Ortmann, 1894; Borg, 1930a), British Isles (Hincks, 1880a), along the eastern coast of North America from Cape Cod to the Gulf of Man (Osburn, 1912, 1933), and the western coast along the northern part of Alaska (Robertson, 1900).

This is an Arctic-boreal, circumpolar species.

2. **Cribrilina spitzbergensis** Norman, 1903 (Figure 248)

Cribrilina annulata var. *spitzbergensis* Norman, 1903b : 103, pl. VIII, f. 11; *et auctt.*; *C. annulata* Waters, 1900 : 64, pl. 8, f. 21.

The zoaria, prostrate in the form of a crust, are of different sizes and shapes, and consist of zooids arranged in irregular rows. The zooids, large, oblong-oval, or hexagonal in shape, with a more or less flat surface, are separated by mildly deep margins. The frontal wall consists of closely adjoining, flat, broad rebra which, arising from the barely noticeable medial line, are separated by minute pores arranged in 2 to 3 transverse rows in the distal half, and 3 to 4 radial rows in the proximal. Rarely, small pores are found on these rebra which open into the inner cavity of the pores. The proximal margin of the secondary orifice, formed by the first pair of rebra due to a bend in the distal margin of the latter toward the upper side, is usually raised. Sometimes the middle part of this margin is either weakly raised or pointed, and sometimes even depressed, depending upon how the inner ends of the first pair of rebra fuse. There are 3 short, broad, slightly flattened spines with a clearly visible inner cavity on the distal margin of the distal orifice in the younger parts of the zoarium. These spines flatten more as they come closer to the middle part of the zoaria, appearing as broad plates with a barely noticeable, middle, terminally flattened cavity, which follows the preceding one. The distal margin of the zooid has a large, round, slightly raised ovicell that has a smooth surface, which is covered with a few pores and a thin, medial keel. A somewhat triangular plate is located on each side of the proximal margin of the ovicell. This plate is the angular spines which, moving slightly downward, broaden at the upper end; sometimes this distal (adjoining the ovicell) corner overgrows the proximal margin of the ovicell up to a stage of fusion, and thus forms a pecten. Avicularia are not present. Two large, longitudinal pore plates with a few pores of different sizes are located along the lateral wall, which sometimes divide into smaller plates. There is 1 pore plate with 3 to 5 pores arranged in a

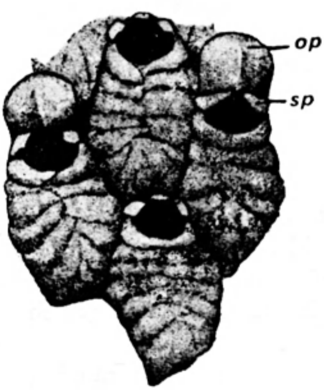


Figure 248. *Cribrilina spitzbergensis* Norman. Part of a zoarium.

row in the lower half of the distal septum.

This species lives on stones, shells of *Polychaeta*, mollusks, and Bryozoa, etc., at a depth varying from 30 to 327 m, more often from 100 to 150 m, on a bed of stone, shell, and silt, under temperatures ranging from −1.9 to 2.56°C, in a salt concentration of 31.44 to 34.83‰; but in the White Sea, under temperatures ranging from 2.3 to 12.5°C, in a salt concentration of 26.87 to 27.48‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, and Bering seas, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868b; Bidenkap, 1900a; Waters, 1900), White Sea (Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Nordgaard, 1912b; Kluge, 1929), Laptev Sea (Kluge, 1929), coastal waters off western and eastern Greenland (Norman, 1903b, 1906; Levinsen, 1914).

This is a high Arctic species, which is more prominent in the eastern hemisphere of the Arctic region.

3. **Cribrilina punctata** (Hassall, 1841) (Figure 249)

Lepralia punctata Hassall, 1841b : 368, pl. IX, f. 7; Hincks, 1880a : 190 (part.), pl. XXVI, f. 1-2; Levinsen, 1894 : 61, t. V, f. 7-22; Osburn, 1912 : 232, pl. XXIV, f. 41, 1933 : 31, pl. 8, f. 5-6; Borg, 1930a : 83, f. 91-92.

The zoaria are prostrate and overgrow in the form of a thin crust with a silvery glaze in a young stage, which thickens and dulls after further growth. The zooids are arranged in straight and oblique rows. They are small, oblong-rectangular, and slightly broader in the middle. The slightly raised frontal surface is covered with more or less irregularly arranged pores of varying size and shape. These pores are sometimes round, and sometimes rectangular; as a result, the development of the frontal surface is sometimes concealed by the fused marginal spines. The orifice is large and transversely oval; there are 2 to 4 spines at its distal margin which sometimes fall, and in the zooids carrying ovicells, the distal pair fuse with the ovicell. The proximal margin of the orifice has a small mucro in the middle, which increases in size with

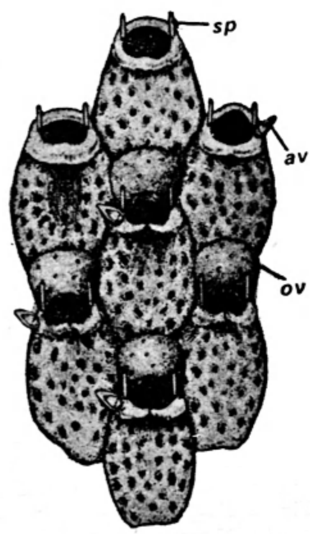


Figure 249. *Cribrilina punctata* (Hassall). Part of a zoarium.

age and is often bifurcated at the end. There is one avicularium on each side, or on one side, of the orifice, whose pointed mandible is directed forward and toward the side. The ovicell is more or less round and slightly stretched; it has a smooth, glassy surface which is covered with a few small pores. There are 5 to 6 pore chambers along the lateral margin of the basal side, and 2 in the distal septum.

The species lives mostly on algae, but also on shells and stones, at a depth ranging from the belt of ebb and flow up to 40 m and more.

Distribution. This species was found by me in the Barents Sea, in the Dal'nie Zelentsi, and in the Gulf of St. Lawrence. *Reports in literature:* Barents Sea (Nordgaard, 1896; Kuznetsov, 1941), White Sea (Kluge, 1908a; Gostilovskaya, 1957), off western Norway (Nordgaard, 1918), Kattegat (Levinsen, 1894; Marcus, 1940), the southwestern part of the Baltic Sea (Borg, 1930a), North Sea (Borg, 1930a), British Isles (Hincks, 1880a), along the northern coast of North America (Osburn, 1923, 1932), western Greenland (Osburn, 1919), and the Gulf of St. Lawrence (Whiteaves, 1901).

This is an Arctic-boreal species.

4. **Cribrilina cryptooecium** Norman, 1903 (Figure 250)

Cribrilina cryptooecium Norman, 1903b : 102, pl. IX, f. 1-2; *Escharipora punctata* Smitt, 1868b : 4, 51, t. 24, f. 4-7.

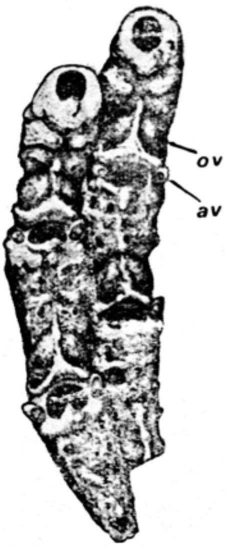


Figure 250. *Cribrilina cryptooecium* Norman. Part of a zoarium. Barents Sea, near Kildin Island.

The zoarium, prostrate in the form of a crust, consists of zooids arranged in more or less regular rows in a checkered pattern. The zooids are small, oblong-rectangular, or hexagonal in shape, and have a convex surface. The frontal wall consists of a small number of rebra, only 3 to 4 pairs. Comparatively large pores, arranged in transverse rows, are found between the rebra; often there are 4 pores in a row. The rebra of the distal pair, forming the proximal margin of the secondary orifice of the zooid, are thick, and by the fusion of their inner ends, form a raised, sharp protuberance in the middle of the proximal margin, which is sometimes bifurcated at the end. The orifice of the zooid is semi-circular. There are 2 small spines at the distal margin of the orifice. There is a small, oval avicularium on one or both sides of the orifice; the avicularium has a mandible whose sharp apex points forward and outward. The ovicells are round; they have an incompletely calcified outer layer which exposes the triangular surface of the open inner layer on the frontal surface. The upwardly bent margin of the ectooecium borders the triangular surface. A keel often stretches in the distal direction from the thickened apex of the triangular surface. This keel sometimes continues up to the proximal part of the frontal surface of the distally located daughter zooid. The surface of the ovicell is small and has no pores. There are 6 pore chambers along the lateral margin of the basal side, and 2 in the distal septum. The chambers along the lateral margin are so narrowed that it sometimes appears as though the pore plates were located in the lateral wall, arranged along the basal margin.

The species is often found on stones and algae, in the littoral zone, near the belt of ebb and flow, and at a small depth in the sublittoral zone.

Distribution. The species was found by me in the Barents Sea along the coast of West Murmansk. *Reports in literature:* Barents Sea in the region of eastern Finmark (Norman, 1903b), coastal waters off western Norway (Norman, 1903b), Skagerrack (Smitt, 1868b), Hebrides and Shetland Islands (Norman, 1903b), Great Britain and Ireland (Hincks, 1880a; Norman, 1903b).

This is an Atlantic, boreal species.

5. **Cribrilina watersi** Andersson, 1902 (Figure 251)

Cribrilina punctata Waters, 1900 : 62, pl. 8, f. 22; *C. punctata* var. *watersi* Andersson, 1902 : 540.

The zoarium, prostrate in the form of a crust, consists of zooids arranged in regular rows in a checkered pattern. The zooids are oblong-rectangular in shape, and have a flat frontal surface. The frontal wall consists of narrow transverse rebra, which thicken in the middle, and look like thin spindles; they are separated by comparatively small pores. The opposite rebra of each pair lie on the medial line which is almost imperceptible. From 6 to 8 rows of rebra and pores can be counted on the zooidal surface, but these rows are not always parallel, the pores are either arranged radially in the proximal half, or they are spread out so that the rows disappear. The rebra of the distal pair, forming the proximal margin of the secondary orifice of the zooid, are thick; being a little longer, their ends bend forward at the point of fusion, leading to the formation of the ligula which covers a large part of the zooidal orifice. One flat, broad spine is situated in the middle of the distal margin which, on greater magnification, appears to consist of 2 closely fused thin spines. Each side of the orifice of the zooid has an oval avicularium whose mandible has its tip directed forward and slightly outward. The distal end of the zooids has round ovicells; their incompletely calcified outer layer exposes the rectangular surface of the open inner layer at the frontal surface of the ovicell. The upwardly bent margin of the outer layer of the ovicell borders the rectangular surface. This surface is located between the avicularia, and the broad, semicircular, smooth surface of the distal half of the oecium (on which pores occur rarely) is visible above it. There are 6 pore chambers along the lateral margin of the basal side, and 2 in the distal septum.

Figure 251. *Cribrilina watersi* Andersson. Part of a zoarium.

The species lives on stones, shells of *Polychaeta* and mollusks, Bryozoa, etc., at a depth of 54 to 698 m, more often from 100 to 250 m, on a bed of stone, silt, and shells, under temperatures ranging from −1.7 to 4.5°C, in a salt concentration of 34.27 to 34.90‰.

Distribution. The species was found by me in the waters of the Barents, Kara, Laptev, and East Siberian seas, and in the coastal waters off western and eastern Greenland. *Reports in literature:* Barents Sea (Smitt, 1879b; Nordgaard, 1896, 1918; Waters, 1900; Andersson, 1902), Kara Sea (Smitt, 1879a), eastern Greenland (Andersson, 1902; Levinsen, 1914), Yan-Maien Island (Lorenz, 1886), Iceland (Nordgaard, 1924), and Northern Norway (Nordgaard, 1918).

This is an Arctic, Atlantic species.

6. **Cribrilina spiculifera** Kluge, 1955 (Figure 252)

Cribrilina spiculifera Kluge, 1955a : 90.

The zoarium, prostrate in the form of a thin crust, consists of zooids arranged in oblique rows. The zooids are medium in size, oval or roundish-hexagonal in shape, and have a raised frontal surface; they are separated by deep margins. The frontal wall of the zooid consists of rebra which arise a little away from its margin, and alternate with transverse rows of pores in the distal half, and radial rows in the proximal. The pores are not large but differ in size and shape. The number of rows of rebra and pores varies from 7 to 9. The rebra of the first distal pair are branched, and the distal branches (their inner ends often fused) are raised sharply upward in a position perpendicular to the frontal surface. A large opening appears between the distal and proximal branches of the first rebral pair in the form of a broad slit or triangle. Two small, unarticulated, conical, calcareous spinules are located slightly below the middle of the proximal margin of the zooidal orifice, on the outer side. Similar spinules can be found on many rebra of the zooids. A small avicularium with its mandible, is located on the margins of the zooidal orifice at either or both sides; the sharp tip of the mandible is perpendicular to the longitudinal axis of the zooid. The oblong, semicircular ovicell has a smooth surface, and is located on the distal end of the zooid; it is covered by calcareous spinules similar to those found in other parts of the zooid. There are 6 pore chambers along the lateral margin of the basal side of the zooid, and 1 in the distal septum.

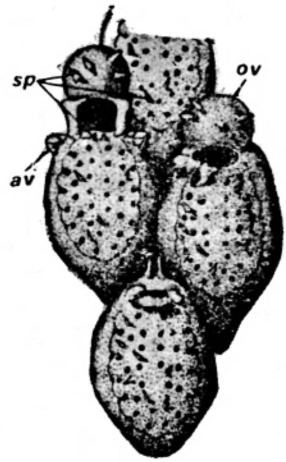


Figure 252. *Cribrilina spiculifera* Kluge. Part of a zoarium. East Siberian Sea.

The species lives on the shell of *Propeamussium groenlandicum* at a depth of 90 m.

Distribution. This species was found by me in the East Siberian Sea, north of the Novo Sibirisk Islands.

Thus far, the species is endemic to the East Siberian Sea.

II. Suborder **Ascophora** Levinsen, 1909

Camarostega Levinsen, 1902 : 2; *Ascophora* Levinsen, 1909 : 213.

The zoaria are prostrate and overgrowing or free-growing. The main distinguishing feature of this suborder is the presence of the so-called compensatory sac. First discovered by Busk (1884) in members of the genera *Siphonocytara* and *Gephyrophora,* and later briefly described under the name of "compensatory sac" in the genus *Catenicella* by Jullien (1888a, 1888b), this organ was studied in detail and described by Harmer (1900, 1903). The investigations of Levinsen (1909) generally confirm the findings of Harmer. As a result of these investigations it became clear that all members of *Cheilostomata* with a convex, frontal, calcareous wall, possess a compensatory sac (see p. 273). The communication between the compensatory sac and the outer environment takes place either continuously through the open ascophore, or temporarily, near the proximal margin of the operculum. Most authors agree with the opinion that the ascophore originated as a result of the separation of the proximal end of the more or less oblong sinus in the primary orifice of the zooid, and thus became an independent orifice. This assumption was based on the observation that the daughter zooids of the ancestrula in some representatives of the genus *Microporella* (*M. impressa*, and others) underwent a direct fusion of the sinus with the future ascophore of fully adult zooids. The temporary communication of the compensatory sac with the outer environment takes place at the time of its widening, as a result of which pressure reduces in the cavity of the sac, and the pressure of the outer water forces the *poster* to drop which, in the invaginated state of the polypide, closes the distally located orifice of the compensatory sac. In the presence of the ascophore, the proximal part of the operculum, or *poster*, is absent. In some genera like *Umbonula, Rhamphostomella,* and others, the operculum is simple and similar to that found in *Malacostega,* but since their compensatory sac opens directly near the proximal margin of the operculum, the proximal margin of the latter continues not into the frontal membrane as in *Malacostega,* but into the lower wall (bottom) of the compensatory sac. In the majority of the members of *Ascophora,* the orifice of the zooid is sometimes encircled by a shorter, sometimes longer, tubular structure, the so-called peristome, which is more strongly developed in the older or ovicell-carrying zooids. In this case the initial orifice, covered by the operculum, is called the primary orifice, while that formed by the thickening of the frontal wall of the body, either through a peculiar, annular lobe, or the 2 lateral lobes of the peristome, is known as the secondary orifice. A slit may be found in the middle of the proximal margin of the primary orifice in some species. This slit, the so-called sinus, varies in size and shape. In some species, there is a denticulate protuberance that is sometimes broad, sometimes narrow, known as the lyrule. A denticle, or so-called condyle, is located on each side of the proximal margin of the primary orifice in most members of *Ascophora.* The complex, chitinous operculum hangs on these condyles. The sinus may also be situated in the middle of the proximal margin of the secondary orifice, or near its proximal margin; or a more or less sharp appendage (known as the mucro), pointing forward and upward, may be located a little below the proximal margin of the secondary orifice. When this mucro (projection), or lobe of the peristome, has an avicularium (in genera *Rhamphostomella, Retepora,* and *Cellepora*), it is known as the rostrum. If the frontal surface is more or less convex, its margins are depressed, but in some species, the margins of the frontal surface are raised or prominent. The pores are often located along the margin of the frontal surface; in many species, these marginal pores are spread all over the surface. Secondary calcification may take place in an initially smooth, frontal surface, either throughout the surface, or only from the margins toward the central part, in the form of rebra; the marginal pores are located in the depressions between these marginal rebra. Oral spines are often absent. The avicularia are usually adventitious, and rarely vicariating. The ovicells are hyperstomial and their ectooecium either completely or partially calcified; rarely are the ovicells endozooecial.

Key for Identification of the Families of the Suborder Ascophora

1 (2). Zoarium, prostrate or free-growing, looks like a series of lumps, and usually consists of a number of layers of semi-erect or erect zooids irregularly arranged. Orifice of the zooid terminal, with 1 or 2 more or less raised rostra which have an avicularium on their apex...........XII. *Celleporidae* Busk (see p. 669).

2 (1). Zoarium, prostrate or free-growing, consists of 1 or 2 zooids arranged in regular or irregular rows; or zoarium cylindrical with zooids arranged in one layer around the middle axis of the stem or branch.

3 (4). Zoarium free-growing and either a complex, sinuate form, or funnel-shaped; lobate nets consist of fused branches with windows or openings........IX. *Reteporidae* Smitt (see p. 637).

4 (3). Zoaria do not form free-growing walls with windows or openings.

5 (6). Zoaria free-growing with chitinous radicular tubes originating from the proximal half of the frontal surface of the zooid. ....II. *Smittinidae* Levinsen (*Pseudoflustra* Bidenkap) (see p. 533).

6 (5). Zoaria devoid of those chitinous radicular tubes of the aforementioned origin.

7 (10). A small, round or semi-circular orifice located proximal to the orifice of the zooid on the medial line of the frontal surface.

8 (9). Primary orifice of the zooid semi-circular with a straight, proximal margin. Below it is situated a round or semi-circular orifice, the ascophore..VII. *Microporellidae* Hincks (see p. 628).

9 (8). Primary orifice round and encircled by a tubular peristome. A round orifice, the spiramen, located at the base of the peristome or below it......VIII. *Tessaradomidae* Jullien (see p. 633).

10 (7). Frontal surface devoid of a round or semi-circular orifice below the proximal margin of the orifice.

11 (16). Primary orifice has a broad, or narrow, or pointed denticle (lyrule) in the middle of the proximal margin.

12 (13). Zoaria prostrate. Proximal margin of the secondary orifice

either has a mucro, or a more or less developed peristome, or neither of the two located on it. Avicularia not present. ....I. *Escharellidae* Levinsen (part.) (see p. 482).

13 (12). Proximal margin of the secondary orifice has no mucro; avicularium located in the middle or on one side.

14 (15). Avicularium located right next to the proximal margin of the secondary orifice, or to one side, corresponding to the plane of the frontal surface...................................... ......II. *Smittinidae* Levinsen (*Smittina* Norman) (see p. 510).

15 (14). Avicularium located at the proximal margin of the secondary orifice in either the conical or semi-circular protuberance, or one of the lateral lobes of the peristome. Avicularium directed toward one or the other side of the zooid, does not correspond to the plane of the frontal surface...................... XI. *Rhamphostomellidae* Kluge (*Rhamphostomella* Lorenz part.) (see p. 650).

16 (11). No denticle on proximal margin of the primary orifice. Avicularium located at the proximal margin of the orifice either in the conical or semi-circular protuberance, or one of the lateral lobes of the peristome; it is directed to one or the other side, or lies on one or the other side of the narrow canal. ....XI. *Rhamphostomellidae* Kluge (*Rhamphostomella* Lorenz part. and *Escharopsis* Verrill) (see p. 650).

17 (24). Proximal margin of the primary orifice straight, barely convex, or concave.

18 (19). Peristome and secondary orifice absent. Zoarium prostrate or free-growing. Zooids large or medium in size. Zooidal orifice large with a mildly convex or concave, proximal margin. Avicularia either present or absent...................... ......II. *Smittinidae* Levinsen (*Umbonula* Hincks) (see p. 569).

19 (18). Peristome and secondary orifice present.

20 (23). Peristome poorly developed, depending upon the thickness of the frontal wall. Zoarium prostrate.

21 (22). Orifice semi-circular, its proximal margin slightly concave. Spines present or absent. Avicularia absent............ ....I. *Escharellidae* Levinsen (*Hemicyclopora* and *Lepralioides*) (see p. 502).

22 (21). Orifice semi-circular, its height more than its width, or vice versa; the proximal margin straight or mildly concave. Avicularia present, arranged asymmetrically or near the margin of the zooid..........X. *Hippoponellidae* Kluge (see p. 644).

23 (20). Peristome more strongly developed, depending upon the

thickness of the frontal wall and the development of the lateral lobes. Zoaria prostrate or free-growing. Avicularium located in the middle of the proximal margin of the secondary orifice, or in the middle of the strongly developed peristome.......
II. *Smittinidae* Levinsen (*Porella* Gray and *Palmicellaria* Alder) (see p. 542).

24 (17). Sinus in the proximal margin of the primary orifice varies in shape from narrow and straight, sharp or rounded at the tip, to broad and bent.

25 (28). Sinus in the proximal margin broad, concave, or semi-circular.

26 (27). Sinus in the proximal margin broad, bent, or semi-circular. Condyles absent. Avicularia absent.......................
.........IV. *Stomachetosellidae* Canu and Bassler (see p. 610).

27 (26). Sinus in the proximal margin broad and more or less concave. Condyles present. Avicularia present in all species, except *Hippodiplosia pertusa*..............................
..III. *Schizoporellidae* Jullien (*Hippodiplosia* Canu) (see p. 598).

28 (25). Sinus in the proximal margin narrow and straight, sharp, or rounded.

29 (30). Sinus in the proximal margin narrow and straight. Avicularia present. Zoaria free-growing, cylindrical, and branched.
........................V. *Myriozoidae* Smitt (see p. 615).

30 (29). Sinus in the proximal margin narrow and straight, sharp, or rounded. Avicularia present or absent. Zoaria prostrate and overgrowing...................................
..III. *Schizoporellidae* Jullien (*Schizoporella* Hincks) (see p. 575).

31 (32). Zoarium prostrate. Zooids small or large. Primary orifice round and without lyrule. Peristome present or absent. Avicularia present or absent.

32 (33). Zooids small, oblong, fusiform, or broad. Primary orifice round, and the sinus in its proximal margin either roundish, or semi-circular with a bent proximal margin. Frontal surface smooth with a transverse pattern, or laden with numerous pores................VI. *Hippothoidae* Levinsen (see p. 620).

33 (32). Zooids large. Primary orifice large, round, or semi-circular. Frontal surface smooth or covered with pores. Paired avicularia may or may not be present.

34 (35). Frontal surface completely covered with pores. Proximal margin of the secondary orifice forms a sharply pointed or broader denticle, or gives rise to a lower, broad, raised portion. Spines absent.....XIII. *Hippopodinidae* Levinsen (see p. 683).

35 (34). Smooth frontal surface has one row of marginal pores. There are 2 to 6 spines on the distal margin of the primary orifice

which is depressed, and forms a strongly developed vestibular arch. Denticulate or saccate protuberance located in the middle of the proximal margin of the secondary orifice..... ....XIV. *Peristomellidae* Kluge (see p. 688).

I. Family **Escharellidae** Levinsen, 1909, char. emend.

Discoporidae (part.) Smitt, 1868b : 25; *Escharidae* (part.) Hincks, 1880a : 295; *Escharellidae* (part.) Levinsen, 1909 : 324.

The zoaria are prostrate and overgrowing. The zooids have a smooth surface which is surrounded by 1 to 2 rows of marginal pores, or rarely, an alveolate surface with the pores on the bottom of the alveoli. There may or may not be a denticle (lyrule) on the proximal margin of the primary orifice. The proximal margin of the secondary orifice often has a sharply pointed or labiate protuberance or mucro, or it has a more or less developed peristome, while the distal margin often has 2 to 8 spines. Frequently, there is a more or less developed, lamellate (discoid) protuberance which lowers down into the cavity from the distal margin of the orifice; this is the so-called vestibular or oral arch. Avicularia are absent. Most genera have pore plates, and rarely these are uniporous or multiporous. The ovicells are hyperstomial, and rarely endozooecial; the outer layer is usually membranous, and rarely partially calcified; the endooecium is calcified without having the ordinary pores.

Key for Identification of the Genera of the Family Escharellidae

1 (6). A denticle (lyrule) or a broad, straight, sharp border located at the proximal margin of the primary orifice.

2 (5). There is a mucro or peristome at the proximal margin of the zooidal orifice.

3 (4). There is a mucro or a more or less developed peristome at the proximal margin of the orifice. Pore chambers located along the basal margin of the zooid.....1. *Escharella* Gray (see p. 483).

4 (3). There is a strongly developed peristome at the proximal margin of the zooidal orifice. There are many pores along the lateral wall and the distal septum...5. *Phylactella* Hincks (see p. 506).

5 (2). There is no mucro or peristome at the proximal margin of the zooids.............2. *Escharelloides* Kluge gen. n. (see p. 498).

6 (1). Denticle or a broad, straight, and sharp border absent from the proximal margin in the transverse orifice of the zooid.

7 (8). Zoiods separated by deep margins. Frontal surface smooth,

surrounded by a row of marginal pores. There are 4 to 6 spines around the orifice........3. *Hemicyclopora* Norman (see p. 502).

8 (7). Zoids separated by a raised margin. Frontal surface covered with pores. Spines absent..4. *Lepralioides* Kluge gen. n. (see p. 505).

1. Genus **Escharella** Gray, 1848

Escharella Gray, 1848 : 125; *Lepralia* (part.) Johnston, 1847 : 325; Busk, 1854a : 75; *Discopora* (part.) Smitt, 1868b : 26; *Mucronella* (part.) Hincks, 1880a : 360.

The zooids usually have a denticle (lyrule) of varying width in the middle of the proximal margin of the primary orifice. A strongly developed vestibular or oral arch often lowers down into the cavity from the distal margin of the orifice. The operculum is either membranous or chitinous. The proximal margin of the orifice is covered from the surface by a more or less pointed labium (mucro), or by a developed and raised peristome which, while moving to the sides, lowers down to the base of the spines, or rests against the closely standing pair of spines. The distal margin of the orifice has 2 to 8 spines. The frontal surface of the zooid is surrounded by 1 to 3 rows of marginal pores. The ovicells, in the majority of cases, are hyperstomial; in certain species, they are pushed back. The majority of the species have numerous, simple, monoporous chambers along the basal margin of the zooid. Avicularia are absent.

Genus type: *Berenicea immersa* Fleming, 1828.

1 (2). There are 2 large pore chambers along the lateral margin of the basal side, and 3 small pore chambers along the distal septum. Orifice of the zooid trapeziform and broad; it has a broad denticle (lyrule), 6 spines, and a flat, straight, suspended but erect mucro at the proximal margin..5. *E. indivisa* Levinsen.

2 (1). Many small, uniform, monoporous chambers along the entire basal margin of the zooid; 2 to 8 spines present.

3 (4). Ovicells endozooecial; zooids flat with raised margins along which short, transverse depressions are located with pores on the bottom; 2 spines present.........2. *E. variolosa* Johnston.

4 (3). Ovicells hyperstomial.

5 (10). Spines number 8.

6 (9). Zooids small; lyrule more or less broad and low; mucro in the form of a small, sharp structure, or a rounded protuberance.

7 (8). Zooids strongly raised with 1 row of marginal pores; height of orifice greater than its width; lyrule broad............

................................9. *E. octodentata* Hincks.

8 (7). Zoids convex, with 1 to 2 rows of marginal pores; orifice semi-circular; lyrule very broad..........................
.............................10. *E. latodonta* Kluge sp. n.

9 (6). Zooids medium in size; lyrule high and narrow, broadens toward the free end; mucro slightly developed or not developed at all...................11. *E. macrodonta* (Levinsen) Kluge.

10 (5). Spines vary from 6 to 2.

11 (18). Zooids have a clearly expressed mucro in the form of a sharp or rounded protuberance, located prior to the orifice.

12 (13). Zooids minute, more or less flat, with 1 row of marginal pores, and frequently, a transverse rebral structure; orifice height greater than its width; lyrule narrow; spines 6...........
................................1. *E. immersa* (Fleming).

13 (12). Zooids medium or large and convex, with 1 to 2 rows of marginal pores; width of orifice greater than its height; adult zooids have 4 to 2 spines.

14 (15). Zooids medium in size; lyrule medium in width; 4 to 2 spines at the distal end; mucro not pushed back.

15 (16). Mucro in the form of a sharp or rounded protuberance, lowers down on the sides toward the base of the 4 spines..........
..............................3. *E. ventricosa* (Hassall).

16 (15). Mucro broadens in the form of a peristome, transforms into the side of the orifice, and fuses with the proximal pair of spines. Spines number 4, sometimes 2; frequently, there are 2 spines at the margins of the zoarium.......................
..............3a. *E. ventricosa* var. *peristomata* Kluge var. n.

17 (14). Zooids large; lyrule broad; mucro pushed back; adult zooids have 2 spines.....................4. *E. dijmphnae* (Kluge).

18 (11). Zooids have a mildly or strongly developed broad peristome, which transforms into the margins of the orifice.

19 (22). Zooids large, flat, or mildly raised, have raised margins, 1 row of marginal pores, a weakly or more developed peristome with a broad, low, straight lyrule, and 2 spines.

20 (21). Zooids almost flat, relatively broad, have a rough granulated surface, thick raised margins, and a weakly developed peristome around the broad orifice, which has a broad, straight lyrule; ovicell broad; 2 to 3 barely noticeable spines present.
..............................6. *E. laqueata* (Norman).

21 (20). Zooids moderately convex and oblong with a thin, raised margin; peristome well-developed and almost round; spines 2.
..............................7. *E. abyssicola* (Norman).

22 (19). Zooids large, strongly raised, with 1 to 3 rows of marginal

pores; peristome strongly developed; 3 spines or, rarely, 2; oral arch strongly developed, ovicell pushed back.................................... 8. *E. microstoma* (Norman).

1. **Escharella immersa** (Fleming, 1828) (Figure 253)

Discopora coccinea forma *Peachi* Smitt, 1868b : 26, 170, t. 27, f. 164-166; *Mucronella Peachi* Hincks, 1880a: 360, pl. 50, f. 1-2; Osburn, 1912 : 243, pl. 26, f. 58; *et auctt.*; *Escharella immersa* Norman, 1903b : 118.

The white or grayish zoarium, prostrate in the form of a thin crust, consists of zooids arranged in regular, straight and oblique rows. The small zooids (length 0.63 to 0.55 mm, width 0.38 to 0.30 mm) are oblong-rhombic in shape, and more or less flat; they have a finely granulated surface, and one row of marginal pores. The slightly raised rebra stretch between the pores from the margins to the center, becoming more prominent at the depressions located between them. The primary orifice of the zooids is semi-circular, and its height is slightly greater than its width; a narrow lyrule with a slightly bent margin in its middle, is located in the center of the proximal margin of the orifice. There are 6 spines at the distal margin, and on the sides of the orifice; in zooids carrying ovicells, there are 2 spines on each side prior to the ovicell. The proximal margin of the secondary orifice usually has a small, sharp mucro. This mucro varies in its development rather strongly sometimes, depending upon the external conditions; sometimes it reaches up to the broad, roundish-triangular lobe, which is pushed back and 1½ to 2 times greater in size than the orifice. As further calcification of the frontal surface sets in, the radial depressions and the marginal pores gradually disappear and the surface becomes almost flat. The ovicells are peristomial, round, and convex, and have a granulated surface.

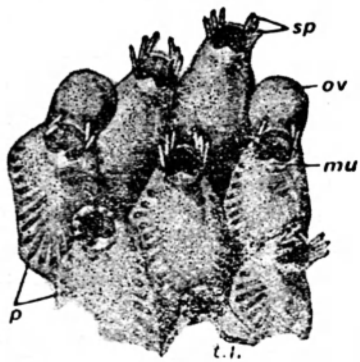


Figure 253. *Escharella immersa* (Fleming). Part of a zoarium.

The species lives on algae, shells, and stones, at a depth of 0 to 540 m, on a bed of stone, silt, and shell, under temperatures ranging from −1.9 to 3°C, in a salt concentration of 34.27‰.

Distribution. The species was found by me in the Barents, Kara, East Siberian, Bering, and Okhotsk seas, and in the waters off western Greenland. *Reports in literature*: Barents Sea (Smitt, 1868b; Nordgaard, 1896, 1912b; Bidenkap, 1900a; Waters, 1900; Kluge, 1906; Kluge in Deryugin, 1915; Kuznetsov, 1941), White Sea (Kluge, 1907; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Nordgaard, 1912b), western Greenland (Norman, 1906; Kluge, 1908b; Levinsen, 1914), Gulf of St. Lawrence (Dawson, 1859; Whiteaves, 1901), Yan-Maien Island (Lorenz, 1886), western Norway (Smitt, 1868b; Nordgaard, 1896, 1905, 1918), Skagerrack and Kattegat (Smitt, 1868b; Levinsen, 1894; Marcus, 1940), North Sea (Borg, 1930a), British Isles (Hincks, 1880a), northern and western coasts of France (Fischer, 1870; Joliet, 1877), along the eastern coast of North America from New Scotland up to Cape Cod (Verrill, 1879b; Osburn, 1912).

This is an Arctic-boreal, circumpolar species.

*2. **Escharella variolosa** (Johnston, 1838) (Figure 254)

Lepralia variolosa Busk, 1854a : 75 (part.), pl. LXXV, f. 1-3; Hincks, 1880a : 366 (part.), pl. LI, f. 3-5.

The zoarium, prostrate in the form of a thin crust, consists of zooids arranged in regular, straight and oblique rows in a checkered pattern. The zooids are medium in size (length 0.75 mm, width 0.50 mm), more or less flat, oblong-rhombic in shape, and separated by raised margins; a row of short depressions with pores at the bottom, is located along the margins. The frontal surface is granulated. The primary orifice of the zooid is semi-circular, and it has a narrow lyrule in the middle of its proximal margin. There are 2 spines at the distal margin of the secondary orifice, whose proximal margin is slightly raised in the form of a sharp or rounded protuberance or hood (mucro). The fertile zoaria, consisting of almost totally flat zooids, present a different picture. The latter are separated by raised margins, along which a row of deep depressions with pores at the bottom is located, but the depressions level off at the frontal surface, farther ahead of the center. The zooids are either oblong rectangular in shape, having a uniform width throughout their length, or broader in the distal half and narrow in the proximal; if an ovicell is

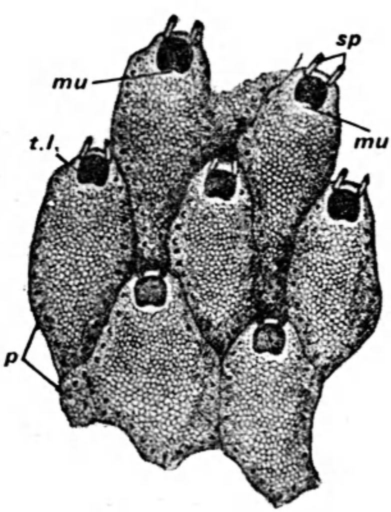


Figure 254. *Escharella variolosa* (Johnston). Part of a zoarium.

present in the maternal zooid, the proximal part of the daughter zooid is also broader. The primary orifice has a transversely oval shape with a narrow lyrule at the proximal margin. The secondary orifice has a slightly raised and flat mucro with a straight margin and pointed corners. The ovicells are endo-peristomial, slightly raised above the surface, round, and sometimes mildly tapered toward the distal end; they are surrounded by depressions proceeding radially toward the center.

This description is based on the preparations kindly provided to me by the director of the Bryozoan Section in the British Museum, Dr. Kirkpatrick, but it must be confessed without reservation, that I have taken the sterile and fertile zoaria as belonging to the same species.

Distribution. This is a purely boreal species, which lives on shells and stones in the waters of Great Britain and northern France (Hincks, 1880a; Joilet, 1877). Repeated indications in literature about the existence of *E. variolosa* in the Barents Sea and in the Arctic region (Levinsen, 1887; Bidenkap, 1897; Andersson, 1902; Borg, 1933a), are incorrect; my examination of the preparations analyzed by all the foregoing authors, revealed that these were either *E. dijmphnae* Kluge or *E. indivisa* Levinsen.

3. **Escharella ventricosa** (Hassall, 1842) (Figure 255)

Lepralia ventricosa Busk, 1854a : 78, pl. 82, f. 5-6; *Mucronella ventricosa* Hincks, 1880a : 363, pl. 50, f. 6-8; Osburn, 1912 : 243, pl. 26, f. 59; *Escharella ventricosa* Nordgaard, 1905 : 169, pl. IV, f. 28; *Smittia ventricosa* (Hassall) var. Waters, 1900 : 89, pl. 12, f. 17.

The zoaria are prostrate, sometimes in the form of large surfaces overgrowing the substrate, and consist of zooids arranged in regular, straight and oblique rows. The zooids are medium in size (length 0.75 to 0.9 mm, width 0.5 to 0.75 mm), hexagonal or oval-rhombic in shape, convex, and separated by deep margins; they have a granulated surface, along which pores are arranged in 2 rows in the distal half, and 1 row in the proximal. The primary orifice of the zooid is sometimes trapeziform, and its width is greater than its height; a tooth (denticle) of medium width, with a straight margin, is located

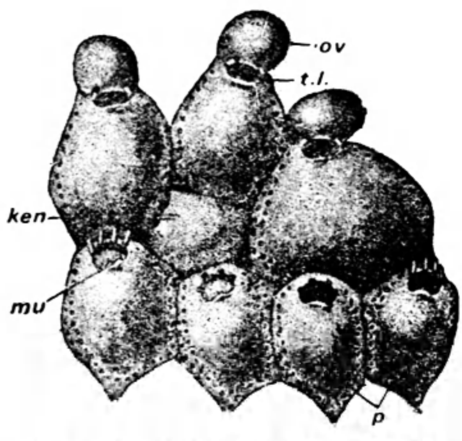


Figure 255. *Escharella ventricosa* (Hassall). Part of a zoarium.

in the middle of its proximal margin. There are usually 4 spines at the distal margin of the secondary orifice, and a mucro on the proximal margin, which may be either pointed, rounded, or broader in the form of a peristome which is not high on the frontal side, and gradually lowers down on the sides toward the base of the proximal pair of spines. The ovicells are peristomial, round, and initially raised, but with further calcification the sharp margin disappears.

Although this species is close to *E. immersa* and hence sometimes difficult to distinguish, it differs from the latter by having 4 spines at the distal margin of the orifice, a larger sized zooid, a greater convexity to its frontal surface, and by the absence of those rebra which originate from the margins and proceed toward the center of the surface—often a very characteristic feature of *E. immersa*. Furthermore, its lyrule is comparatively broader than that of *E. immersa*.

This species lives on shells, calcareous Bryozoa, and stones, at a depth of 5 to 450 m, under temperatures ranging from −1.7 to 6.2°C, in a salt concentration of 34.86 to 34.96‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868b; Bidenkap, 1900a; Waters, 1900; Nordgaard, 1912a; Kuznetsov, 1941), White Sea (Kluge, 1907, 1908a; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Nordgaard, 1923; Kluge, 1929), Laptev Sea (Kluge, 1929), Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1923, 1932), Labrador (Osburn, 1913), western Greenland (Norman, 1876, 1906; Osburn, 1919), Gulf of St. Lawrence (Whiteaves, 1901), eastern Greenland (Levinsen, 1916), Yan-Maien Island (Lorenz, 1886), Iceland (Nordgaard, 1924), western Norway (Norman, 1894; Nordgaard, 1896, 1905, 1918), Kattegat (Levinsen, 1894; Marcus, 1940), British Isles (Hincks, 1880a), western coast of France (Fischer, 1870), and the Mediterraenan Sea (Calvet, 1902).

This is an Arctic-boreal, circumpolar species.

3a. **Escharella ventricosa** var. **peristomata** Kluge var. n. (Figure 256)

Escharella ventricosa Gostilovskaya, 1957 : 446 (part.), f. 3.

The zoaria are prostrate, overgrow the substrate like a crust, and consist of zooids arranged in regular, straight and oblique rows. The zooids are medium in size, roundish-hexagonal in shape, broad in the middle, raised, and have a granulated frontal surface along which one row of marginal pores is located. The primary orifice is semi-circular, and a low and narrow tooth (lyrule) is situated in the middle of its proximal margin. There are usually 4 (rarely, 6 to 4) spines near the margins, 2 located in the center of the zoaria, at its distal margin; but it may happen that there are 2 spines in the middle zooids, and again zooids with 4 spines, and frequently, zooids at the margins with 2 spines. The

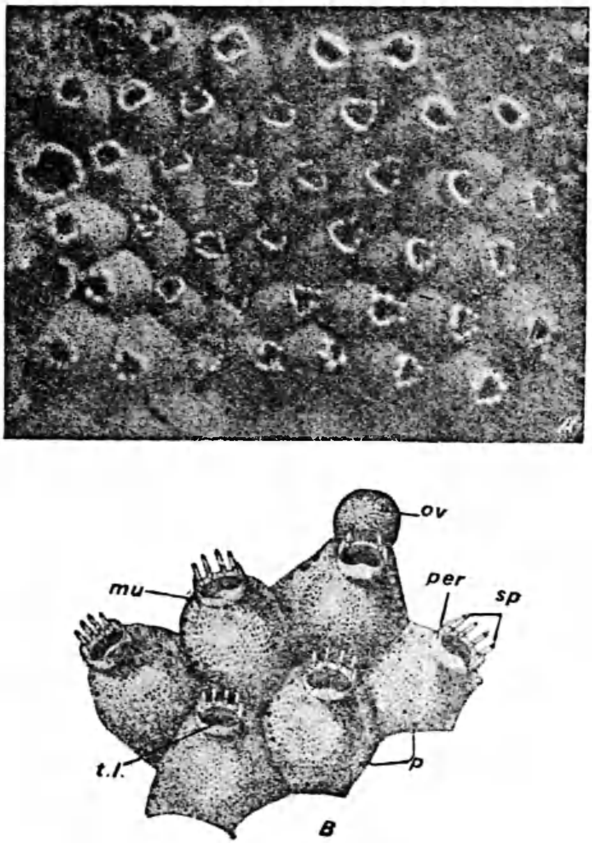


Figure 256. *Escharella ventricosa* var. *peristomata* Kluge. *A*—zoarium; *B*—part of a zoarium. White Sea.

orifice is encircled by a low peristome from the frontal and lateral sides, which rests against and fuses by its sides to both the spines. In some zooids, the peristome is slightly stretched in the middle in the form of a bluntly pointed protuberance or hood (mucro). The ovicells are hyperstomial, round, and slightly raised; they do not have a sharp margin which converts into the frontal surface of the overlying daughter zooid. Their surface is granular.

This species lives on shells and stones, at a depth of 91 to 136 m, on a bed of shells.

Distribution. The species was found by me in the Barents Sea toward the south of Spitsbergen. *Reports in literature:* White Sea (Gostilovskaya, 1957).

This is an Arctic species.

4. **Escharella dijmphnae** (Kluge, 1929) (Figure 257)

Mucronella dijmphnae Kluge, 1929 : 11; Abrikossov, 1932 : 144, f. 1-3; *Escharella dijmphnae* Gostilovskaya, 1957 : 446; *Mucronella variolosa* Levinsen, 1887 : 323; *M. ventricosa* Kluge, 1908a : 533 (part.).

The zoaria, prostrate and overgrowing, consist of zooids arranged in regular, straight and oblique rows in a checkered pattern. The zooids are large (height 8 to 1 mm, width 0.5 to 0.6 mm) and oblong, or oval-rhombic in shape, with a finely granulated, convex, frontal surface; often 2 rows of pores are located along the margins of the frontal surface in the distal half, and 1 row in the proximal. The primary orifice of the zooid is semi-circular, and its width is greater than its height; a broad, low lyrule is situated in the middle of its proximal margin. The lyrule has either a straight or a rounded margin; there is one lateral, triangular denticle on each side of the lyrule. A sharp protuberance or hood (mucro) is suspended at the proximal margin of the secondary orifice of the zooid; sometimes it is pushed back a little. In adult zooids, 2 spines are permanently located close to the medial line at the distal margin of the orifice. In zooids with ovicells the spines are located away from the medial line, at the sides of the orifice of the latter. The ovicells are peristomial, round or oblong, raised, and pushed back a little; they have a strongly granulated surface. Their orifice is covered with a lid (operculum) that is commonly shared with the

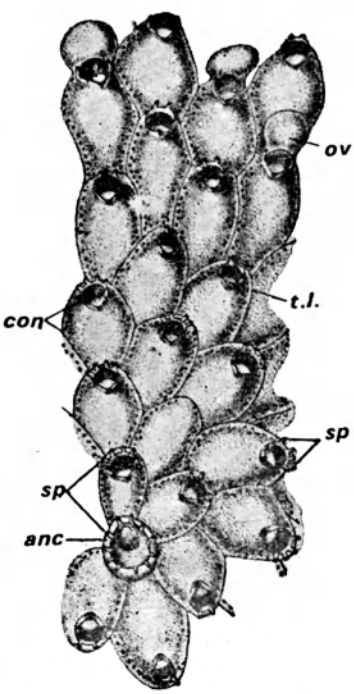


Figure 257. *Escharella dijmphnae* (Kluge). A zoarium with its ancestrula.

zooidal orifice. There are 8 to 12 pores in the pore chambers.

The ancestrula has 11 spines around its aperture, followed by zooids with 6 spines, then those with 4 around their orifices, and lastly, adult zooids with 2 permanently fixed spines at the distal margin of their orifices.

The species lives on stones, shells of mollusks, and worms, at a depth of 6.5 to 410 m, on a bed of stone, silt, and shells, under temperatures varying from —1.62 to 2.42°C, in a salt concentration of 33.13 to 34.92‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, and Chukotsk seas, and in the waters off eastern Greenland. *Reports in literature:* White Sea (Gostilovskaya, 1957), and the Laptev Sea (Abrikossov, 1932).

This is a high Arctic species, fairly well distributed in the Siberian seas.

5. **Escharella indivisa** Levinsen, 1916 (Figure 258)

Escharella indivisa Levinsen, 1916 : 450, pl. XX, f. 1-2; *Mucronella indivisa* Osburn, 1919 : 610; 1923 : 10D; 1932 : 14; *M. variolosa* Bidenkap, 1897: 625 (part.); Andersson, 1902 : 548 (part.).

The zoaria, prostrate and overgrowing, consist of zooids arranged in regular, straight and oblique rows. The zooids are medium in size (length 0.75 to 1.00 mm, width 0.45 to 0.65 mm), hexagonal-rhombic in shape, though sometimes broader, sometimes narrower, and convex; they have a minutely granulated frontal surface with one row of marginal pores, and 2 rows of pores in its distal half. The primary orifice is a round trapeziform, and its width twice exceeds its height; one low, broad lyrule is located on its straight, proximal margin. Usually 6, but sometimes 4 or 5 spines, are located at the distal margin of the secondary orifice; there are 4 spines prior to the ovicell in the ovicell-carrying zooids, although sometimes it would seem that only 2 spines were present; the latter is due to the fact that the second pair of spines is tightly fused with the ovicell and consequently, less noticeable. The mucro is located at the proximal margin of the secondary orifice in the form of a fairly broad,

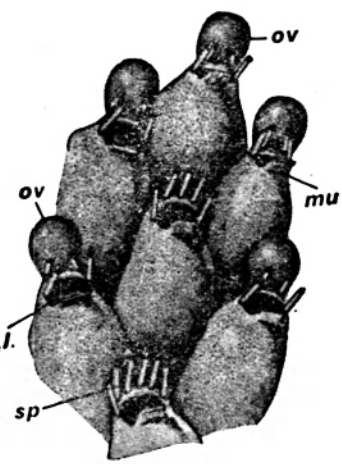


Figure 258. *Escharella indivisa* Levinsen. Part of a zoarium.

flat, rounded, and triangular or trapeziform lobe. It is suspended near the frontal plane of the zooid so that the lyrule, located in front of it, is always clearly visible. Small condyles can be seen on both sides of the latter. The ovicells are comparatively small and round; they have a convex and granulated frontal surface, and a flattened and slightly bent, marginal part between the first pair of spines. There are 2 large pore chambers along the basal, lateral wall, and 3 small pore chambers along the transverse wall. Of these chambers, the middle one is smaller than the lateral ones.

The ancestrula has 9 spines, of which 4 surround the orifice while the remaining 5 surround the slightly lowered cryptocyst.

The species lives on stones, Bryozoa, and shells, at a depth of 1.5 to 300 m, on a bed of stone and sand, under temperatures ranging from —1.27 to 2.2°C, in a salt concentration of 31.44 to 34.83‰.

Distribution. This species was found by me in the Barents, Kara, Laptev, and East Siberian seas, and in the waters off western Greenland. *Reports in literature:* Archipelago of the Canadian Islands (Osburn, 1923, 1932, 1936), and the waters off eastern Greenland (Levinsen, 1916).

This is a high Arctic species.

6. **Escharella laqueata** (Norman, 1864) (Figure 259)

Lepralia laqueata Norman, 1864 : 85, pl. X, f. 5; *Mucronella laqueata* Hincks, 1880a : 368, pl. 51, f. 8; *Discopora coccinea* forma *ovalis* Smitt, 1868b : 27, 174 (part.), pl. 27, f. 175.

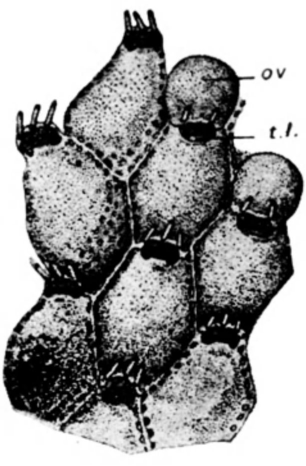


Figure 259. *Escharella laqueata* (Norman). Part of a zoarium. Waters of Finmark.

The zoaria, prostrate and overgrowing the substrate in the form of a dense crust, consist of zooids arranged in more or less regular, oblique rows. The zooids are large (height 0.97 mm, width 0.70 mm), mildly raised, thick-walled, and broad, rhombic-hexagonal in shape; they have a roughly granulated frontal surface; the zooids are surrounded by more or less thick, raised margins, along which 1 row of pores is usually located. The primary orifice of the zooid is semi-circular, or transversely oval and broad; its proximal margin has a broad lyrule with a straight margin, and there are 2 to 3 spines at the distal margin. The orifice is encircled by a poorly developed peristome and a straight or slightly bent margin; sometimes the peristome is raised more in the form of a broad, trapeziform lobe. The ovicells are large, semi-circular, broad, and slightly raised; they have a roughly granulated surface, and are surrounded by a row of large pores along the margin.

The species lives on shells and stones, at a depth of 60 to 375 m, on a bed of silt and stone, under temperatures ranging from 6.0 to 6.3°C.

Distribution. Reports in literature: Barents Sea (Vigelius, 1881-82; Bidenkap, 1900a), coastal waters off northern and western Norway (Smitt, 1868b; Norman, 1894; Nordgaard, 1896, 1905, 1906b), western coast of Sweden (Smitt, 1868b), Shetland and Hebrides Islands (Norman, 1864), and the southern part of the Norwegian Sea (Nordgaard, 1907b).

This is an Arctic-boreal, Atlantic species, which dwells in deep water.

7. **Escharella abyssicola** (Norman, 1869) (Figure 260)

Lepralia abyssicola Norman, 1869 : 307; *Mucronella abyssicola* Hincks, 1880a : 369, pl. 38, f. 1-2; Osburn, 1933 : 52, pl. 15, f. 8-9c; *Escharella abyssicola* Levinsen, 1916 : 451, pl. XX, f. 10-14.

The zoarium, prostrate in the form of a crust of sometimes remarkable size, consists of zooids arranged in irregular, oblique rows. The zooids are large (height 1.00 to 1.25 mm, width 0.7 to 0.9 mm), oblong, rhombic, or oval in shape, and convex; they have a granulated surface, and are bordered by thin raised margins along which stretches 1 row of pores. The primary orifice of the zooid is semi-circular, and encircled by a well-developed, almost tubular, peristome, the proximal part of which often forms a broad, raised lobe. Its distal margins has 2, rarely 3, thin spines. A broad lyrule is located in the depression of the proximal margin; it has a straight margin, and sometimes sharply pointed ends. The oral arch is comparatively low, and consists of a larger middle part with a more or less raised margin, and lower lateral walls. A large number of uniformly small pore chambers are located along the basal margin of the zooid. The ovicells are round and raised; they have a granulated surface.

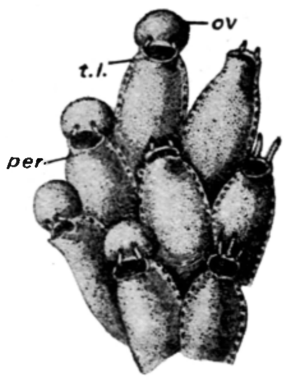


Figure 260. *Escharella abyssicola* (Norman). Part of a zoarium.

The species lives on stones, shells of mollusks, calcareous tubes of *Polychaeta*, and hard Bryozoa, at a depth of 5 to 320 m, on a bed of silt, stone, and shells, under temperatures ranging from −1.56 to 2.38°C, in a salt concentration of 34.50 to 34.96‰.

Distribution. The species was found by me in the Barents Sea, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Nordgaard, 1896), Archipelago of the Canadian Islands (Nordgaard, 1906a), Gulf of St. Lawrence (Whiteaves, 1901), eastern Greenland (Kirchenpauer, 1874; Levinsen, 1916), Yan-Maien Island (Lorenz, 1886), western Norway (Nordgaard, 1905, 1906b, 1918), the Faeroes (Nordgaard, 1907b) and Shetland Island (Norman, 1869), and the Bay of Fundy on the eastern coast of North America (Osburn, 1933).

This is an Arctic-boreal, Atlantic species, which dwells in deep water.

8. **Escharella microstoma** (Norman, 1864) (Figure 261)

Lepralia microstoma Norman, 1864 : 87, pl. XI, f. 2; *Escharella labiata* Nordgaard, 1905 : 170, pl. IV, f. 25-26, 31; 1906a : 27; Levinsen, 1916 : 451, pl. XX, f. 3-9.

The zoarium, overgrowing in the form of small white crusts, is clearly distinguished from other crustaceous Bryozoa by its strongly raised zooids, and an uprising distal end. The zooids are large (height 0.9 to 1.13 mm, width 0.75 to 0.88 mm), rhombic or oval in shape, strongly raised, separated by a deep furrow, and arranged in irregular, short rows. The frontal surface is minutely granulated, more or less sharply raised toward the zooidal orifice, which is located on the distal end, and surrounded by 1 to 3 rows of small, marginal pores. The primary orifice is semicircular, and encircled by a more or less strongly raised convex labrum, which narrows toward the upper side. A broad, low, deeply fixed lyrule is located on the proximal margin of the primary orifice which, in certain instances, such as in the White Sea, may be very low and narrow, or even absent; usually 3, rarely 2, spines are located on the distal margin, and the ovicell-carrying zooids always have 2 situated on the sides of the orifice of the ovicell. A strongly developed vestibular or oral arch lowers down in the form of a roundish-triangular shed from the distal margin of the

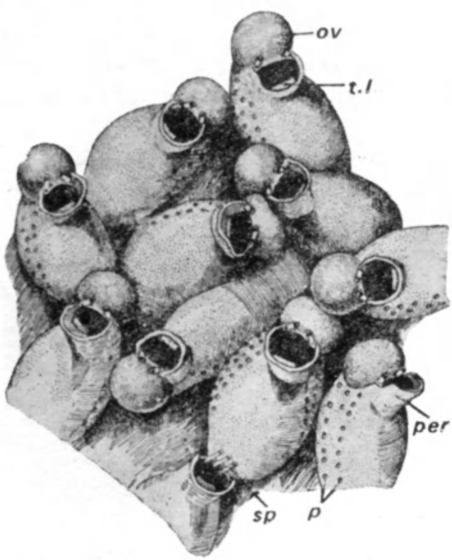


Figure 261. *Escharella microstoma* (Norman). Part of a zoarium.

orifice, into the zooid, in a proximal and basal direction. The ovicells are round, convex, and strongly pushed back; they have a finely granulated surface. An orifice is situated at their basal surface. There are several small, uniform, uniporous chambers along the basal margin. The species varies considerably in the location of the zooids in the zoaria, and in the size of the individual zooids, as well as in the convexity of the frontal surface, the development of the peristome, and of the lyrule, but the stronger development of the vestibular arch remains constant.

The species lives on stones, shells of mollusks, and calcareous tubes of *Polychaeta*, at a depth of 20 to 280 m, more often at 100 to 200 m, on a bed of stone, silt, and shell, under temperatures ranging from −1.38 to 3.5°C, in a salt concentration of 34.63 to 34.88‰.

Distribution. The species was found by me in the Barents, Kara, and East Siberian seas, and in the waters off northern Greenland. *Reports in literature:* White Sea (Gostilovskaya, 1957), Archipelago of the Canadian Islands (Nordgaard, 1906a), eastern Greenland (Levinsen, 1916), and the Shetland Islands (Norman, 1864).

This is an Arctic, Atlantic species which dwells in deep water.

9. **Escharella octodentata** (Hincks, 1880) (Figure 262)

Mucronella Peachi var. *octodentata* Hincks, 1880a : 361, pl. 51, f. 2.

The zoaria, prostrate in the form of small crusts, consist of zooids arranged in more or less regular, straight and oblique rows. The zooids, are small (length 0.6 to 0.8 mm, width 0.4 to 0.5 mm), strongly raised, oblong-rhombic or oval in shape, and have a large, granulated surface along whose depressed margin is located a row of pores. The primary orifice is small and semi-circular; its height is a little more than its width; its proximal margin has a comparatively broad lyrule which has a straight margin and pointed ends. The secondary orifice has a small and clearly sharpened mucro on the proximal margin and 8 spines (4 on each side), which are retained even in the zooids carrying ovicells. The ovicells are round, hyperstomial, and clearly raised; most of the surface is granulated. The width of the ovicell is sometimes a little greater than

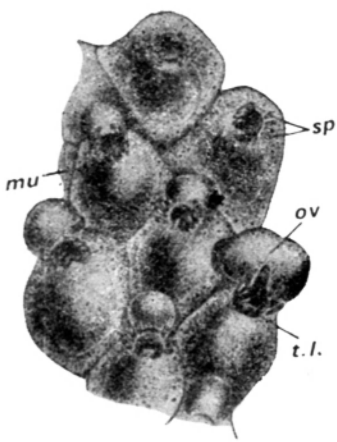


Figure 262. *Escharella octodentata* (Hincks). Part of a zoarium.

its height.

The species lives on the shells of worms, mollusks, and stones, at a depth of 100 to 200 m, on a bed of stone and silt.

Distribution. The species was found by me in the Barents Sea and in the coastal waters off western Murmansk. *Reports in literature:* Coastal waters off northern Norway (Nordgaard, 1905, 1918), and the Shetland Islands (Hincks, 1880a).

This is a northern boreal species.

10. **Escharella latodonta** Kluge sp. n. (Figure 263)

The zoarium, prostrate and overgrowing, consists of short, regular, oblique zooidal rows. The zooids are small (height 0.55 mm, width 0.43 mm), hexagonal, and more or less convex. The frontal surface is finely granulated and surrounded by 1 to 2 rows of small marginal pores, from which thin striations sometimes originate which stretch toward the middle part of the surface. The semi-circular and broad zooidal orifice, located in the distal part and surrounded by a slightly thickened margin on the proximal side, forms a very small, sharp mucro in the middle; there are 8 spines in the distal half (4 on each side) and 3 on each side in the zooids carrying ovicells. A very wide lyrule with a straight margin and pointed ends is located on the proximal margin of the primary orifice; its sharp ends are directed in opposite directions. The condyles are located on the side of the primary orifice opposite to the sharp lyrule, causing a sort of small, round orifice to form on each side of the lyrule. This orifice is connected by a narrow opening to the upper part of the primary orifice. The lyrule is so wide that it occupies almost the entire proximal margin of the primary orifice, and thus the latter appears very wide and oval. The ovicells are round and raised, and have a granulated surface.

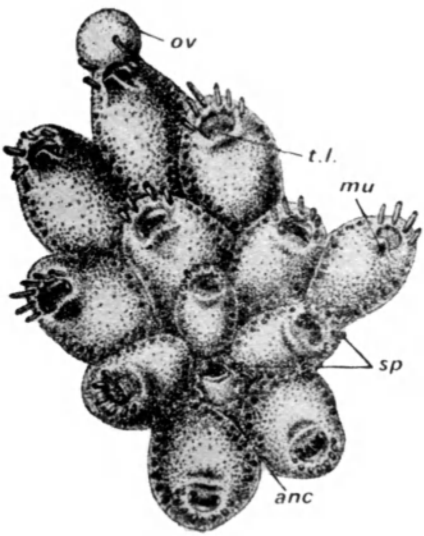


Figure 263. ***Escharella latodonta*** **Kluge. Part of a zoarium with an ancestrula. Barents Sea.**

The ancestrula has an oval form; the aperture, occupying two-thirds of the frontal surface, is surrounded by 9 spines; a strongly developed cryptocyst occupies the large proximal part under the aperture.

The species lives on small stones and shells of mollusks, at a depth of 385 m.

Distribution. The species was found by me in the southwestern trough of the Barents Sea, on the slope of the continental shelf.

11. **Escharella macrodonta** Levinsen, 1916 (Figure 264)

Escharella macrodonta Levinsen,[7] 1916, pl. XXIV, f. 1-2; Kluge, 1946 : 197, f. 3.

The overgrowing zoaria consist of irregularly arranged zooids. The zooids are medium in size (height 0.88 to 1.00 mm, width 0.65 to 0.75 mm), rhombic-hexagonal or oval in shape, and convex; they rise from all sides in the direction of the oral orifice, and have a finely granulated, frontal surface, along whose margins 1 or 2 rows of pores are located. The orifice of the young zooids is roundish; in adult zooids it is rounded and trapeziform. A tall lyrule, sometimes narrow, sometimes broad, is located in the middle of the proximal margin of the orifice; the lyrule widens strongly toward the free end, forming 2 lateral, sharp edges which point in opposite directions. An insignificantly raised, secondary orifice forms a mildly raised mucro in the middle of the proximal margin; when this mucro does not form, the impression is given that the frontal surface of the proximal margin of the orifice directly continues to a terminally lowered lyrule. There are 8 comparatively long spines on the distal margin and the two sides of the orifice, and 3 generally, on each side in the zooids carrying ovicells, but sometimes there are 4. The ovicells are hyperstomial, relatively small, round, and slightly pushed back; they have a granulated surface and a high, semicircular orifice.

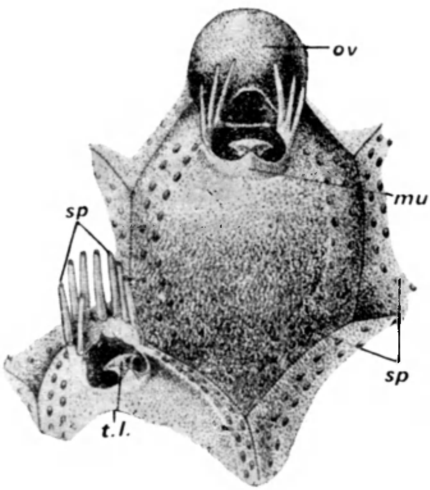


Figure 264. *Escharella macrodonta* Levinsen. Zooids in detail (from Kluge, 1946).

A large number of uniformly small pore chambers are located in a circle along the basal margin of the zooid.

[7] Levinsen did not give a description of this species, but the name and sketch provided by him were included in his posthumously published paper (Levinsen, 1916).

The species lives on shells of bivalved mollusks, at a depth of 81 to 91 m, on a bed of silt and pebbles.

Distribution. The species was found by me in the East Siberian Sea near the margin of the continental shelf. *Reports in literature:* Northeastern Greenland (Levinsen, 1916, giving sketch and name only).

This is a high Arctic species.

2. Genus **Escharelloides** Kluge gen. n.

Discopora Smitt, 1872a : 1127; *Mucronella* Hincks, 1889 : 431; *Monoporella* Hincks, 1892 : 152; *Lepralia* Waters, 1900 : 73.

The zoaria are prostrate and overgrowing. The zooids are medium in size and more or less convex. The frontal surface is granulated and surrounded by 1 to 2 rows of marginal pores along the deep margin, or largely alveolate with pores at the bottom of the alveoli. The transverse orifice either has a small, sharp lyrule (when it exists) in the middle of the proximal margin, or a more or less broad, low tooth. A secondary orifice is formed by the raised distal and lateral margins. Spines are either present or absent. The mucro is absent. Pore chambers are located along the basal, lateral, and distal margins, or else pore plates occur along the lateral and transverse walls. The ovicells are hyperstomial.

Genus type: *Monoporella spinulifera* Hincks, 1889.

1 (4). Primary orifice transversely oval with a more or less sharp lyrule in the middle of the concave, proximal margin. Zooids have pore chambers.

2 (3). Zooids have a coarsely granulated frontal surface which is surrounded by 1 row of marginal pores .... 1. *E. spinulifera* (Hincks).

3 (2). Zooids have an alveolate frontal surface with more or less large pores at the bottom of the deep alveoli .... 2. *E. cancellatum* (Smitt).

4 (1). The primary orifice is semi-circular or trapeziform in shape; there is a small, pointed, or more or less broad and low tooth at the proximal margin. Zooids have pore plates.

5 (6). Height of primary orifice exceeds its width; its proximal margin has a sharp lyrule. Frontal surface has a deep margin .... 3. *E. stenostoma* (Smitt).

6 (5). Width of primary orifice exceeds its height; its proximal margin has a broad, low tooth. Frontal surface slightly convex with a raised margin .... 4. *E. simplex* (Kluge).

1. **Escharelloides spinulifera** (Hincks, 1889) (Figure 265)

Monoporella spinulifera Hincks, 1889 : 431, pl. 21, f. 3; Osburn, 1933 : 52, pl. 15, f. 10; *Porina ciliata* forma *dura* Smitt, 1868b : 6, 61, pl. 24, f. 17; *Discopora cruenta* Smitt, 1872a : 1127, t. 21, f. 20, 21.

The zoarium, prostrate and overgrowing the substrate in the form of reddish-brown spots, consists of more or less regular, oblique zooidal rows. The zooids are medium in size (height 0.88 mm, width 0.63 mm), sometimes hexagonal, sometimes oval, sometimes rectangular, slightly convex, and thick-walled; they have a coarsely granulated frontal surface which is surrounded by 1 row of either small or large marginal pores. The primary orifice, sometimes roundish, sometimes semi-circular, has a small, pointed lyrule in the middle of its proximal margin. This denticle sometimes disappears after a stronger calcification of the frontal wall, but usually its presence is typical of this species. The peristome is developed only on the distal and lateral sides of the orifice, in the form of a thickening of the body wall; on the proximal side, the frontal wall usually thins toward the margin of the orifice. The ovicells are small, semi-circular, and barely raised; their frontal wall is strongly thickened and the surface coarsely granulated.

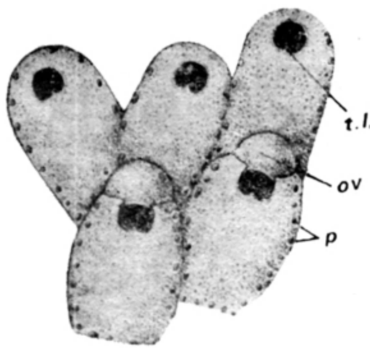


Figure 265. *Escharelloides spinulifera* (Hincks). Part of a zoarium. Barents Sea.

There are 4 pore chambers with several pores along the basal, lateral margin, and 2 along the distal margin.

This species lives on stones and shells of mollusks, at a depth of 8 to 186 m, under temperatures ranging from —1.6 to 2.7°C, in a salt concentration of 31.64 to 34.40‰.

Distribution. This species was found by me in the Barents and Kara seas, and in the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1868b; Bidenkap, 1900a; Waters, 1900; Nordgaard, 1918), White Sea (Kluge, 1907, 1908a; Kluge in Deryugin, 1928; Gostilovskaya, 1957), Archipelago of the Canadian Islands (Nordgaard, 1906a), waters off Labrador (Osburn, 1913), western Greenland (Norman, 1903b, 1906; Kluge, 1908b), and the Gulf of St. Lawrence (Hincks, 1889; Whiteaves, 1901; Norman, 1903b).

This is an Arctic, Atlantic species.

2. **Escharelloides cancellatum** (Smitt, 1868) (Figure 266)

Escharella porifera forma *cancellata* Smitt, 1868b : 9, 75, t. 24, f. 40-41.

The zoarium, prostrate in the form of a thick, white crust, consists of zooids arranged in regular, oblique rows. The zooids are medium in size (length 0.78 mm, width 0.58 mm) and rhombic-hexagonal in shape, although sometimes narrower, sometimes broader. The frontal surface is raised; except for the small area adjoining the proximal margin of the orifice, it is completely covered with deep, polygonal alveoli, at the bottom of which round or oval pores of different sizes are located; the surface is bordered with a raised margin. The primary orifice, located at the distal margin of the zooid, is transversely oval with a concave, proximal margin; a blunt lyrule rises from the middle of this margin into the cavity of the orifice. Small, thin, and pointed condyles are located along the edges of the proximal margin. The ovicells are hyperstomial, round, and raised. The lateral wall of the zooid has 6 to 8 pore plates with a few pores each, and the distal septum has up to 15 uniporous plates arranged along its lateral and basal margins.

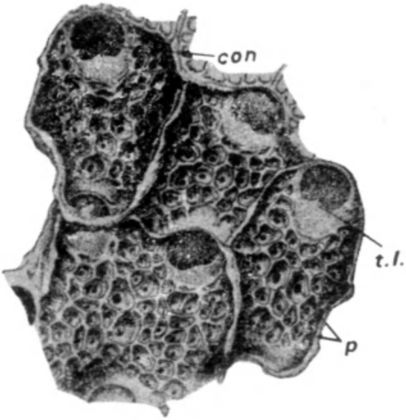


Figure 266. *Escharelloides cancellatum* (Smitt). Part of a zoarium. Barents Sea.

The species lives on the shells of *Balanus*, on the Bryozoa *Cellepora* and others; the depth is not known.

Distribution. Reports in literature: Barents Sea, Isfjorden in Spitsbergen (Smitt, 1868b).

3. **Escharelloides stenostoma** (Smitt, 1872) (Figure 267)

Discopora stenostoma Smitt, 1872a : 1130, t. 21, f. 29-30.

The zoarium, prostrate and overgrowing the surface like a thin, white, shiny crust, consists of zooids arranged in regular, oblique rows. The zooids are medium in size (length 0.8 to 1.00 mm, width 0.5 to 0.8 mm), hexagonal, and convex; the smooth surface is finely granulated, and there are 1 to 2 rows of pores along the deep margin of the zooid. The distal half of the zooids is a little higher, gradually sloping down to the proximal margin. The transverse orifice of the zooid is small, rounded, and trapeziform; its height is greater than its width. The frontal surface is a little deeper toward the proximal margin of the orifice which usually has a clearly noticeable, small, pointed denticle (lyrule) in the middle; however, this lyrule may be absent. The secondary orifice is in the form of a margin raised only on the sides and distal part; 8 spines are found on the distal part, but the mucro is absent from the proximal half. There are 6 to 8 spines located prior to the ovicell in the zooids carrying ovicells. The ovicells are round, raised, and slightly pushed back.

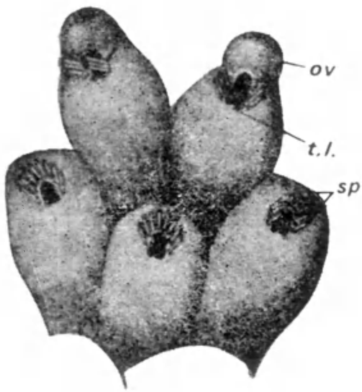


Figure 267. *Escharelloides stenostoma* (Smitt). Part of a zoarium.

The species lives on shells and stones, at a depth of 45 to 540 m, on a bed of stone, silt, and pebbles, under temperatures ranging from −1.2 to 4°C, in a salt concentration of 34.54 to 34.96‰.

Distribution. The species was found by me in the Barents Sea and in the waters off northeastern Greenland. *Reports in literature:* Barents Sea (Smitt, 1872a).

This is an Arctic, Atlantic species.

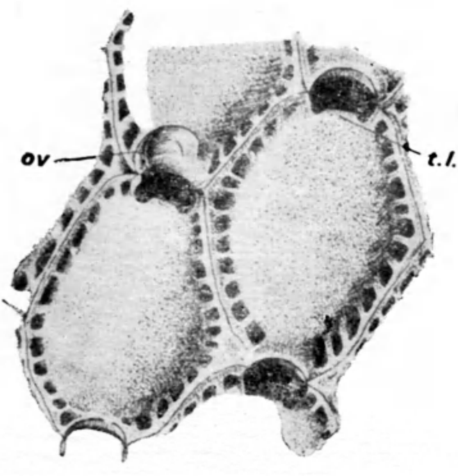


Figure 268. *Escharelloides simplex* (Kluge). Zooids without ovicells, and with an undeveloped ovicell (from Kluge, 1955a).

4. **Escharelloides simplex** (Kluge, 1955) (Figure 268)

Smittina simplex Kluge, 1955a: 93, f. 38.

The zoarium, prostrate and lightly attached to the substrate, consists of zooids arranged in more or less regular, oblique rows. The zooids are medium in size (length 0.68 mm, width 0.55 mm), and hexagonal in shape. The frontal surface is slightly raised and finely granulated; it has a raised margin along which small depressions are located with pores at the bottom. The depressions are separated by short rebra positioned perpendicular to the margin. The primary orifice, located at the distal margin of the zooid, is semi-circular and relatively broad; it has a broad, short tooth at the proximal margin, which bends downward slightly at its straight free end. Fully developed ovicells were not found, but judging from the one which had started to develop, these would have been hyperstomial. There are 4 pore plates with several pores each in the lateral wall of the zooid, and 2 plates with many pores each in the distal septum. The basal surface forms tubular protuberances of varying thickness and length, which help attach the zoarium to the substrate.

The species lives on calcareous tubes of worms at a depth of 279 m.

Distribution. The species was found by me in the northern part of the Kara Sea.

Thus far, this species is endemic to the Kara Sea.

3. Genus **Hemicyclopora** Norman, 1894

Hemicyclopora Norman, 1894 : 124; *Discopora* Smitt, 1872a : 1129; *Lepralia* Norman, 1864 : 87; Hincks, 1880a : 315.

The zoaria are prostrate and consist of zooids which have a raised surface, and are separated by depressions. A row of small pores is located along the margins. The orifice is semi-circular, and has a straight, proximal margin; there are 4 to 6 spines around it. There are many uniform, simple pores along the basal side.

Genus type: *Lepralia polita* Norman, 1864.

1 (2). Frontal surface rises slightly in the middle of the zooid; distal margin of the orifice lower than the proximal; there are 6 large, thick spines around the orifice.........2. *H. emucronata* (Smitt).

2 (1). Frontal surface smoothly raised from the sides and the proximal margin toward the distal margin of the orifice; there are usually 4 thin spines around the orifice, and rarely, 6...1. *H. polita* (Norman).

1. **Hemicyclopora polita** (Norman, 1864) (Figure 269)

Lepralia polita Norman, 1864 : 87, pl. XI, f. 1; Hincks, 1880a : 315, pl. 32, f. 5; *Hemicyclopora polita* Norman, 1894 : 124, non 1906 : 92; ?*Eschara polita* Nordgaard, 1905 : 167; *E. moskensis* Nordgaard, 1905 : 167, pl. IV, f. 3-5.

The zoarium, prostrate in the form of a crust, consists of raised zooids arranged in regular, oblique rows. The zooids are relatively large (height 0.88 to 1.13 mm, width 0.75 to 0.88 mm), rhombic-hexagonal, sometimes short and broad, and sometimes more oblong and narrower. The frontal surface is raised, gradually rising from all sides to the distal margin of the orifice, which is located at a distance of one-fourth to one-third the length of the zooid from the distal margin. The surface is finely granulated and surrounded by 1 row of small marginal pores in the proximal half, and 2 to 3 rows in the distal. The primary orifice is semi-circular; its height exceeds its width; the proximal margin is slightly bent and triangular condyles are located close to its sides. There are 4, rarely 6, short, thin spines on the raised distal part. Sometimes the bases of the spines develop somewhat strongly, and then "shoulder-like" raised structures form on the margins of the orifice ("peristomes", according to Norman and Hincks), which rest against the ovicells in the zooids carrying ovicells. The operculum is chitinized. The ovicells are hyperstomial, round, and raised, sometimes broader, sometimes narrower. There are several uniform, uniporous chambers along the length of the basal margin of the zooid. Avicularia are absent.

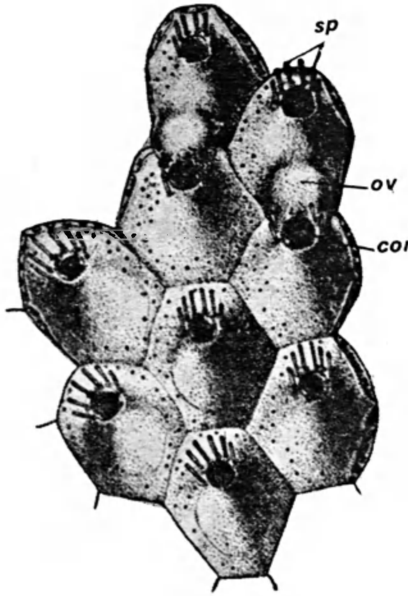


Figure 269. *Hemicyclopora polita* (Norman). Part of a zoarium.

The species lives on stones and shells of bivalved mollusks, at a depth of 126 to 400 m, on a bed of silt and stone.

Distribution. Reports in literature: Coastal waters off northern Norway (Norman, 1894; Nordgaard, 1905), and the Shetland and Hebrides Islands (Norman, 1864; Hincks, 1880a).

I never came across any colonies of *Hemicyclopora polita* in our waters, but keeping in mind that Nordgaard in his paper of 1905 mentioned 2 species, i.e., *Eschara polita* from Hammerfest, and *E. moskensis* from the more southern waters (Moskenstremen), it is possible that *E. polita* is a form close, if not identical, to *Hemicyclopora emucronata,* and therefore it is quite likely that this species may be found in the coastal waters of western

Murmansk.

This is a boreal, Atlantic species.

2. **Hemicyclopora emucronata** (Smitt, 1872) (Figure 270)

Discopora emucronata Smitt, 1872a : 1129, pl. 21, f. 27-28; Kluge, 1908b : 552 (*Lepralia*); *Hemicyclopora polita* Norman, 1906 : 92.

The zoarium, prostrate in the form of a crust, consists of convex zooids arranged in more or less regular, oblique rows. The zooids are large (height 0.88 to 1.13 mm, width 0.70 to 0.86 mm), rhombic-hexagonal or oval in shape, sometimes more oblong, sometimes broader and shorter; they are separated by deep furrows. The frontal surface is raised, uprising relatively abruptly on the side and proximal margin, toward the middle part of the surface, and lowering toward the orifice. The surface is finely granulated, and surrounded by a row of marginal pores over a certain distance from the margin. The orifice is located close to the distal margin of the zooid. The primary orifice is semi-circular; its height is slightly larger than its width; the proximal margin is usually straight, but sometimes it is very weakly concave or convex; triangular condyles are located on the side close to the proximal margin. Six large spines, usually 3 on each side, are always arranged around the orifice, leaving the distal margin of the orifice free over the small or large orifice; as a result the distal margin appears to be lower than the proximal one, contrary to the situation found in *H. polita* Norman. The 6 spines are always found in this species, and in zooids carrying ovicells, there are 3 on each side prior to the ovicell. Probably the articulations of the spines are mildly chitinized at their base, and therefore in our preparations, the large, lower parts of the spines were visible with an orifice in the middle. The operculum is chitinized. The ovicells are peristomial, round, and convex; their height is always slightly

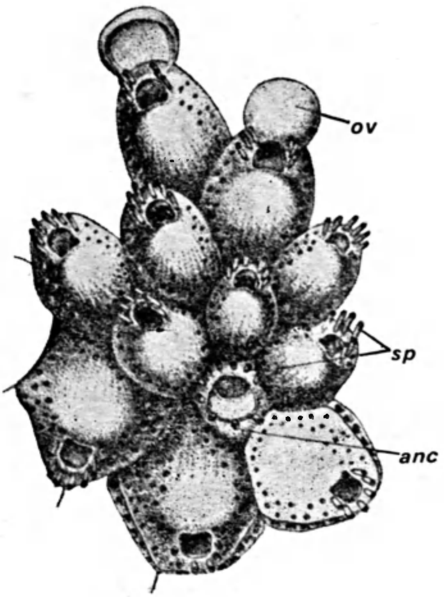


Figure 270. *Hemicyclopora emucronata* (Smitt). A zoarium with an ancestrula.

greater than their width. Avicularia are absent.

The ancestrula has a roundish form with 11 spines located on the margin of the entire aperture.

The species lives on stones and shells of mollusks, at a depth of 30 to 180 m, on a bed of silt and stone, under temperatures ranging from −1.7 to 2.7°C.

Distribution. The species was found by me in the Barents and Kara seas, and in the Davis Strait. *Reports in literature:* Davis Strait (Norman, 1906), and Baffin Bay (Kluge, 1908b).

This is an Arctic, Atlantic species.

4. Genus **Lepralioides** Kluge gen. n.

Eschara Nordgaard, 1905 : 167; *Lepralia* auctt. (part.).

The zoaria are prostrate and consist of zooids arranged in straight or oblique rows. The zooids have an oblong-rectangular or hexagonal shape. The orifice is semi-circular and often slightly broad; the distal half is usually encircled by a low peristome. The proximal margin of the orifice is slightly concave and almost straight. The sharp condyles are located at the side of the orifice near the proximal margin. Spines and avicularia are absent. The ovicells are hyperstomial; their surface is covered with an oecial coating which consists of parts of the frontal surface of 3 neighboring zooids. The lateral and transverse walls have pore plates.

Genus type: *Eschara nordlandica* Nordgaard, 1905.

Lepralioides nordlandica (Nordgaard, 1905) (Figure 271)

Eschara nordlandica Nordgaard, 1905 : 167, pl. IV, f. 32-35; 1906a : 22; *Discopora megastoma* Smitt, 1872a : 1128 (part.), t. 21, f. 24.

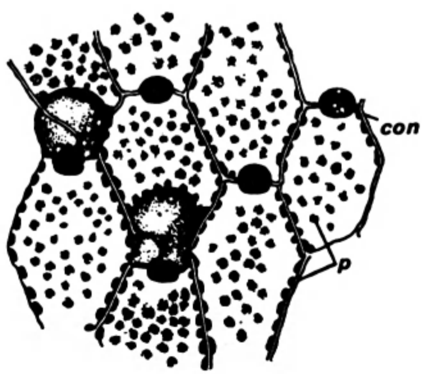


Figure 271. *Lepralioides nordlandica* (Nordgaard).

The zoarium, prostrate in the form of a flat crust, consists of zooids arranged in regular, straight and oblique rows in a checkered pattern. The zooids are medium in size (length 0.88 mm, width 0.63 mm), oblong-rhombic-hexagonal in shape, and separated by raised margins. The frontal surface is slightly raised, and completely covered with small pores which tend to be larger along the margins. The primary orifice is semicircular, and has a straight or slightly concave proximal margin, near which small condyles are located along the sides. Spines are absent. The ovicells are hyperstomial, round, and a little raised; their surface is covered by an oecial coating, and divided by 3 thin rebra, which originate in the middle, into 2 lower, lateral, and 1 upper section, which represent parts of the frontal surfaces of the neighboring zooids. Often a roundish or oval orifice is found in the place where the rebra originate. There are 6 to 7 pore plates in the lateral wall along the lower margin, and 2 simple ones in the distal septum. Avicularia are absent.

The species lives on stones and shells, at a depth of 27 to 178 m, on a bed of silt, stone, and shells, under temperatures ranging from −1.2 to 1.62°C, in a salt concentration of 34.61 to 34.83‰.

Distribution. The species was found by me in the Barents, Kara, East Siberian, and Chukotsk seas. *Reports in literature:* Barents Sea (Smitt, 1872a), Archipelago of the Canadian Islands (Nordgaard, 1906a), western Greenland (Kluge, 1908b), Gulf of St. Lawrence (Whiteaves, 1901), ? Yan-Maien Island (Lorenz, 1886), and northern Norway (Nordgaard, 1905).

This is an Arctic, circumpolar species.

5. Genus **Phylactella** Hincks, 1880

Phylactella Hincks, 1880a : 356; *Discopora* Smitt, 1868b : 27; *Mucronella* Levinsen, 1887 : 323; *Escharella* Nordgaard, 1905 : 170; *Escharoides* Nordgaard, 1912a : 21.

The zoaria, prostrate and overgrowing, consist of large zooids with a strongly developed peristome. The primary orifice is semi-circular; a broad straight border with a sharp margin, or a more or less short lyrule, is located at its proximal margin; the distal margin may or may not have spines. The lateral walls of the zooid (in our species) have many simple pore plates, a characteristic which distinguishes this genus from *Escharella,* which is characterized by the presence of pore chambers at the basal side. Avicularia are absent. The ovicells are hyperstomial and pushed back.

Genus type: *Lepralia labrosa* Busk, 1854.

1 (2). Primary orifice of the zooid has a broad, straight, sharp edge along the entire proximal margin.......1. *Ph. labiata* (Boeck).

2 (1). Primary orifice of the zooid has a broad, low lyrule in the middle of its proximal margin............2. *Ph. pacifica* O'Donoghue.

1. **Phylactella labiata** (Boeck in Mss. by Smitt, 1868) (Figure 272)

Discopora coccinea forma *labiata* Smitt, 1868 : 27, 175, t. 27, f. 176; *Phylactella grandis* Hincks, 1880b : 280, pl. 15, f. 4-5; non *Escharella labiata* Nordgaard, 1905 : 170 (part.), pl. IV, f. 25-26; non Levinsen, 1916 : 451, pl. XX, f. 3-9.

The zoaria, overgrowing and strongly outgrown, sometimes form large surfaces consisting of regular, straight and oblique rows of zooids arranged in a checkered pattern. The zooids are large (length 0.9 to 1.4 mm, width 0.63 to 0.89 mm) and rhombic-hexagonal in shape, sometimes broader in the middle, sometimes more oblong, but of almost uniform width throughout their length. The frontal surface is finely granulated, and a radial pattern extends from the middle of the peristomial base toward the margins; the surface is surrounded by 1 row of pores situated slightly away from the zooidal margin. The primary orifice is semi-circular, and has a broad, straight, sharp edge along the entire proximal margin. Condyles are absent. The orifice is covered on the proximal side by a strongly developed, broad, convex peristome, which reaches to the margins and lowers to the base of the spines. There are 4, or rarely, 5 spines located on the distal margin of the orifice. The peristome is quite sharply raised at the frontal surface and covers one-fourth to one-third, sometimes even one-half, of the zooidal length. The secondary orifice formed by it is very narrow in the transverse direction. The ovicells are large, hyperstomial, and sometimes round, sometimes a little oblong; they have a finely granulated surface and are pushed back to a varying degree. The lateral wings of the peristome reach over the ovicell where 1 spine is usually located. There are 15 to 20 simple, single-pored plates spread irregularly over the lateral wall of the zooid. The ancestrula is oval in shape; its almost round aperture occupies two-thirds of the frontal surface, and is surrounded by 11 to 17 spines; the cryptocyst, located under the aperture, occupies one-third of its proximal part.

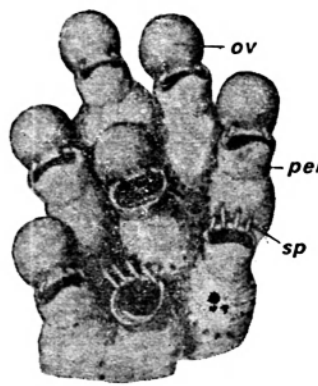


Figure 272. *Phylactella labiata* (Boeck). Part of a zoarium.

The species lives on the shells of mollusks, and the tubes of *Palychaeta*, but more often on the calcareous Bryozoa *Hornera* and *Retepora*, at a depth of 1.5 to 1,000 m, more often from 75 to 200 m, on a bed of silt and stone, under temperatures ranging from −1.9 to 4.5°C, in a salt concentration varying from normal to 31.4‰.

Distribution. The species was found by me in the Barents, Kara, and Laptev seas, and in the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Marenzeller, 1877; Urban, 1880; Nordgaard, 1896; Bidenkap, 1900b; Kluge, 1906; Kluge in Deryugin, 1915), Kara Sea (Smitt, 1879a; Levinsen, 1887; Nordgaard, 1912b; Kluge, 1929), Laptev Sea (Kluge, 1929), western Greenland (Norman, 1906), eastern Greenland (Kirchenpauer, 1874; Andersson, 1902), Iceland and its eastern side (Nordgaard, 1907b, 1924), and in the fiords of northern Norway (Nordgaard, 1918).

This is an Arctic, Atlantic species, which dwells in deep water.

2. **Phylactella pacifica** O'Donoghue, 1923 (Figure 273)

Phylactella pacifica O'Donoghue, 1923 : 44, pl. IV, f. 33; 1926 : 74; Kluge, 1952 : 162, f. 16; 1955b : 107, t. XXII, f. 7.

The zoarium, prostrate and sometimes covering large areas, consists of regular, oblique rows of zooids. The zooids are large (height 1.23 mm, width 0.49 mm) and oblong-rhombic-hexagonal in shape; thin, raised margins separate them. The frontal surface is convex and finely granulated. Radially arranged rebra uprise from the raised margin toward the center of the frontal surface. These rebra separate the strong depressions along the margin of the zooid. Pores are located at the bottom of these depressions. The primary, transversely oval orifice, located near the distal end, has a broad, low tooth (lyrule) at the proximal margin, and is continuously encircled by a raised peristome of uniform length, i.e., without interstices. There are no spines at the distal margin. Condyles are also absent. In zooids without ovicells, a weakly developed oral arch lowers down from the distal side of the primary orifice. It is slightly convex at the center and depressed on the sides. The operculum is membranous. In zooids carrying ovicells, the peristome encircles the orifice from the frontal side and the sides, resting against the ovicell. The ovicells are hyperstomial, round, raised, and convex; they have a finely granulated surface. Avicularia are

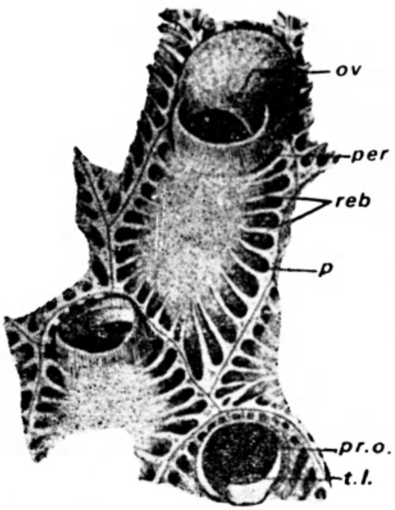


Figure 273. *Phylactella pacifica* O'Donoghue. Zooids in detail (from Kluge, 1952).

absent. Several (12 to 14) uni- or bi-porous plates are located at the lateral walls of the zooid.

The species lives on stones and shells of bivalved mollusks, at a depth of 0 to 54 m, on a bed of shells, under a temperature of −0.4°C.

Distribution. The species was found by me in the Bering Strait, and in the Bering and Okhotsk seas. *Reports in literature:* Pacific coast of North America (O'Donoghue, 1923, 1926).

This is a boreal, Pacific species.

II. Family **Smittinidae** Levinsen, 1909, char. emend.

Smittinidae (part.) Levinsen, 1909 : 335; *Myriozoidae* (part.) Smitt, 1868b : 8; *Escharidae* (part.) Smitt, 1868b : 19; Hincks (part.), 1880a : 295.

The zoaria are prostrate, overgrowing or free-growing, cylindrical or lamellate (discoid), and branched. The frontal surface either has 1 to 2 rows of marginal pores, or is entirely covered with pores. The primary orifice is semi-circular or roundish; either there is a slightly raised lyrule in the middle of the proximal margin, or there is no lyrule and the proximal margin is straight. Condyles are present in most specimens. In the majority of cases, the operculum is membranous or strongly chitinized. Spines are absent in most species. The peristome is developed to a varying degree. Avicularia are present in most species, and located in the middle of the proximal margin of the zooidal orifice, rarely on the lateral margin of one or both sides; the avicularian chamber varies strongly in form and size. Pore plates with one or many pores predominate in the lateral and transverse walls, as pore chambers are rarely found. The ovicells in most species are hyperstomial; the outer layer is calcified, quite often has pores on the surface, and is rarely membranous.

Key for Identification of the Genera of the Family Smittinidae

1 (2). Zoaria free-growing, and chitinous, radicular tubes originate from the proximal half of the frontal surface of the zooids.................................. 2. *Pseudoflustra* Bidenkap (see p. 533).

2 (1). Zoaria prostrate or free-growing; there are no chitinous, radicular tubes.

3 (4). Condyles absent in the primary orifice. Orifice large and semi-circular, with a slightly raised proximal margin in which the avicularium is located with its strongly raised, avicularian chamber; or the orifice is round, and sometimes has a small,

sharp denticle in the middle of its proximal margin, and 2 oval avicularia on its sides..........5. *Umbonula* Hincks (see p. 569).

4 (3). Condyles present in the primary orifice.

5 (6). Primary orifice has a broad, narrow, or sharp denticle (lyrule) in the middle of its proximal margin...1. *Smittina* Norman (see below).

6 (5). Primary orifice has a straight, slightly convex, or concave, proximal margin which, in rare cases, has a broad, low denticle.

7 (8). Peristome strongly developed with 1 to 5 raised, terminally narrowed, avicularian protuberances; a round avicularium with a semi-circular mandible is located at the tip of the middle protuberance, or on the base from the inner side, and at the tip of the lateral ones........4. *Palmicellaria* Alder (see p. 565).

8 (7). Peristome either absent or weakly developed; avicularium, located near the proximal margin between the lateral lobes of the peristome, not raised in the form of a terminally narrowed protuberance....................3. *Porella* Gray (see p. 542).

1. Genus **Smittina** Norman, 1903

Smittia Hincks, 1880a : 340; *Smittina* Norman, 1903b : 120; *Lepralia* (part.) Johnston, 1847 : 310; *Escharella* (part.) Smitt, 1868b : 10.

In most cases the zoaria are prostrate or, rarely, free-growing. A lyrule is located in the middle of the proximal margin of the primary orifice; it varies in size from broad and tall to low and sharp. Condyles are absent. In most species, the avicularium is present, and often located in the middle of the proximal margin of the secondary orifice, or rarely, on one side of the frontal surface. The pore plates in the lateral wall and the distal septum are often uniporous. The ovicells are usually hyperstomial; the outer, calcified layer may or may not have pores on its surface.

Genus type: *Lepralia reticulata* MacGillivray, J., 1842.

1 (10). Entire frontal surface covered with pores.

2 (5). Avicularian chamber at the proximal margin of the secondary orifice raised with the avicularium at the tip.

3 (4). Lyrule in the middle of the proximal margin of the primary orifice usually sharply pointed. Mandible of the avicularium semi-oval, narrowing toward the free end..3. *S. majuscula* (Smitt).

4 (3). Lyrule in the middle of the proximal margin of the primary orifice mildly broadened, and slightly broader still toward the

end; it has a straight, free margin. Mandible of the avicularium semi-circular.................4. *S. minuscula* (Smitt).

5 (2). Avicularian chamber at the proximal margin of the secondary orifice not raised above the frontal surface.

6 (7). Frontal wall of the zooid thick and reticulate; it rises gradually toward the proximal margin of the orifice, and has deeply placed pores at the bottom of the alveoli. Primary orifice triangular in shape, with a sharp lyrule on its narrow, proximal margin, and a round, almost suspended, avicularium at the proximal margin of the secondary orifice................ ....13. *S. tuberosa* Kluge.

7 (6). Frontal surface more or less flat, covered with large depressions which are covered with small pores, or only have small pores on the bottom. Secondary orifice semi-circular with an almost straight margin, or tapers toward the proximal margin.

8 (9). Secondary orifice semi-circular with a small, oval avicularium in the middle of the proximal margin. Frontal surface covered with depressions that have small pores on the bottom........ ....14. *S. beringia* Kluge.

9 (8). Secondary orifice narrows down toward the proximal margin where a small avicularium tilts toward the orifice. Frontal surface covered with small pores...........7. *S. rigida* Lorenz.

10 (1). Frontal surface of the zooid has 1 or 2 rows of marginal pores.

11 (14). Avicularium, located between the secondary and primary orifices of the zooid, not noticeable from the surface.

12 (13). Frontal surface of the zooid more or less smooth. Secondary orifice of the zooid rounded-triangular in shape, tapers toward the proximal end. Lyrule in the primary orifice broadens toward the free end.................17. *S. thompsoni* Kluge.

13 (12). Frontal surface ramose, sharply raised from the margins toward the center, and often terminates in a pointed apex. Secondary orifice roundish. Lyrule in the primary orifice slightly narrows toward the free end.................8. *S. mucronata* (Smitt).

14 (11). Avicularia located on the surface of the zooid, or at the proximal margin of the orifice.

15 (20). Avicularia arranged on one side of the frontal surface, or in the middle at a certain distance from the proximal margin of the orifice.

16 (19). Avicularia located on the side of the frontal surface.

17 (18). Secondary orifice present, with 2 to 4, often 3, spines at its distal margin. Frontal surface, covered with large pores, has a strongly raised margin; a more or less large avicularium is located on one side, slightly below the orifice, which has

a triangular mandible whose sharp tip is directed toward the frontal side..................15. *S. trispinosa* (Johnston).

18 (17). Secondary orifice present, with 2 spines usually at its distal margin. Zoarium usually in the form of tubular structures. Flat frontal surface, covered with small pores, has a slightly raised margin. One to 2 small, oval avicularia often found on the surface, in addition to the large avicularium located on the side........................16. *S. jeffreysi* Norman.

19 (16). Avicularium located in the middle of the frontal surface on that part which is continuous and proximal to the lyrule. Its mandible's free, sharp end is directed forward and toward the side.........................12. *S. smitti* (Kirchenpauer).

20 (15). Avicularium located at the proximal margin of the orifice.

21 (32). Avicularian chamber broad.

22 (29). Avicularian chamber broad, reaching up to the opposite margins of the zooid.

23 (26). Zooids medium in size; avicularian chamber convex.

24 (25). Avicularian chamber strongly raised. One avicularian chamber with an oval avicularium at the top, located directly on one or both sides.............11. *S. muliebris* Kluge sp. n.

25 (24). Avicularian chamber less raised. In addition to the oval, oral avicularium, similar or sometimes very large avicularia located on other places, as well as near the oral orifice of the zooid..................10. *S. pseudoacutirostris* Gostilovskaya.

26 (23). Zooids small. Avicularian chamber not raised or very slightly raised over the frontal surface.

27 (28). Zooids rhombic or oval. Frontal wall thin and slightly raised. Oral avicularium oval and slightly tilted toward the orifice; its distal half juts into the orifice. There are often 1 to 2 additional oval avicularia on the surface of the zooid........ ....9. *S. concinna* (Busk).

28 (27). Zooids often rectangular. Frontal wall thick. Round, oral avicularium almost suspended to the plane of the orifice...... ....9a. *S. concinna* var. *belli* (Dawson).

29 (22). Avicularian chamber, although broad, does not reach up to the opposite margins of the zooid.

30 (31). Frontal surface raised. Avicularian chamber raised, and has 3 to 5 pores in its wall. Oval, oral avicularium at the top of the chamber slightly tilted toward the orifice. A broad lyrule clearly visible in the orifice. Peristome tubular in shape and strongly developed in zooids carrying ovicells. ....5. *S. peristomata* (Nordgaard).

31 (30). Frontal surface flatter. Avicularian chamber slightly raised,

has 2 to 3 pores in its wall. Round, oral avicularium almost suspended to the plane of the orifice. Peristome poorly developed. Ovicell has 2 to 3 pores at the surface........ ....6. *S. glaciata* (Waters).

32 (21). Avicularian chamber narrow and small.

33 (34). Transverse orifice roundish with a more or less broad lyrule. A small, conical avicularian chamber, with a round, almost suspended avicularium pointed toward the orifice, located between the poorly developed lateral lobes of the peristome. ....2. *S. landsborovii* (Johnston).

34 (33). Secondary orifice a rounded triangle. Well-developed lateral lobes of the peristome lowered toward the proximal margin of the primary orifice, from which a broad tooth is located distally; proximally there is a long avicularium with a sharp mandible whose free end is pointed in the proximal direction.......... ....1. *S. reticulata* (MacGillivray).

1. **Smittina reticulata** (MacGillivray, 1842) (Figure 274)

Lepralia reticulata Busk, 1854a : 66 (part.), pl. 90, f. 1; *Smittia reticulata* Hincks, 1880a : 346 (part.), pl. 48, f. 1; non *Smittia reticulata* Levinsen, 1887 : 319; non Robertson, 1908 : 306; *Escharella legentilii* forma *typica* Smitt, 1868b : 10, 81, t. 24, f. 50-52.

The zoaria, partly prostrate, partly free-growing, consist of zooidal rows arranged in a checkered pattern. The zooids are medium in size (length 0.63 to 1.13 mm, width 0.43 to 0.50 mm), and either oblong-rhombic-hexagonal or rectangular in shape. The frontal surface is slightly raised and granulated; it has a strongly raised margin along which closely placed depressions are located with pores at the bottom. The primary orifice, located at the distal end of the zooid, is round; a lyrule which narrows toward its free end, is located at the center, and thin condyles at the margins. There are 2 spinules on the distal margin. The thin peristome rises above the surface from a deep incision in the

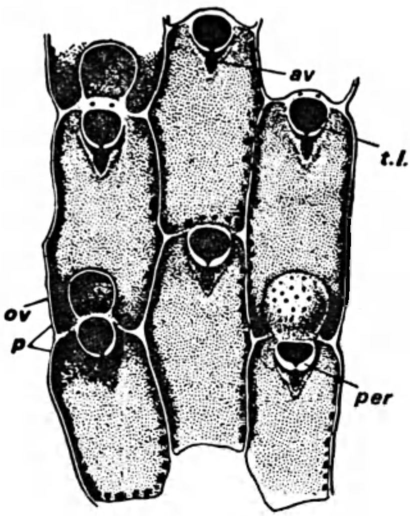


Figure 274. *Smittina reticulata* (MacGillivray). Part of a zoarium.

middle of the proximal margin. Beyond this incision is located an oval avicularium, which is sometimes slightly raised, sometimes lowered. The avicularium has a mandible whose sharp end is directed toward the proximal side. There are from 1 to 3, more often 2, pores on the surface of each lateral lobe of the avicularian chamber. The ovicells are large, semi-circular, or circular; the inner layer has a slightly flattened frontal surface, which is covered with a large number of pores, and is bordered by an incompletely calcified outer layer. There are up to 10 pore plates along the lower half of the lateral wall of the zooid, and up to 12 simple ones in the distal septum.

The species lives on coral, Bryozoa, tubes of worms, shells, and stones, at a depth of 12 to 540 m, on a bed of silt, stone, and shell, under a temperature of $-1.42°C$.

Distribution. Reports in literature: Barents Sea (Andersson, 1902; Nordgaard, 1912a), waters off western and southern Norway (Nordgaard, 1912a, 1918), Skagerrack and Kattegat (Smitt, 1868b; Levinsen, 1894; Silen, 1936; Marcus, 1940), Shetland (Norman, 1869) and British Isles (Hincks, 1880a), northwest France (Joliet, 1877), Mediterranean Sea (Calvet, 1902), and California (Robertson, 1908).

This is an amphiboreal species.

*2. **Smittina landsborovii** (Johnston, 1847) (Figure 275)

Lepralia landsborovii Johnston, 1847 : 310, pl. LIV, f. 9; Hincks, 1880a : 341, pl. XLVIII, f. 6-9; Marcus, 1940 : 275, f. 141.

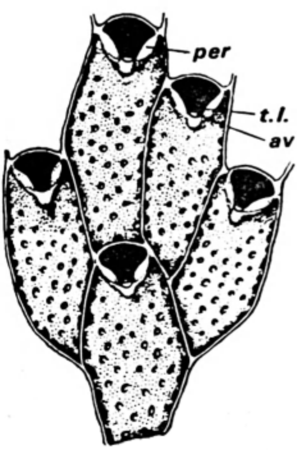


Figure 275. *Smittina landsborovii* (Johnston). Part of a young zoarium.

Despite the fact that this species has been reported a number of times as occurring in our waters, and in Arctic waters in general (Smitt, 1868b: 12; Lorenz, 1886: 91; Levinsen, 1887: 321; Hincks, 1892: 156; Waters, 1900: 90), in actuality it is a purely boreal species; in order to avoid further mistaken identifications, I have given a figure and description of it here.

The zoaria, prostrate or free-growing, consist of zooids arranged in regular, oblique rows. The zooids are comparatively large (length 0.75 to 1.00 mm, width 0.50 to 0.63 mm), more or less broad, and hexagonal in shape. The frontal surface rises gradually, is continuous, and has a strongly raised margin along which 1 to 2 rows of pores are located. The primary orifice, located near the distal margin, is roundish; there is a low, more or less broad lyrule in the middle of its proximal margin, and sharply pointed condyles at its margins. A short peristome whose raised lateral lobes surround the primary orifice, encloses a slightly raised, round avicularium located in the middle of the secondary orifice; its mandible's free end is pointed downward. This avicularium may not be present in some zooids of the zoarium. The lateral wall of the zooids has 6 to 8 simple pores arranged along the basal margin in the distal septum. The ovicells are hyperstomial, round, and convex; they have an incompletely calcified ectooecium, and a calcareous endooecium which is covered with pores.

The species lives on algae, hydroids, shells, and stones, at a depth of 11 to 350 m.

Distribution. Reports in literature: Coastal waters of Denmark (Marcus, 1940), British Isles (Hincks, 1880a), Ireland (Nichols, 1911), and the Bay of Biscay (Jullien and Calvet, 1903).

This is a boreal species.

3. **Smittina majuscula** (Smitt, 1868) (Figure 276)

Escharella porifera forma *minuscula* Smitt, 1868b : 9, 74, t. 24, f. 36-38; *Smittia landsborovii* forma *porifera* Hincks, 1888 : 225, pl. 14, f. 2; *Smittina porifera* Osburn, 1912 : 245, pl. 26, f. 64; *Smittina arctica* Levinsen, 1916 : 455, pl. XXII, f. 1-3; *Smittina majuscula* Nordgaard, 1905 : 170, pl. IV, f. 36-38.

The zoaria, prostrate and overgrowing, consist of zooids arranged in more or less regular, oblique rows. The zooids are medium in size (length 0.88 mm, width 0.50 mm) and rhombic-hexagonal or oval in shape, sometimes broader, sometimes narrower. The frontal surface is convex and completely covered with pores between which a large number of minute tubercles are situated. The primary orifice, located at the distal end of the zooid, is round; a lyrule is located in the middle of its proximal margin, which narrows toward the free end

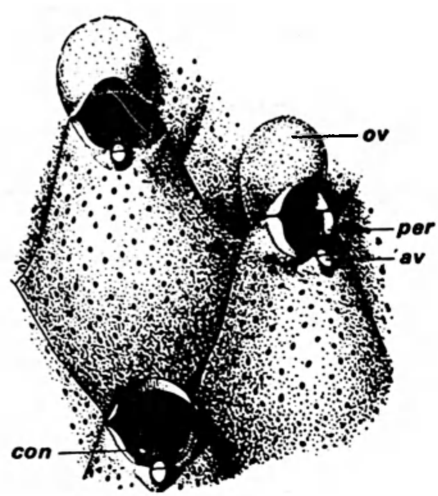


Figure 276. *Smittina majuscula* (Smitt). Zooids in detail.

and sometimes converts into a sharp edge. There is 1 denticle with a rounded tip at each of the margins. The slightly chitinized operculum has an oblong chitinous cylinder on each side for the attachment of the occlusor muscles. A raised, oval operculum is located between the small, lateral lobes of the peristome on the proximal margin of the secondary orifice, sometimes not covering the lyrule with its own body; the free end of its slightly semi-oval mandible is pointed in the proximal direction. The avicularian cavity forms narrowing protuberances at the margins, which do not reach up to the margins, and open to the outer side through a small pore. The ovicells are semi-circular, convex, coarsely granulated, and often have an upwardly turned proximal margin, which resembles a peak. A thin, calcareous, triangular coating may be found on some of the ovicells on one or both sides. This coating is a part of the frontal surface of the neighboring, lateral zooids. The lateral wall of the zooid has 5 to 6 oval pore plates with a few pores, and the distal septum, 3 to 4 uniporous plates on each side.

The species lives on algae, ascidia, and shells, at a depth of 11 to 310 m, more often from 40 to 150 m, on a bed of stone, silt, and sand, under temperatures varying from -1.9 to 6.3°C, in a salt concentration of 34.27 to 34.72 ‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, and Bering seas, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Andersson, 1902; Norman, 1903a; Nordgaard, 1905), White Sea (Kluge, 1907, 1908a; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Nordgaard, 1912b), Laptev Sea (Kluge, 1929), Baffin Bay (Osburn 1936), western Greenland (Smitt, 1868c; Norman, 1906; Kluge, 1908b; Levinsen, 1914), Gulf of St. Lawrence (Hincks, 1888; Whiteaves, 1901), eastern Greenland (Nordgaard, 1907a; Levinsen, 1916), northern Norway (Nordgaard, 1905, 1918), and the region of Woods Hole on the eastern coast of North America (Osburn, 1912).

This is an Arctic, circumpolar species.

4. **Smittina minuscula** (Smitt, 1868) (Figure 277)

Escharella porifera forma *minuscula* Smitt, 1868b : 9, pl. 24, f. 33-35; *Smittina arctica* Norman, 1894 : 128 (part.); *Smittina Landsborovii* var. Waters, 1900 : 90, pl. 12, f. 7; *Smittina minuscula* Nordgaard, 1906a : 28, pl. 3, f. 46-47; Kluge, 1952 : 155; *et auctt.*

The overgrowing zoarium consists of zooids arranged in straight and oblique rows. The zooids are small (length 0.65 mm, width 0.38 mm) and oblong-rhombic-hexagonal or oval in shape. The frontal surface is mildly raised and porous. The primary orifice, located near the distal end of the zooid, is semi-circular; it has a broad lyrule which broadens more toward its free end, and a straight margin with small condyles, which are hidden by the avicularium. The weakly chitinized operculum has no oblong, chitinous cylinders. The peristome between the lateral lobes, is more strongly developed in the zooids carrying ovicells. A raised oval avicularium is located at the proximal margin of the secondary orifice, and its hind half, covered with a membrane, is raised and juts into the cavity of the orifice in the form of a semi-circular ligula which covers the lyrule; the mandible is semi-circular and its width is slightly greater than its length. The avicularian chamber is semi-circular and not broad. The ovicells are hyperstomial, round, convex, coarsely granulated, and sometimes have a small orifice below the center of the frontal surface. The frontal surface of the neighboring, lateral zooids overgrows as a triangular surface on the proximal half of the ovicell; their narrower parts come close to each other up to a stage of fusion, and bend upward like a peak from a semi-circular comb above the proximal margin of the ovicell; the peristome, together with the lateral lobes, forms the secondary, transverse, oval orifice of the zooid.

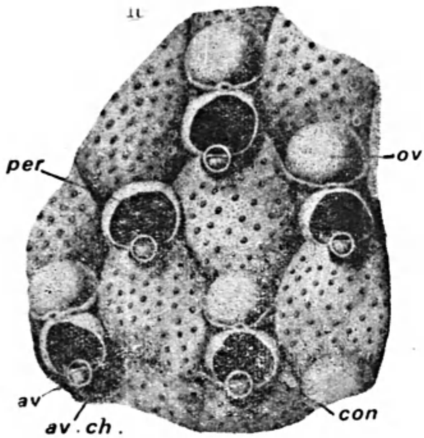


Figure 277. *Smittina minuscula* (Smitt). Part of a zoarium.

There are 5 to 6 uniporous chambers located along the basal margin of the lateral wall, and 1 on each side of the distal septum.

The species lives on algae, Bryozoa, acorn barnacles (*Balanus* sp.), and mollusk shells, at a depth of 6 to 288 m, on a bed of silt, stone, and shell, under temperatures varying from —1.61 to 3.2°C, in a salt concentration of 32.86 to 34.83‰.

Distribution. This species was found by me in the Barents, Kara, Laptev, Chukotsk, and Bering seas, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Bidenkap, 1900a; Kluge in Deryugin, 1915; Nordgaard, 1923), White Sea (Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Nordgaard, 1912b), Laptev Sea (Kluge, 1929), Archipelago of the Canadian Islands (Nordgaard, 1906a), Hudson Bay (Osburn, 1932), western Greenland (Norman, 1906; Kluge, 1908b; Levinsen, 1914; Osburn, 1919), Gulf of St. Lawrence (Whiteaves, 1901), eastern Greenland (Levinsen, 1916), Iceland

(Nordgaard, 1924), and Finmark (Smitt, 1868b; Nordgaard, 1918).
This is an Arctic, circumpolar species.

5. **Smittina peristomata** (Nordgaard, 1905) (Figure 278)

Phylactella peristomata Nordgaard, 1905 : 170, pl. V, f. 28-31; *Porella peristomata* Kluge, 1906 : 41, f. 2.

The zoarium, prostrate in the form of a thin, white crust, consists of radially divergent rows originating at the ancestrula, and arranged in a checkered pattern. The zooids are small (length 0.70 mm, width 0.40 mm), and rhombic-hexagonal in shape. The frontal surface is mildly raised and bordered by a thin raised margin along which lie shallow, saccate depressions. The primary orifice, located near the distal margin of the zooid, is semi-circular and broad; it has a broad tooth at the proximal margin and 4 to 6 spines on the distal margin. An oval avicularium with a broad avicularian chamber, is raised between the lobes of the peristome behind the lyrule; this chamber does not reach up to the lateral margins of the zooid; there are 3 to 5 pores located on the wall of the latter. The ovicells are hyperstomial, round, convex, and broad; they have a smooth surface. The peristome is strongly overgrown in the zooids carrying ovicells; its sides rest against the ovicell and completely cover the raised avicularium, a characteristic feature of this species.

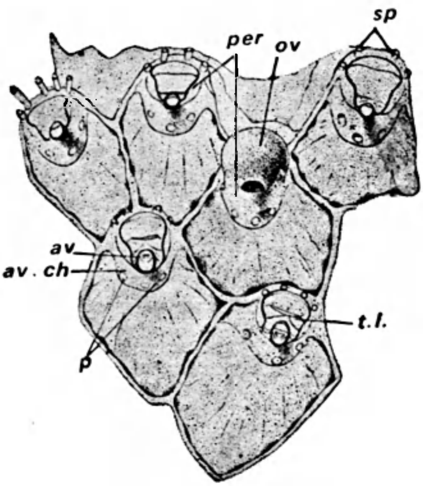


Figure 278. *Smittina peristomata* (Nordgaard). Part of a zoarium (from Kluge, 1906).

The species lives on shells of bivalved mollusks and brachiopods, at a depth of 73 to 630 m, more often from 150 to 300 m, at temperatures ranging from —1.4 to 3.9°C, in salt concentration of 34.27 to 34.90‰.

Distribution. The species was found by me in the Barents and Kara seas. *Reports in literature:* White Sea (Gostilovskaya, 1957), northern Norway (Nordgaard, 1905, 1918), to the east of Iceland (Nordgaard, 1907b), and the northern part of the Atlantic Ocean (Kluge, 1906).

This is an Arctic, Atlantic species.

6. **Smittina glaciata** (Waters, 1900) (Figure 279)

Porella glaciata Waters, 1900 : 78; non Nordgaard, 1905 : 168; 1907b : 13; 1912a : 21; non Levinsen, 1914 : 593; *Smittina glaciata* Kluge, 1946 : 203, t. II, f. 8.

The zoarium, prostrate and overgrowing, consists of zooids arranged in a checkered pattern. The zooids are medium in size (length 0.80 mm, width 0.50 mm), rhombic-hexagonal, and separated by a thick, raised margin. The frontal surface is mildly raised, but limited on the sides by depressions along the margin; radially arranged rebra are located between these depressions. The surface of the zooid has large granulations. The primary orifice, located at the distal end of the zooid, is semi-circular; a more or less broad lyrule is located in the middle of the proximal margin, and blunt condyles are situated at the sides of the latter. Rounded, triangular lobes are located at the sides of the secondary orifice of the zooid; these have tips which tilt slightly toward the middle of the orifice. A low, round, conical avicularium with a semi-circular mandible is raised in the middle of its proximal margin. Its avicularian chamber produces narrow protuberances on the sides, which do not reach up to the lateral margins of the zooid. The outer wall of the chamber has 2 to 4 pores. There are 4 short spines at the distal margin of the orifice of the cystid in young zooids. The basal wall of the zooid often forms 1 to 2 hollow outgrowths for the fixation of the zooid to the surface. The ovicells are hyperstomial, small, round, and strongly raised with 1 to 3 round orifices in the middle of their granular surface. The zooids carrying ovicells have a peristome whose lateral lobes overgrow the surface of the ovicells in the form of short cylinders, which often fuse with each other in the medial part of the ovicell, near its proximal part.

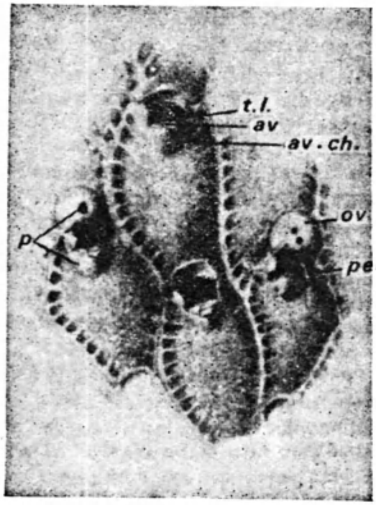


Figure 279. *Smittina glaciata* (Waters). A small part of a zoarium (from Kluge, 1946).

There are 4 pore plates with 2 to 3 pores each in the lateral wall, and 2 with 2 pores each in the distal septum.

The species lives on calcareous Bryozoa, more often on *Reticulipora intricaria,* at a depth of 55 to 410 m, on a bed of silt and stone, under temperatures ranging from −1.48 to 0.82°C, in a salt concentration of 34.65 to 34.92‰.

Distribution. The species was found by me in the Barents and Kara seas. *Reports in literature:* Barents Sea (Waters, 1900).

This is a high Arctic species.

7. **Smittina rigida** Lorenz, 1886 (Figure 280)

Smittina rigida Lorenz, 1886 : 91 (9) (part.), t. VII, f. 8-8a; *Escharella landsborovii* Smitt, 1868b : 12 (part.), t. 24, f. 60-61, 63-65; *Smittina landsborovii* Johnston var. Waters, 1900 : 90, pl. 12, f. 7; *Smittina novanglia* Osburn, 1933 : 50, pl. 9, f. 8, pl. 13, f. 7-8.

The zoaria, prostrate in the form of a crust, consist of zooids arranged in comparatively oblique rows. The zooids are medium in size (length 0.73 mm, width 0.48 mm) and rhombic-hexagonal, sometimes oblong and narrow, sometimes short and broad. The frontal surface is slightly raised and bordered by a thin, wavy, raised margin, along which pores are arranged; the whole surface surrounding the orifice, except for the frontal section, is covered with pores. The primary orifice, located near the distal margin of the zooid, is semi-circular; there is a tooth in the middle of the proximal margin, and small condyles on the margins; the tooth is usually low, but in some forms it is straight and narrow, while in others it is a blunt, tapering denticle which is often barely observable. The secondary orifice, semi-circular in the distal half, narrows toward the proximal margin on which a small, oval avicularium tilts toward the orifice. The ovicells are hyperstomial, round, and slightly raised; the covering layer has a granulated surface. In some zooids, this layer consists of 3 lobes connected by sutures: the 2 lateral ones belong to the frontal surfaces of the neighboring, lateral zooids, and the third, distal one belongs to the frontal surface of the overlying zooid. There are 6 uniporous plates in the lateral wall, and 2 in the distal septum.

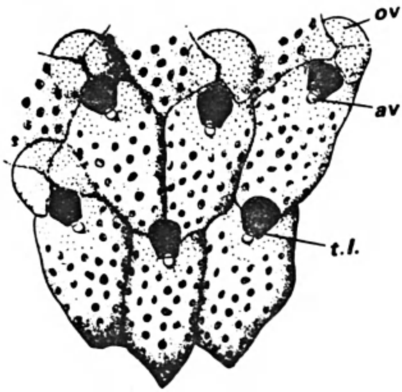


Figure 280. *Smittina rigida* Lorenz. Part of a zoarium.

The species lives on shells and stones, at a depth of 10 to 250 m, more often from 75 to 150 m, on a bed of stone, shells, and silt, under temperatures ranging from −1.9 to 3.7°C, in a salt concentration of 32.86 to

34.79‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, and Chukotsk seas, and off the western coast of Greenland. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Bidkenkap, 1900a; Waters, 1900; Nordgaard, 1905; Kluge in Deryugin, 1915), White Sea (Gostilovsakaya, 1957), Chukotsk Sea (Osburn, 1923), western Greenland (Norman, 1906; Kluge, 1908b; Levinsen, 1914), Gulf of St. Lawrence (Hincks, 1889; Whiteaves, 1901), Gulf of Man (Osburn, 1933), eastern Greenland (Andersson, 1902), Yan-Maien Island (Lorenz, 1886), western Norway (Norman, 1894; Nordgaard, 1905, 1906b, 1912a, 1918), and the Shetland Islands (Norman, 1894).

This is an Arctic, circumpolar species.

8. **Smittina mucronata** (Smitt, 1868) (Figure 281)

Escharella landsborovii forma *mucronata* Smitt, 1868b : 13, t. 24, f. 66-67; *Porella mucronata* Kluge, 1906 : 42; *Smittina mucronata* Nordgaard, 1923 : 11, f. 2.

The zoarium, prostrate and overgrowing the substrate in the form of a thick crust with a tubular surface, consists of zooids arranged in regular, oblique rows. The zooids are small (length 0.54 to 0.63 mm, width 0.40 mm) and rhombic, though broader in the distal half. The frontal surface is tubular and rises quite sharply from the margins toward the center, where it often terminates in a sharp apex. In a young stage, the surface is surrounded by depressions around the lowered margins, the former having pores at the bottom; between these depressions, weak rebra stretch toward the center; the surface is covered with sparse pores. The primary orifice, located near the distal margin of the zooid, is semi-circular; its height is greater than its width, and a low, narrow lyrule with a straight margin, is located at the proximal margin. The secondary orifice is roundish, and narrows toward the proximal margin. Between the proximal margins of the secondary and primary orifices, a small round avicularium lies close to the primary orifice, which is not observable from the surface. The ovicells are hyperstomial, semi-circular, and less raised.

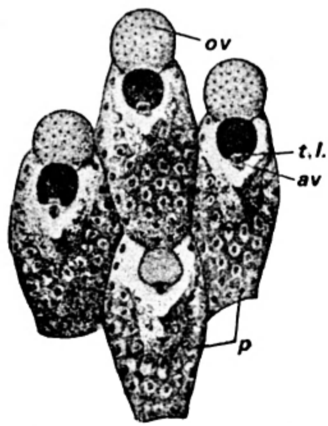


Figure 281. *Smittina mucronata* (Smitt). A small part of a zoarium. Kara Sea.

The species lives on shells and stones, at a depth of 9 to 252 m, more often from

10 to 40 m, on a bed of stone, sand, and silt, under temperatures ranging from 0.24 to 3.70°C, in a salt concentration of 32.86 ‰.

Distribution. The species was found by me in the Barents, Kara, and Chukotsk seas. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879a, 1879b; Nordgaard, 1923; Kuznetsov, 1941), White Sea (Kluge, 1908a; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Kluge, 1929), Chukotsk Sea (Kluge, 1929), and off northern Norway (Kluge, 1906).

This is an Arctic species.

9. **Smittina concinna** (Busk, 1854) (Figure 282)

Lepralia concinna Busk, 1854a : 67 (part.), pl. 99, f. 1-3; *Porella concinna* Hincks, 1880a : 323 (part.), pl. 46, f. 1; *Smittina concinna* Jullien and Calvet, 1903 : 150, pl. 17, f. 4; *Porella laevis* forma *lepraliae* auctt. Smitt, 1868b : 21 (part.), t. 26, f. 115-117.

The zoarium, prostrate in the form of a thin, overgrowing crust, consists of zooids arranged in regular, straight and oblique rows. The zooids are small (length 0.50 mm, width 0.38 mm) and rhombic or oval in shape. The frontal surface is slightly raised, finely granulated, and surrounded by a row of pores along the margins. The primary orifice, located near the distal end of the zooid, is semi-circular; it sometimes has a broad, low tooth, sometimes a low, pointed denticle in the middle, and sometimes even just a straight, proximal margin. The secondary orifice in the distal half is semi-circular, but narrows toward the proximal margin; an oval avicularium with a semi-circular mandible, is located in the middle of the orifice and tilts slightly toward the orifice. A semi-circular avicularian chamber, which is visible through the wall, reaches up to the lateral margins of the zooid; in younger zooids this chamber bulges somewhat at the margin of the zoarium. In addition to the oral avicularium, small, oval avicularia are often found on the frontal surface, usually near the margins; rarely, a large, oval avicularium is present in the middle of the surface. The ovicells are hyperstomial, round, and convex; they have a finely granulated surface. There are 4 pore plates along the lateral wall, and 2 with a few pores in the distal septum.

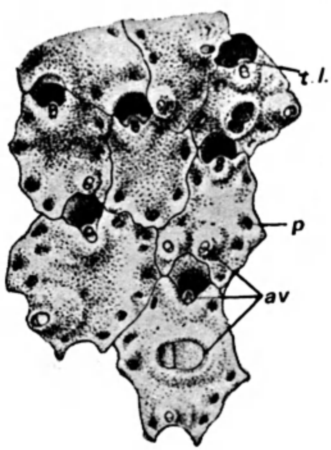


Figure 282. *Smittina concinna* (Busk). Part of a young zoarium with oral and additional avicularia. White Sea.

The species lives on stones and shells, at a depth of 8 to 512 m, more often from 30 to 150 m, on a bed of silt, stone, and shells, under temperatures ranging from 1.9 to 3.7°C, in the White Sea from −1.2 to 1.4°C, in a salt concentration of 32.86 to 34.96‰, in the White Sea from 27.4 to 29.4‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, Chukotsk, Bering, and Okhotsk seas, and off western Greenland and the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Bidenkap, 1900a; Waters, 1900; Norman, 1903b), White Sea (Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Nordgaard, 1923), Chukotsk Sea (Kluge, 1929), northern coast of North America and the Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1923, 1932), Labrador (Osburn, 1913), Gulf of St. Lawrence (Hincks, 1889; Whiteaves, 1901), western Greenland (Norman, 1906; Kluge, 1908b; Levinsen, 1914; Osburn, 1919) eastern Greenland (Levinsen, 1916), western Norway (Smitt, 1868b; Norman, 1894; Nordgaard, 1918), Skagerrack and Kattegat (Smitt, 1868b; Levinsen, 1894; Marcus, 1940), North Sea (Nordgaard, 1907b), Shetland Islands (Norman, 1869), British Isles (Hincks, 1880a), Mediterranean Sea (Calvet, 1902), eastern coast of North America from Cape Cod to the Gulf of Fundy (Osburn, 1912, 1933), western coast of North America from Queen Victoria Islands to California (Robertson, 1908; O'Donoghue, 1923, 1926).

This is an Arctic-boreal, circumpolar species.

9a. **Smittina concinna** var. **belli** (Dawson, 1859) (Figure 283)

Lepralia Belli Dawson, 1859 : 256; *Porella concinna* var. *Belli* Hincks, 1880a : 324, pl. 46, f. 2; *P. concinna* (*granular* var.) Hincks, 1892 : 156, pl. 8, f. 6; *Smittina concinna* Osburn, 1933 : 45 (part.), pl. 10, f. 5.

The zoaria, prostrate and overgrowing in the form of a crust, consist of zooids arranged in regular, straight and oblique rows. The zooids are small (length 0.45 mm, width 0.40 mm) and rhombic-hexagonal or rectangular in shape. The frontal surface is mildly raised, granulated, and surrounded by a row of pores along the deep margin. When a stronger calcification occurs and the pores are larger, the margin of the frontal surface becomes sinuate. The primary orifice, located at the distal margin of the zooid, is semi-

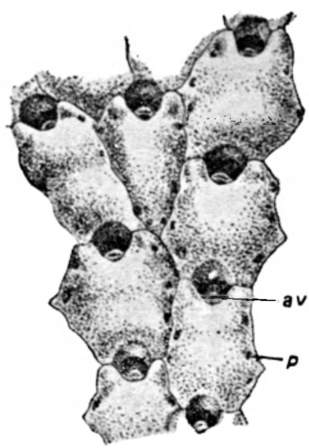


Figure 283. *Smittina concinna* var. *belli* (Dawson). Part of a zoarium. Barents Sea (Kola Bay).

circular; sometimes it has a more or less broad and low tooth, and sometimes it is slightly raised. The lateral margins of the secondary orifice are usually thick and rounded; an almost suspended, round avicularium with a semi-circular mandible is located at the proximal margin. The avicularian chamber is slightly broader and more raised than that of *S. concinna*. The ovicells are hyperstomial, round, and slightly raised; on stronger calcification, their frontal wall is less raised, and the ovicell is only slightly visible; it appears to be endozooecial. There are 4 pore plates with a few pores in the lateral wall, and 2 in the distal septum.

The species lives on stones and shells of *Pecten* and other bivalved mollusks, at a depth of 25 to 162 m, on a bed of stone, silt, and shells, under a temperature of 2.56°C, in a salt concentration of 32.86‰.

Distribution. This form was found by me in the Barents, Chukotsk, Bering, and Okhotsk seas, and off western Greenland. *Reports in literature:* Barents Sea (Bidenkap, 1900a; Kluge 1906; Nordgaard, 1918; Kuznetsov, 1941), White Sea (Gostilovskaya, 1957), Labrador (Packard, 1863), western Greenland (Norman, 1906), Gulf of St. Lawrence (Dawson, 1859; Hincks, 1892; Whiteaves, 1901), eastern coast of North America from Cape Cod to the Bay of Fundy (Osburn, 1933), northern Norway (Nordgaard, 1905; Guerin-Ganivet, 1911), and the Shetland Islands (Norman, 1869).

This is an Arctic-boreal species.

10. **Smittina pseudoacutirostris** Gostilovskaya, 1957 (Figure 284)

Smittina pseudoacutirostris Gostilovskaya, 1957 : 451, f. 4.

The zoaria, prostrate and sometimes overgrowing a large area, consist of zooids arranged in irregular rows. The zooids are small (length 0.50 to 0.63 mm, width 0.33 to 0.38 mm) and rhombic-hexagonal or oval in shape. The frontal surface is mildly raised and coarsely granulated; it has a raised, wavy margin along which are located a few more or less depressions which have a single pore at the bottom. The primary orifice, located at the distal margin, is semi-circular; a low, broad lyrule is often located at the proximal margin, which either narrows toward the free end to the extent of a short mucro, or is simply convex. An oval avicularium is located between the lateral lobes of the peristome at the proximal margin of the secondary orifice; its posterior half juts into the orifice in the form of a semi-circular ligula, and its semi-circular mandible points in the proximal direction. The avicularian chamber is convex and broad, and extends up to the lateral margins. In some colonies, in addition to the aforementioned avicularium, similar avicularia are also found in other places of the zooid, but often these are in the region of the oral orifice. Besides these small avicularia, sometimes very large ones are likewise found, situated either in the place of the oral avicularium, or near it. The ovicells are large, round, broad, and convex; they have a granulated surface. There are 4 pore plates with a few pores in the lateral wall, and 2 in the distal septum.

The species lives on shells, stones, and sandy conglomerates, at a depth of 16 to 363 m, under temperatures varying from 7.5 to 12.5°C, in a salt concentration of 26.87‰.

Distribution. The species was found by me in the Barents Sea, in eastern Murmansk, and in the northeastern, deep water trough. *Reports in literature:* White Sea (Gostilovskaya, 1957).

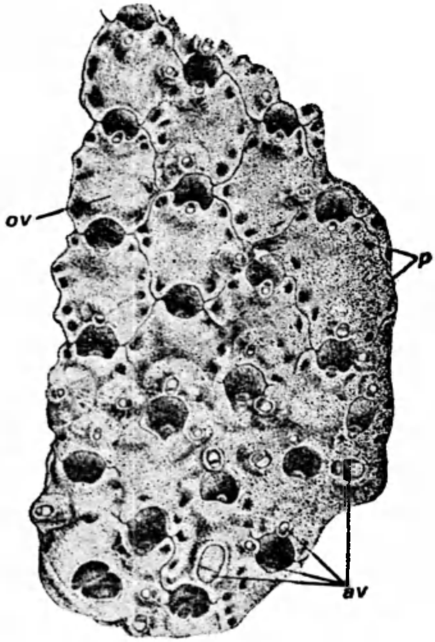


Figure 284. *Smittina pseudoacutirostris* Gostilovskaya. Part of a zoarium, with oral and additional avicularia in the zooids. White Sea.

11. **Smittina muliebris** Kluge sp. n. (Figure 285)

The zoaria, prostrate and overgrowing, consist of zooids arranged in regular, oblique rows. The zooids are less than medium in size (length 0.58, mm, width 0.43 mm) and hexagonal or oval in shape. The frontal surface, raised and granulated, has sparse pores along its deep margin. The primary orifice, located at the distal margin of the zooid, is semi-circular with a blunt or somewhat sharper tooth in the middle of the proximal margin. An oval avicularium is located on the raised avicularian chamber between the lateral lobes of the peristome, at the proximal margin of the secondary orifice. The avicularium is rather strongly tilted toward the orifice, and its semi-oval mandible is directed with its free end toward the frontal surface. The avicularian chamber, convex, semi-circular, and broad, often reaches up to the lateral margins of the zooid. One oval avicularium with a raised, oval avicularian chamber,

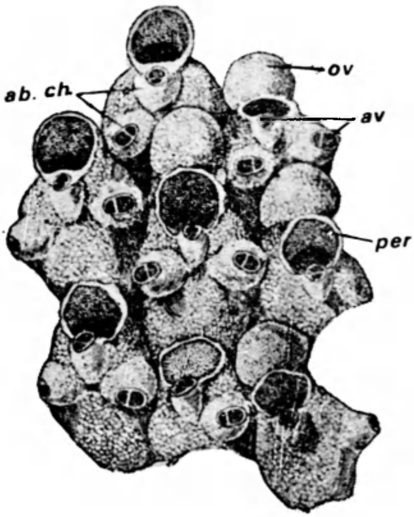


Figure 285. *Smittina muliebris* Kluge sp. n. Part of a zoarium. Barents Sea.

which broadens toward the base, is usually placed symmetrically directly below the avicularian chamber, on each of its sides. The free margins of their semi-oval mandibles are pointed toward the sides. Sometimes, instead of 2 avicularia, only 1 is found on any side, or the lateral ones are absent, and a larger avicularium with a semi-oval mandible is located in the middle; this mandible's free end is pointed in the distal direction. The ovicells are hyperstomial, round, and convex, they have a granulated surface. The lateral lobes of the peristome are more strongly developed in the zooids carrying ovicells, and their distal ends extend over the ovicell; fusing in the middle, they form a rebral margin along the proximal margin of the ovicell. There are 2 uniporous plates in the lateral wall of the zooid, and 2 uniporous chambers in the distal septum.

The species lives on the tubes of worms and the shells of lamellibranched mollusks, at a depth of 6 to 42 m.

Distribution. The species was found by me in the northern parts of the Kara Sea.

12. **Smittina smitti** (Kirchenpauer, 1874) (Figure 286)

Lepralia smitti Kirchenpauer, 1874 : 420; *Escharella reticulata* Levinsen, 1887 : 319, pl. 27, f. 5-6; Bidenkap, 1897 : 622 (*Smittia*), pl. 25, f. 3; *E. Legentilli* forma *prototypa* Smitt, 1868b (part.), pl. 24, f. 49; *Smittina smitti* Nordgaard, 1905 : 171, pl. 4, f. 24.

The zoarium, prostrate and not wholly attached to the substrate, consists of zooids arranged in regular, oblique rows. The zooids are large (length 1.00 to 1.40 mm, width 0.61 to 0.65 mm) and rhombic-hexagonal or rectangular in shape, sometimes more oblong, sometimes broader. The frontal surface is mildly convex and granulated; it has a strongly raised, thin margin along which 2 rows of pores are located. The primary orifice, located at the distal end of the zooid, is transversely oval, and has a lyrule that slightly narrows toward the free end. The lyrule is located at the proximal margin, and thin, sharp denticles are located on the sides. An oval avicularium lies proximal to the lyrule on the continuous surface, with the sharp tip of its mandible directed forward and to one side. The ovicells are hyperstomial, round, and mildly convex; they have a granulated surface, and are often covered on the sides by a part of the frontal surface of the neighboring zooids. There are 6 to 9 pore plates in the lateral wall of the zooid with 2 to 3 pores each. There are 8 to 12 uni- or bi-borous plates arranged along the lateral and basal sides in the distal septum.

The basal wall often produces projections and protuberances for attaching the zoaria to the substrate.

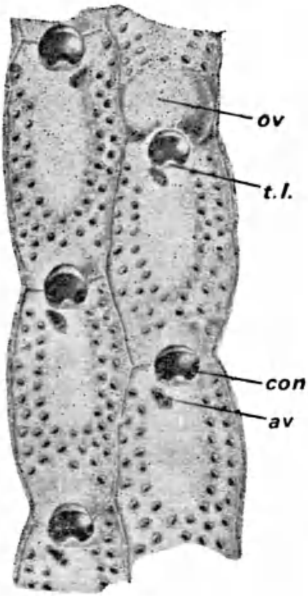


Figure 286. *Smittina smitti* (Kirchenpauer). Part of a zoarium. Barents Sea.

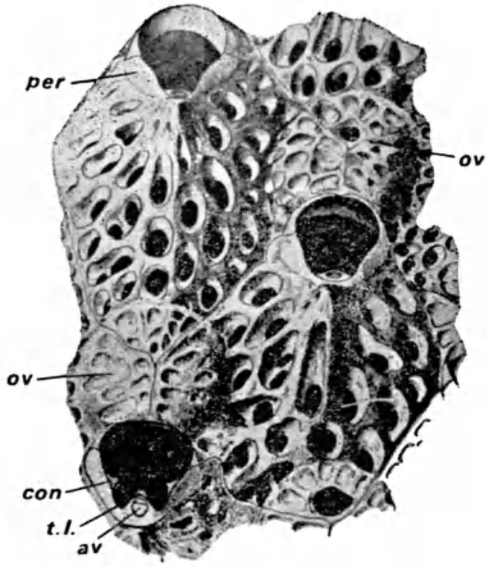


Figure 287. *Smittina tuberosa* Kluge. Zooids in detail (from Kluge, 1952).

The species lives on hydroids, Bryozoa, and shells of lamellibranched mollusks, at a depth of 5.5 to 252 m, more often from 50 to 150 m, on a bed of silt, stone, and sand, under temperatures ranging from −1.68 to 0.74°C, in a salt concentration of 33.72 to 34.83‰.

Distribution. The species was found by me in the Barents, Kara, and East Siberian seas, and in the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1868b; Bidenkap, 1897, 1900a; Kluge in Deryugin, 1915), Kara Sea (Smitt, 1879a; Levinsen, 1887), Laptev Sea (Kluge, 1929), northern coast of North America and the Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1932), western Greenland (Smitt, 1868c, Levinsen, 1914; Osburn, 1919), eastern Greenland (Kirchenpauer, 1874; Andersson, 1902), Yan-Maien Island (Lorenz, 1886), and northern Norway (Nordgaard, 1905, 1918).

This is an Arctic species.

13. **Smittina tuberosa** Kluge, 1952 (Figure 287)

Smittina tuberosa Kluge, 1952 : 155, f. 10; 1955a : 95, f. 40.

The zoarium, prostrate in the form of a yellowish-gray, thick crust, consists of zooids arranged in regular, straight and oblique rows. The zooids are medium in size (length 0.90 mm, width 0.53 mm) and rhombic or oval in shape. The frontal wall is thick and convex, gradually rises toward the proximal margin of the orifice, and reticulate throughout; an orifice of varying size is located at the bottom of each alveolus. The basal walls are smooth and translucent with broad, longitudinal, dark strips alternating with narrow, white, opaque strips, to form the double, lateral walls of the 2 neighboring zooids. The primary orifice, located near the distal margin of the zooid, is triangular, and its distal margin semi-circular; the lateral walls narrow toward the proximal margin which has a lyrule situated in its center that tapers toward its free end; there is one triangular condyle on each of the sides, which support the operculum. The primary orifice is encircled by a peristome, thus forming a secondary orifice that narrows in the proximal direction; the lateral lobes of the peristome enclose the round avicularium located at the proximal margin. This avicularium has a mandible whose free end is pointed upward. The wall above the avicularian chamber, situated behind the proximal margin of the orifice, thickens and often forms a sort of tubercle at this place. The ovicells are hyperstomial, round, and slightly raised; their surface consists of 3 parts which fuse by a suture—a distal and 2 lateral—which form sections of the frontal surfaces of the neighboring zooids. Their surface has a similar reticulate structure, but there are no pores at the bottom of their alveoli; a round orifice is often found in the center of this surface. There are 4 pore plates with 4 to 6 pores each in the lateral wall of the zooid, and 2 with several (about 10) pores each in the distal septum.

The species lives on shells of bivalved mollusks, at a depth of 49 m.

Distribution. The species was found by me in the Chukotsk Sea along the northwestern coast of Alaska.

14. **Smittina beringia** Kluge, 1952 (Figure 288)

Smittina beringia Kluge, 1952 : 156, f. 11; 1955a : 95, f. 41; 1955b : 108, t. XXIII, f. 2.

The zoaria, prostrate in the form of short outcroppings, consist of zooids arranged in more or less regular, oblique rows. The zooids are medium in size (length 0.88 mm, width 0.50 mm) and oblong-hexagonal in shape. The frontal surface is slightly raised and covered by irregularly arranged depressions with pores at the bottom; the row of depressions is arranged along the slightly depressed margin of the zooid. The primary orifice, located near the distal margin of the zooid, is semi-circular; it has a broad tooth which narrows toward its free end, and a straight margin, plus thin, sharply pointed condyles on the sides. An oval avicularium, which is slightly inclined toward the side of the orifice, is situated in the middle of the proximal margin of the secondary orifice. The avicularian cavity located under it lifts the frontal surface slightly. The ovicells are hyperstomial, small, semi-circular, and barely raised above the surface. Their surface consists of 3 parts separated by sutures—an unpaired distal and 2 lateral—which belong to the frontal surfaces of the distal and 2 neighboring lateral zooids. Their surface is granular and, sometimes, a small orifice is found where the sutures fuse. There are 6 pore plates with 1 to 2 pores each in the lateral wall, and 2 with many pores in the distal septum.

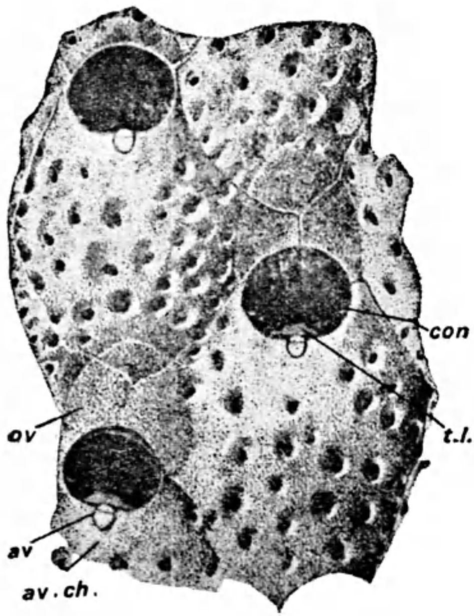


Figure 288. *Smittina beringia* Kluge. A small part of a zoarium (from Kluge, 1952).

The species lives on shells and stones, at a depth of 31 to 57 m, on a bed of shells, stones, and sand.

Distribution. The species was found by me in the Bering Strait.

15. **Smittina trispinosa** (Johnston, 1838) (Figure 289)

Smittina trispinosa Hincks, 1880a : 353, pl. 49, f. 1-3, 5-8; *et auctt.;* Kluge, 1955b : 107, t. XXIII, f. 3; *Escharella Jacotini* forma *typica* Smitt, 1868b : 11, 86 (part.), t. 24, f. 53-55.

The zoaria, prostrate and partly free-growing, consist of zooids arranged in more or less regular, oblique rows. The zooids are large (length 1.00 to 1.13 mm, width 0.65 mm) and have an oblong-rhombic-hexagonal or rectangular shape. The frontal surface is mildly raised, granulated, and bordered by a strongly raised margin along which depressions with pores on the bottom are situated; short rebra are located crosswise to the margins between the depressions. The primary orifice, located at the distal margin of the zooid, is roundish; its height is greater than its width; it has a lyrule which narrows toward its free end, on the proximal margin, thin pointed condyles on the margins, and 2 to 4, often 3, spines at the distal margin. The lobes of the peristome develop at the margins of the orifice in young zooids, and fuse with each other at the proximal margin to form the secondary orifice. Sometimes the peristome is strongly developed and freely raised at the proximal margin. An avicularium with a more or less developed rostrum, usually develops slightly below the orifice on the sides. The pointed end of the rostrum is raised, and the triangular, pointed mandible is directed toward the distal side. Sometimes a small, oval avicularium is located on the side of the orifice, whose mandible is pointed toward one side. The ovicells are hyperstomial, round, and convex with 2 to 3 orifices in the middle of their smooth frontal surface. There are 10 to 12 uniporous plates in the lower half of the lateral wall, and up to 10 in the lower half of the distal septum.

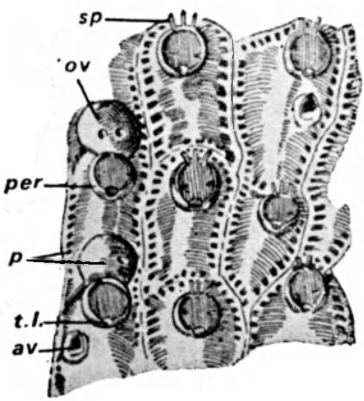


Figure 289. *Smittina trispinosa* (Johnston). Part of a zoarium.

The species lives on tubes of worms, Bryozoa, shells, and stones, at a depth of 5.5 to 300 m, on a bed of silty sand with stone, under temperatures ranging from −1.3 to 4.78°C, in a salt concentration of 31.80‰.

Distribution. The species was found by me in the Barents, Laptev, Chukotsk, Bering, and Okhotsk seas. *Reports in literature:* Barents Sea (Nordgaard, 1912a), western Norway (Nordgaard, 1905, 1907b, 1912a, 1918), Skagerrack and Kattegat (Smitt, 1868c; Levinsen, 1894; Marcus, 1940), North Sea (Ortmann, 1894), Shetland (Norman, 1869) and the British Isles (Hincks, 1880a), Mediterranean Sea (Calvet, 1902), eastern coast of North America in the region of Woods Hole (Osburn, 1912), Gulf of St. Lawrence (Dawson, 1859; Whiteaves, 1901), Labrador (Packard, 1866-69; Osburn, 1919), western coast of North America from South Alaska to California (Hincks, 1884; Robertson, 1900, 1908; O'Donoghue, 1923, 1926).

This is an amphiboreal species which is sometimes relict in the Arctic.

16. **Smittina jeffreysi** Norman, 1903 (Figure 290)

Escharella Jacotini forma *lamellosa* Smitt, 1868b : 11, t. 24, f. 56-57; *Smittia trispinosa* var. *lamellosa* Waters, 1900 : 88, pl. 12, f. 19-21; *Lepralia trispinosa* var. Hincks, 1877a : 100, pl. XI, f. 1; *Escharella trispinosa* var. *arborea* Levinsen, 1887 : 320, pl. 27, f. 7-8; *Smittina jeffreysi* Norman, 1903b : 120; *Smittina trispinosa* (part.) Whiteaves, 1901 : 106.

The zoaria are free-growing, usually in the form of tubular structures, and consist of more or less regular, straight rows of zooids arranged in a checkered pattern. The zooids range from medium to large in size (length 0.75 to 1.25 mm, width 0.38 to 0.55 mm) and are oblong-rectangular in shape. The frontal surface is very slightly raised, granulated, and surrounded by a raised, thin margin along which weak depressions with pores at the bottom are visible. The primary orifice, located at the distal end of the zooid, is roundish-rectangular, has a lyrule which tapers toward its free end, small, pointed condyles at the margins, and usually 2 small spines at the distal margin. The lateral lobes of the peristome are either absent or very poorly developed. A round or oval avicularium is located below the orifice, usually on one side, but sometimes on both sides. The avicularium has a strongly raised rostrum whose

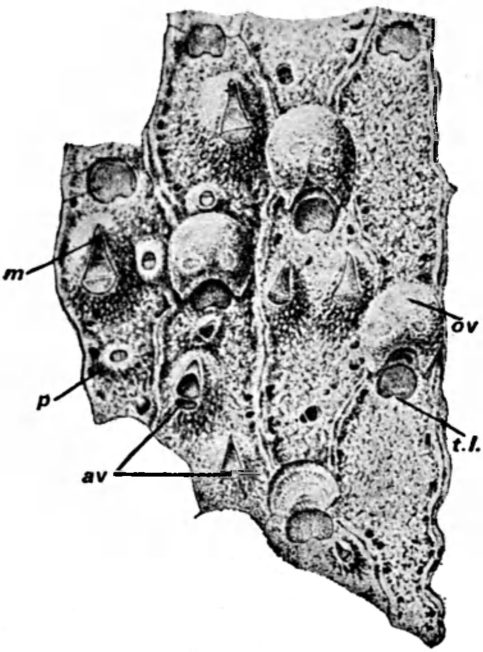


Figure 290. *Smittina jeffreysi* Norman. Part of a zoarium. Kara Sea.

pointed mandible is often distally directed. The zooids carrying ovicells usually have 2 avicularia and, since the bases of the avicularian chambers are quite broad and the zooids comparatively narrow, they are located one under the other, the smaller one on top. In addition to large avicularia, small, oval avicularia are often found at the surface. The ovicells are hyperstomial, round, and raised; they often have 2 large orifices located in the center, which have a smooth frontal surface. There are 10 to 12 simple, uniporous plates along the lower half of the lateral wall of the zooid and in the distal septum.

The species lives on hydroids, tubes of worms, Bryozoa, and shells, at a depth of 5 to 400 m, more often from 75 to 300 m, on a bed of silt, stone, and shells, under temperatures ranging from −1.9 to 4.25°C, in a salt concentration of 31.15 to 34.96‰.

Distribution. The species was found by me in the Barents, Kara, Bering, and Okhotsk seas, and in the waters off Labrador and western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868b; Bidenkap, 1897, 1900a; Waters, 1900; Andersson, 1902; Nordgaard, 1900, 1905, 1907b, 1912b), Kara Sea (Smitt, 1879a; Levinsen, 1887; Nordgaard, 1912b; Kluge, 1929), Laptev Sea (Kluge, 1929; Abrikossov, 1932), Archipelago of the Canadian Islands (Nordgaard, 1906a), Labrador (Packard, 1863), Gulf of St. Lawrence (Whiteaves, 1901; Norman, 1903b), western Greenland (Smitt, 1868c; Norman, 1876, 1903b, 1906; Hincks, 1877a; Hennig, 1896; Kluge, 1908b; Levinsen, 1914), eastern Greenland (Andersson, 1902; Levinsen, 1916), and Finmark (Nordgaard, 1912a).

This is an Arctic, circumpolar species.

*17. **Smittina thompsoni** Kluge, 1955 (Figure 291)

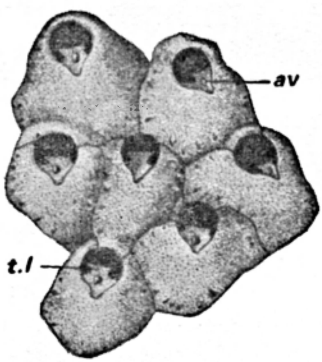


Figure 291. *Smittina thompsoni* Kluge. Part of a zoarium (from Kluge, 1955a).

Smittina thompsoni Kluge, 1955a : 94, f. 39.

The zoarium, prostrate and closely overgrowing the substrate, consists of zooids arranged sometimes in regular, sometimes in irregular rows. The zooids are medium in size (length 0.65 to 0.88 mm, width 0.63 to 0.75 mm), irregularly hexagonal or rhombic in shape, more or less broad, and thick-walled with uneven, deep margins. The frontal surface is mildly raised and granulated; depressions are located along the margins, the latter being slightly stretched in a radial direction; a small round pore is located at the base of each depression. As the frontal wall further calcifies and thickens, a large, broad tubercle often forms on it. The primary orifice, located at the distal end of the zooid, is roundish; its proximal margin forms a broad, suspended tooth which lowers down and broadens toward its free end, forming pointed corners which stretch in the transverse direction. The secondary orifice, located in the distal half, is semi-circular, but tapers and stretches out into a short sinus in the proximal half. The proximal, oral depression has a small avicularium between the outer surface and the denticle, opening through a semi-circular mandible. The avicularian chamber, located under the frontal surface, lies sometimes on one, sometimes on the other, side of the sinus, depending upon which side the mandible opens. The ovicells are endozooecial and slightly raised at the surface.

The species lives on shells and stones at a depth of 80 to 162 m.

Distribution. The species was found by me in Baffin Bay in the region of Disko Island.

2. Genus **Pseudoflustra** Bidenkap, 1897

Flustra Stimpson, 1854 : 19; *Eschara* M. Sars, 1863a : 146; *Escharella* Smitt, 1868b : 10; *Flustrimorpha* Verrill, 1880 : 191; *Pseudoflustra* Bidenkap, 1897 : 618; *Smittia* Andersson, 1902 : 546; *Smittina* Levinsen, 1909 : 340.

The zoaria are free-growing, lamellate-lobate, and bilateral. The zooids are arranged on a uniform plane in long, straight rows in a checkered pattern. The zooids are oblong-rectangular, sometimes slightly broader in the middle, thin-walled, and hyaline. The frontal surface is mildly raised, continuous, and bordered by a raised margin from which transverse, short, thin, vertical rebra originate, sometimes directed slightly forward. The sections or chambers formed by the latter usually stretch upward in the form of a thin, calcareous plate with a large or small orifice in the middle. The frontal surface is covered by the epitheca and a thin, cuticular layer which, in many zooids of the proximal part, becomes dense and converts into a tube that stretches along the surface of the zoarium until it meets with similar tubes from other zooids. These tubes fuse at the base of the zoarium to form bundles, and the bundles outgrow due to the tubes branching into a large number of thinner branches. These tubes help attach the zoarium to the substrate, as well as hold it up should the lobe break due to it brittle nature. An oval or round avicularium lies proximally behind the margin of the orifice; it has a stretched ligulate or semi-circular mandible whose free end is directed upward and downward. The ovicells are hyperstomial, round, and more or less convex; they have an ectooecium which has a smooth frontal surface covered with pores, and is encircled by an oecial coating on the sides. There are 4 pore plates with a few pores in the lateral wall, and a small number (up to 12) of simple pores in the lower half of the distal septum. All the foregoing characters are common to all the species of this genus.

The structure of the zooidal orifice differs in different species, distinguishing one from the other. The structure of the zooidal orifice usually plays a significant part in placing any species under one or the other genus; genera such as *Lepralia, Schizoporella, Smittina, Porella,* etc., have been established on this basis. In the species of the genus under discussion, the structure of the orifices of the zooids is the same for all the four genera just mentioned, particularly *Pseudoflustra solida* in *Lepralia, P. hincksi* and *P. anderssoni* in *Schizoporella, P. sinuosa* in *Smittina,* and lastly, *P. birulai* in *Porella.* It would appear at first glance, that all these species would have been better included in the corresponding genera. An attempt in this direction was made by Andersson who, in addition to the earlier known forms of *P. solida* and *P. solida* var. Hincks, described a new form in which the zooidal orifice is of the *Smittina* type (by the presence of a tooth at the proximal margin of the orifice), and this he named var. *sinuosa.* But since all the other characters of this form are undoubtedly similar to the earlier known form, *P. solida,* he transferred this generic character to the latter form, and named it *Smittina solida,* and labeled the form described by him as its variation, i.e., *S. solida* var. *sinuosa* Andersson. Thus it happened that the character of the variation became a generic character for the main form which has no tooth and, with regard to the structure of its orifice, is closer to the genus *Lepralia.* A further study of the development of these species, the structure of their ancestrula, and the first generations of the latter, may even provide a basis for a subdivision of this genus, but at present, on the basis of the fairly close structure of all the species in question, we must include them under the genus *Pseudoflustra,* not giving undue importance to the orifice of the zooid as a criterion for a generic character.

Genus type: *Pseudoflustra solida* Stimpson.

Key for Identification of the Species of the Genus Pseudoflustra

1 (2). Primary orifice has a tooth at the proximal margin.......... ....4. *P. sinuosa* (Andersson).
2 (1). Primary orifice has no tooth at the proximal margin.
3 (6). Primary orifice has a shallow sinus at the proximal margin.
4 (5). Secondary orifice does not form a sinus which encloses the pre-oral avicularium......................2. *P. hincksi* Kluge.
5 (4). Secondary orifice forms a sinus enclosing the pre-oral avicularium.

..................................3. *P. anderssoni* Kluge.

6 (3). Primary orifice has no sinus at the proximal margin.

7 (8). Secondary orifice does not enclose the pre-oral avicularium, and the latter lies in the plane of the frontal surface of the zooid. ....1. *P. solida* (Stimpson).

8 (7). Secondary orifice encloses the semi-circular rostrum of the pre-oral avicularium, which lies in a plane almost perpendicular to the plane of the frontal surface of the zooid................ ....5. *P. birulai* Kluge.

1. **Pseudoflustra solida** (Stimpson, 1854) (Figure 292)

Flustra solida Stimpson, 1854 : 19, f. 12; Hincks, 1880b : 282, pl. 15, f. 2-3; 1892 : 149 (part.); *Escharella palmata* Smitt, 1868b : 10, t. 24, f. 42-46; *Eschara solida* Vigelius, 1882 : 15, f. 2, 3a-b.

The zoarium is free-growing, lamellate-lobate, and flat; it has a bilateral arrangement of zooids. The zooids, arranged in straight, longitudinal rows in a checkered manner, are large (average length) 1.15 mm, width 0.38 mm), oblong-rectangular in shape, a little broader in the middle, thin-walled, and hyaline. The frontal surface is mildly raised, continuous, and granulated; it has a raised margin from which low and short, transverse rebra uprise. The sections or chambers formed during this between the rebra, have pores at the bottom, and stretch upward in the form of a calcareous plate, which forms an orifice in the center that is sometimes large, sometimes small. The frontal surface is covered by the epitheca and a thin, cuticular layer which, in many zooids, gradually becomes dense as it proceeds toward the proximal end; there it converts into a relatively strongly chitinized tube which stretches along the surface of the zoarium until it meets similar tubes

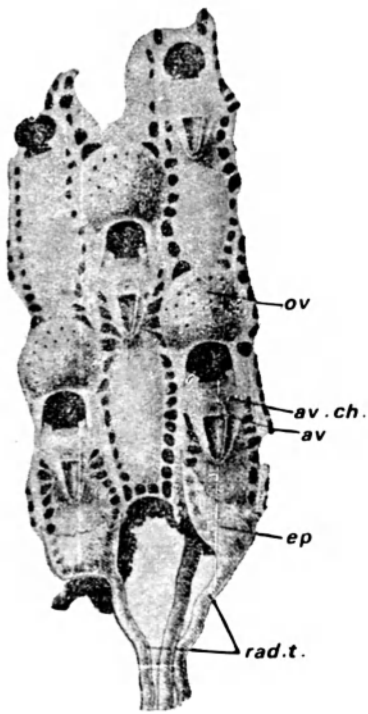


Figure 292. *Pseudoflustra solida* (Stimpson). Proximal part of a zoarium with radicular tubes. Barents Sea.

of other zooids; these tubes form more or less thick bundles which help affix the zoarium to the substrate. The primary orifice, located at the distal end of the zooid, is semi-circular; its width is slightly larger than its length; it has a mildly concave, proximal margin, and one triangular condyle located at each end. Corresponding to the form of the primary orifice, the proximal margin of the chitinous operculum is weakly convex. An avicularium is located behind the proximal margin of the orifice; its distal half is occupied by a broad avicularian chamber that spreads up to the lateral margins of the zooid; the proximal half is a raised rostrum which tapers toward its free end, and is covered by a ligulate mandible. One pore is located on either or both sides of the avicularian chamber. The ovicells are hyperstomial and round; their width is slightly greater than their length; they are more or less raised and have an incompletely calcified outer layer; the smooth frontal surface of the inner layer is laden with numerous pores. There are 4 pore plates with 3 to 4 pores in the lateral wall, and about 10 to 12 pores in the distal septum arranged in one row near the basal margin.

The species lives on Bryozoa, tubes of annelids, shells, and stones, at a depth of 5 to 475 m, more often from 100 to 300 m (according to Nordgaard), in the Norwegian Sea down to 1,159 m, under temperatures from −1.9 to 3.5°C, in a salt concentration of 31.87 to 34.96‰.

Distribution. This species was found by me in the Barents, Kara, Laptev, and East Siberian seas, and in the Davis Strait. *Reports in literature:* Barents Sea (M. Sars, 1863a; Smitt, 1868b; 1879b; Marenzeller, 1877; Vigelius, 1881-82; Bidenkap, 1897, 1900a, 1900b; Nordgaard, 1900, 1905, 1912a, 1918; Waters, 1900; Andersson, 1902; Kluge, 1906; Kluge in Deryugin, 1915; Grieg, 1925), Kara Sea (Smitt, 1879a; Levinsen, 1887; Nordgaard, 1912b; Kluge, 1929), Laptev Sea (Kluge, 1929), East Siberian Sea (Kluge, 1929; Nordgaard, 1929), northern coast of North America (Osburn, 1923, 1932), western Greenland (Smitt, 1868c; Levinsen, 1914), Gulf of St. Lawrence (Hincks, 1829; Whiteaves, 1901), eastern Greenland (Andersson, 1902; Levinsen, 1914, 1916), Yan-Maien Island (Lorenz, 1886; Nordgaard, 1900), Iceland (Nordgaard, 1900, 1907b), Greenland and the Norwegian Seas (Nordgaard, 1900, 1907b, 1918; Andersson, 1902), and northern Norway (Nordgaard, 1905, 1912a, 1918).

2. **Pseudoflustra hincksi** Kluge, 1915 (Figure 293)

Pseudoflustra hincksi Kluge, 1946 : 199, t. II, f. 4; *Flustra solida* Hincks, 1892 : 149 (part.) "a small variety", pl. 8, f. 1, The zoarium is free-growing, lamellate-lobate, and flat; it has a bilateral arrangement of zooids. The zooids are large (length 1.05 mm, width 0.30 mm), markedly oblong-rectangular in shape, thin-walled, and hyaline. The frontal surface is mildly raised, smooth, continuous, and bordered with a raised margin along which short, transverse, vertical septa are located. The sections or chambers thus formed are slightly stretched along the margins in the form of a calcareous plate, leaving a larger part of their surface open in the form of regular orifices with an irregular shape. The entire frontal surface is covered by the epitheca and a thin, cuticular layer which, in many zooids, continues in the proximal part like a strongly chitinized tube that fuses with similar tubes from neighboring zooids to give rise to bundles which help attach the zoarium to the substrate. The primary orifice, located at the distal end of the zooid, is semi-circular; it has a concave proximal margin, in the center of which is located a shallow sinus; the margins of the latter form a triangle of condyles which appear to deepen the sinus. A chitinous operculum is suspended at the condyles which, corresponding to the form of the primary orifice, has a semi-circular ligula at its proximal margin. A weakly developed peristome reaches up to the ovicell in the zooids carrying ovicells with its distal ends, but these do not grow over its frontal surface. A small, oval avicularium, with a semi-circular chamber, is located behind the proximal margin of the primary orifice. The avicularian chamber spreads toward both sides up to the lateral margins of the zooid. The ovicells are hyperstomial, almost round, somewhat stretched in length, and convex; they have an incompletely calcified outer layer, and a smooth frontal surface on the inner layer, which is covered with a few (from 4 to 7) pores that are arranged in a different manner in different zooids. The lateral wall of the zooid has 4 pore plates with 3 to 4 pores each; there are 5 to 6 simple pore plates in the distal septum arranged in the middle of its lower half.

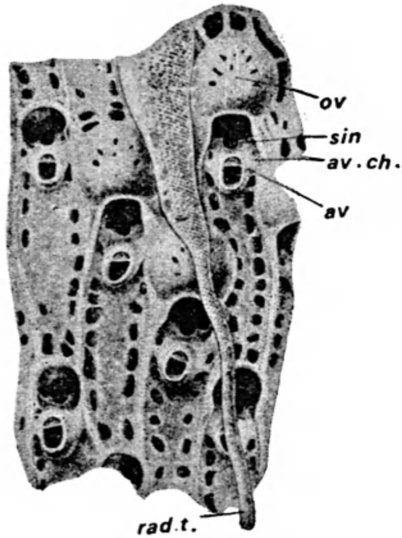


Figure 293. *Pseudoflustra hincksi* Kluge. Part of a zoarium with a radicular tube. Kara Sea.

The species lives on Bryozoa, shells, and stones, at a depth of 40 to

445 m, more often from 100 to 200 m, under temperatures ranging from −1.68 to 4.95°C, in a salt concentration of 34.65 to 34.95‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, and East Siberian seas, and in the waters off eastern Greenland. *Reports in literature:* Gulf of St. Lawrence (Hincks, 1892; Whiteaves, 1901), and the Gulf of Man (Verrill, 1879b).

This is an Arctic species.

3. **Pseudoflustra anderssoni** Kluge, 1946 (Figure 294)

Pseudoflustra anderssoni Kluge, 1946 : 198, t. II, f. 5.

The zoaria are free-growing, lamellate-lobate, and flat; they have a bilateral arrangement of zooids. The zooids are arranged in regular, longitudinal rows in a checkered pattern. They are large (average length 1.07 mm, width 0.34 mm), oblong-rectangular, slightly broadened in the middle, thin-walled, and hyaline. The frontal surface is convex, smooth, continuous, and covered by the epitheca and a thin, cuticular layer which, in many zooids, continues in the proximal part in the form of a strongly chitinized tube that fuses with similar tubes from neighboring zooids into bundles, which help attach the zoarium to the substrate. Short, thin-walled, vertical rebra develop along the raised lateral margins of the zooids, which are directed slightly forward in the center. The sections or chambers formed in this, are stretched from the upper side in the form of a thin, calcareous, slightly raised plate, which has a centrally located, round or oval orifice that varies in size from zooid to zooid. Such a frontal surface gives the impression that a row of alveolate swellings is located along its lateral margins, which open out through orifices. A pore is located at the bottom of the lateral chamber. The primary orifice, located at the distal margin of the zooid, is semi-circular; it has a concave, proximal margin in the middle of which is located a weakly concave sinus; the sides of the latter have triangular condyles which make the sinus appear deep. Due to the strong development of the peristome, the primary orifice and the chitinous operculum are seated low. Corres-

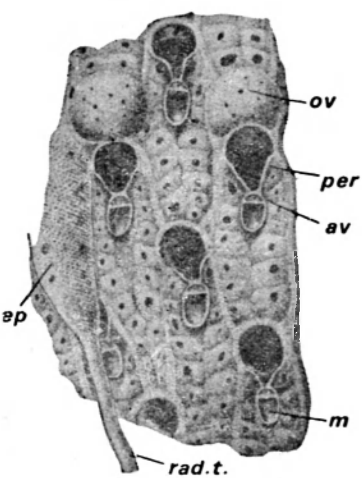


Figure 294. *Pseudoflustra anderssoni* Kluge. Part of a zoarium with a radicular tube. Kara Sea.

ponding to the form of the primary orifice, the proximal margin of the operculum has a fairly large, broad, and rounded ligula. The secondary orifice, formed by the peristome, surrounds the primary orifice like a sessile collar that is open in the middle of its proximal side. The lateral lobes of the peristome, at the proximal margin of the orifice, enclose the oval avicularium which is located slightly behind it. The avicularium has a ligulate mandible whose free end is directed downward. The distal ends of the peristome in the zooids carrying ovicells overgrow the frontal surface of the ovicells from both sides like a small cylinder, and bending toward the medial line of the ovicell, usually do not reach up to it; however, in certain cases, their free ends fuse. The ovicells are hyperstomial, round, and more or less raised; they have an incompletely calcified outer layer with 5 to 8 pores, often arranged in a circle, located in the middle of it.

There are 4 pore plates with 4 to 5 pores along the lower margin of the lateral wall, and 6 to 8 simple pore plates in the distal half, which appears divided by 2 transverse, calcareous, rebral thickenings. The pore plates are located parallel to the basal margin of the septum.

The species lives on Bryozoa, shells, and stones, at a depth of 39 to 820 m, more often from 100 to 300 m, on a bed of silt, stone, and sand, under temperatures ranging from −1.45 to 3.5°C, in a salt concentration of 34.07 to 34.92‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, and East Siberian seas, and in the northern part of the Greenland Sea.

This is an Arctic species.

4. **Pseudoflustra sinuosa** (Andersson, 1902) (Figure 295)

Smittina palmata var. *sinuosa* Andersson, 1902 : 546, pl. 30, f. 5.

The zoarium is free-growing, lamellate-lobate, and flat; it has a bilateral arrangement of zooids. The zooids are arranged in short, often ramose rows; they are large (average length 1.38 mm, width 0.50 mm), oblong or irregularly hexagonal, broader in the middle, thin-walled, and hyaline. The frontal surface is convex and smooth; it has a strongly raised margin along which thin-walled, vertical rebra originate that are transversely directed toward the center in the distal half, and toward the center and forward in the proximal half. The sections thus formed between the rebra remain open, and only a very few in the distal part stretch mildly from the margins in the form of a thin, calcareous plate, leaving the large, enclosed orifice open. The entire frontal surface is covered by the epitheca and a thin, cuticular layer which, in many zooids, continues in the proximal part to give rise to a strongly chitinized tube.

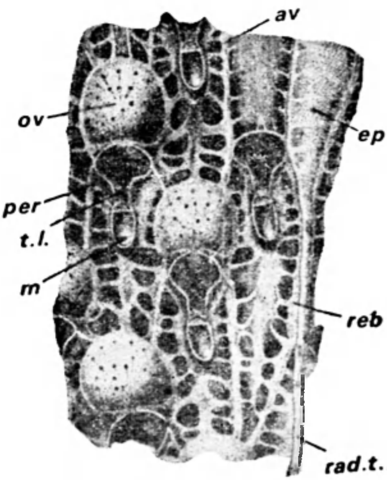


Figure 295. *Pseudoflustra sinuosa* (Andersson). Part of a zoarium with a radicular tube. Barents Sea.

The primary orifice, located at the distal margin of the zooid, is almost round; it has one broad tooth at the proximal margin and 2 barely noticeable condyles at the sides. Because the peristome is strongly developed, the primary orifice is deeply placed. The secondary orifice is formed by the peristome, which surrounds the primary orifice like a sessile collar that is open in the middle of its proximal side. The lateral lobes of the peristome, at the proximal margin of the orifice, enclose the oval avicularium which is located somewhat behind it. The avicularium has a long, ligulate mandible (length 0.23 mm) whose free end points downward. The distal ends of the peristome in the zooids carrying ovicells, overgrow the frontal surface of the ovicells from both sides like a small, rebral cylinder, and bending toward the medial line of the ovicell, often fuse by their free ends. The ovicells are hyperstomial, large, and convex, although sometimes they are more stretched out, and sometimes broader; they have an incompletely calcified outer layer, and a smooth, frontal surface on the inner layer, which is covered with a large number of pores. There are 4 pore plates with a few pores in the lateral wall, and 7 to 8 pores in the distal septum arranged in a row along the middle line, and near the basal margin of the septum.

The species lives on Bryozoa, shells of worms and mollusks, and stones, at a depth of 1.5 to 1,000 m, frequently from 200 to 400 m, but more often from 100 to 160 m, under temperatures ranging from —1.9 to 2.47°C, in a salt concentration of 27.22 to 34.92‰.

Distribution. This species was found by me in the Barents, Kara, Laptev, and East Siberian seas. *Reports in literature:* Barents Sea (Andersson, 1902; Norman, 1903b; Nordgaard, 1912a, 1918), Kara Sea (Smitt, 1879a), and the coastal waters off eastern Greenland (Andersson, 1902).

This is a high Arctic species, which dwells in deep water.

5. **Pseudoflustra birulai** Kluge, 1929 (Figure 296)

Pseudoflustra birulai Kluge, 1929 : 16; 1946 : 199, t. II, f. 3.

The zoarium, free-growing, lamellate-lobate, and flat, has more or less narrow lobes and a bilateral arrangement of zooids. The zooids are arranged in regular, longitudinal rows in a checkered pattern; they are large (average length 1.23 mm, width 0.32 mm), oblong-rectangular in shape, thin-walled, and hyaline, with a uniform width throughout their length. The frontal surface is slightly raised, continuous, and granular; it has a raised margin along which vertical rebra arise in a forward direction to form saccate sections or chambers, as it were, which sometimes remain completely open, but often stretch in the form of a thin, calcareous plate with relatively large orifices. Pores are located at the bottom of these chambers. The surface is covered by an epitheca and a thin, cuticular layer; in the lower part of the zoarium, the epitheca continues in many zooids at the proximal end in the form of a strongly chitinized tube, which fuses with similar tubes from neighboring zooids to form bundles which help affix the zoaria to the substrate. The primary orifice, located near the proximal margin of the zooid, is semi-circular; its width is greater than its height; it has a mildly concave or almost straight, proximal margin; a barely noticeable blunt denticle is sometimes located in the center of this margin, and condyles are located on the sides. A semi-circular avicularium is located in the middle of the proximal margin of the secondary orifice; its chamber is slightly stretched in the longitudinal direction, slightly raised above the frontal surface, and sometimes spread on the sides up to the lateral margins of the zooids. A semi-circular orifice, located at the distal end of the chamber, almost perpendicular to the frontal surface, is covered by a semi-circular mandible. The peristome, stretched on each side of the avicularium, is markedly developed in the zooids carrying ovicells. The peristome in the latter stretches from each side of the avicularium toward the middle of the zooidal orifice, where its ends sometimes meet and cover the orifice by their bodies; simultaneously the lateral margins of the peristome also appear to be greatly raised and their free ends are transformed (converted) into

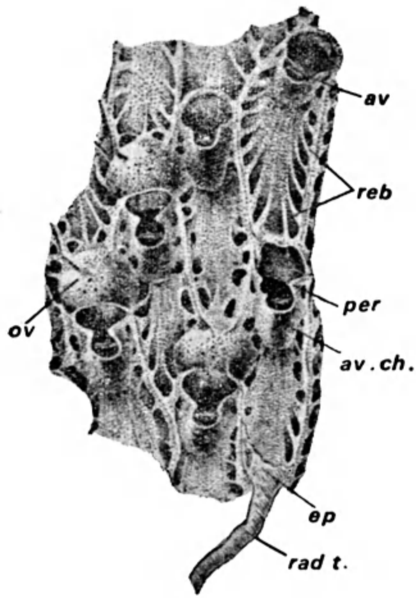


Figure 296. *Pseudoflustra birulai* Kluge. Proximal part of a zoarium. Barents Sea.

cylinder-like structures at the frontal surface of the ovicell; here, after bending toward each other, they often fuse. The ovicells are hyperstomial, semi-circular, and have a width that exceeds their height. They have an incompletely calcified ectooecium, and the smooth surface of the endooecium has 1 to 3 more or less larger orifices located in its center. There are 4 pore plates with 2 to 4 pores each located in the lateral wall near the basal margin, and 7 to 8 simple pores in the distal septum near and along the basal margin.

This species lives on Bryozoa, shells, and stones, at a depth of 1.5 to 445 m, more often from 75 to 300 m, under temperatures ranging from −1.7 to 2.2°C, in a salt concentration of 31.44 to 34.92‰.

Distribution. The species was found by me in the Barents, Kara, and East Siberian seas. *Reports in literature:* Kara Sea (Kluge, 1929).

This is a high Arctic species.

3. Genus **Porella** Gray, 1848

Cellepora (part.) Johnston, 1847 : 298; *Eschara* (part.) Busk, 1854a : 92; *Porella* Gray, 1848 : 127; Smitt, 1868b : 20; Hincks, 1880a : 320.

The zoaria are prostrate, overgrowing or free-growing, cylindrical or lamellate, and branched. The primary orifice has a straight or slightly convex or concave, proximal margin which, in certain cases, has a broad and low lyrule. Condyles are present. The operculum in rare cases is strongly chitinized. Spines are absent in most species. The peristome varies in development. The avicularian chamber varies strongly in shape and size. In some species, multiporous plates are found in the lateral and distal walls; in others, the pore chambers are placed along the basal margin of the zooid. The ovicells are hyperstomial and their outer layer, in the majority of the species, is calcareous and nonporous.

Genus type: *Millepora compressa* Sowerby, 1806.

1 (20). Zoarium prostrate and overgrowing.

2 (5). Entire frontal surface covered with pores. Avicularia located between the primary and secondary orifices and not visible at the surface; but zooids are found in some zoaria which, coming closer to the margin of the secondary orifice, become noticeable.

3 (4). Zooids large, thick-walled, and in most cases, rose-red in color. Secondary orifice semi-circular with a straight or mildly concave, proximal margin. Frontal wall, proximal to the orifice, strongly thickened, and forms a raised tubercle. ....8. *P. princeps* Norman.

4 (3). Zooids large and thin-walled. Secondary orifice roundish and narrows toward the middle of the proximal margin. Frontal wall has no tubercle...........7. *P. groenlandica* (Norman).

5 (2). Only 1 row of pores located along the margin of the frontal surface of the zooid; one species has 2 rows of pores and a transverse row of pores bordering the large avicularian cavity.

6 (13). Large, broad avicularian cavity located under the proximal margin of the orifice, is raised above the remaining part of the frontal surface.

7 (10). Zooids large. Avicularian chamber reaches directly up to the opposite margins of the zooid without being separated from the margins by marginal pores.

8 (9). Zooids large and broad. Avicularium at the level of the lateral lobes of the peristome; mandible semi-circular. Ovicells have a concave, proximal margin which bends out like a narrow rim........................3. *P. aperta* (Boeck).

9 (8). Zooids medium in size and narrow. Avicularium above the level of the lateral lobes of the peristome; mandible tapers toward the end.....................4. *P. acutirostris* Smitt.

10 (7). Zooids small or minute. Avicularian chamber separated from the margins of the zooid by marginal pores. Lateral lobes of the peristome weakly developed.

11 (12). Zooids small, walls thick. Avicularian chamber broad; avicularium lies suspended to the orifice of the zooid........ ....5. *P. tumida* Kluge.

12 (11). Zooids minute and thin-walled. Avicularian chamber narrower; avicularium raised above the orifice and bent toward the latter.........................6. *P. minuta* (Norman).

13 (6). Avicularian chamber not raised above the remaining part of the frontal surface; it is like a small, conical or rostral protuberance at the proximal margin of the orifice.

14 (17). Avicularian chamber not raised above the remaining part of the frontal surface. Orifice of the zooid broader or taller. Avicularian chamber either broader or narrower and oval.

15 (16). Zooids large, hexagonal, or rectangular. Orifice of the zooid broad. Avicularian chamber broad and separated from the remaining part of the frontal surface by a row of pores. ....2. *P. struma* (Norman) (part.).

16 (15). Zooids medium in size and oval in shape. Zooidal orifice taller. Avicularian chamber narrower, oblong-oval in shape, and not separated from the remaining part of the frontal surface by pores. In more calcified zooids, avicularia

depressed in the orifice and not visible from the surface.......
...........................1. *P. compressa* (Sowerby) (part.).

17 (14). Avicularian chamber like a small, conical or rostral protuberance at the proximal margin of the orifice.

18 (19). Avicularian chamber in the form of a small, conical protuberance at the proximal margin of the orifice with a round avicularium pointing toward the orifice, which is suspended but erect near the latter. Besides this avicularium, sometimes similar avicularia are found at the margin of the zooidal orifice at different places. In more calcified zoaria, avicularian chamber lower in the orifice, and avicularium not visible from the outside........................9. *P. smitti* (Kluge) (part.).

19 (18). Avicularian chamber like a proboscis raised above and slightly bent toward the orifice, has a round avicularium at its end. In addition to this avicularium, similar avicularia often located near it on either or both sides....................
..................................10. *P. proboscidea* Hincks.

20 (1). Zoarium free-growing, rises from the prostrate base.

21 (22). Margin of the zooidal orifice often has, in addition to the usual (1 to 3) avicularia, a few (up to 6) small and round ones arranged around the orifice. Zoarium cylindrical or lamellate. Furthermore, similar avicularia with semi-circular mandibles often found at the frontal surface and the zooidal margins..............................11. *P. plana* Hincks.

22 (21). Only one avicularium at the margin of the zooidal orifice, located in the middle of the proximal margin.

23 (24). Zoarium cylindrical. A round avicularium stands suspended to the plane of the orifice near the proximal margin of the secondary orifice, between the weakly developed lateral lobes of the peristome; in strongly calcified zooids, it sinks into the orifice. Pores are present at the margin right at the frontal surface......................12. *P. laevis* (Fleming).

24 (23). Zoarium lamellate, simple, or ramose, bi- or uni-lateral.

25 (26). Zoarium lobate and unilateral. Secondary orifice semi-circular. Oral avicularium large and round with a semi-circular mandible which stands almost suspended to the plane of the orifice. A large, broad avicularian chamber located under the orifice, reaches up to the opposite margins of the zooid. There are 2 rows of pores along the margin of the frontal surface......................2. *P. struma* (Norman) (part.).

26 (25). Zoarium lamellate, branched, lobate, and bilateral.

27 (32). Frontal surface has no pores or rebra along its margin. Avicularian chamber narrow and long, almost reaching the

length of the zooid. Proximal margin of the orifice convex; a large avicularium with a semi-circular mandible lies suspended under it. One or 2 small orifices often found in the proximal part of the frontal surface.

28 (29). Distal end of the avicularian chamber has an avicularium located at its tip which is strongly raised forward and upward to cover the orifice of the zooid. Proximal part of the avicularian chamber narrower than the distal, raised portion. Sometimes a second avicularian chamber grows out at the broad, raised part of the chamber in the form of a long, narrow tube, which has an avicularium at its tip............ ....14. *P. fragilis* Levinsen.

29 (28). Distal end of the avicularian chamber not raised forward and upward, and does not cover the orifice of the zooid. Proximal part of the chamber narrower than the distal portion.

30 (31). Avicularian chamber at a level, throughout its length, with the proximal margin of the avicularium, or its distal part is slightly above the proximal. Mandible its semi-circular. ....13. *P. saccata* (Busk).

31 (30). Avicularian chamber slightly broader and its distal part more raised above the proximal portion. Mandible larger and shaped like a rounded triangle.......................... ....13a. *P. saccata* var. *beringia* Kluge.

32 (27). Frontal surface covered with more or less large pores along the margin of the zooid, and short, transverse or radial septa stand between them which, on stronger calcification, become unnoticeable. Avicularian chamber not long.

33 (34). A conical avicularian chamber located near the proximal margin of the secondary orifice on which a round avicularium with a semi-circular mandible lies suspended to the latter. In some zoaria, in addition to the oral avicularium, 1 to 2 similar avicularia are often located either close to the oral one, or near the distal margin of the orifice. In more calcified zoaria, the avicularian chamber and the avicularium sink into the orifice and become unnoticeable from the surface. ....9. *P. smitti* Kluge (part.).

34 (33). A raised, round avicularium with mandible, located near the proximal margin of the secondary orifice between the lateral lobes of the peristome. In more calcified zoaria, this avicularium sinks into the orifice, and the proximal margin of the orifice looks like a ligulate incision....................... ....1. *P. compressa* (Sowerby) (part.).

1. **Porella compressa** (Sowerby, 1806) (Figure 297)

Eschara cervicornis Busk, 1854a : 92, pl. 109, f. 7, pl. 119, f. 1; *E. cervicornis* forma *Escharae* Smitt, 1868b : 23, t. 26, f. 138-139; *Porella compressa* Hincks, 1880a : 330, pl. 45, f. 4; Marcus, 1940 : 271, f. 139.

The zoaria, free-growing, double-layered, and arising from a single-layered base, are irregularly branched; alive they are a pale flesh color which turns white in alcohol. The branches are more or less flattened like roundish or truncated lobes. In young zoaria, the zooids are arranged in regular, straight and oblique rows; with further growth, the rows become irregular. The zooids are medium in size (length 0.88 mm, width 0.43 mm), oblong-oval, and broader in the distal half. The frontal surface of the zooids is finely granulated, and more raised in young zooids but as calcification of the zoarium occurs, becomes flat; it is bordered by a thin, raised margin along which a row of more or less large pores is located, often with a radial, short, rebral structure between them. The primary orifice is either semi-circular, or has a straight proximal margin, or a broad, straight tooth suspended toward the frontal surface. The secondary orifice is roundish-broad, located in the distal part, and narrows toward the proximal margin; its lateral margin, not reaching up to the proximal, is slightly bent toward the opening of the orifice. A comparatively large and round avicularium with a semicircular mandible, is located between the proximal margins of the primary and secondary orifices, but nearer to the secondary one. A saccate avicularian chamber follows after the avicularium, and passes through the young zooids; it is a little more strongly developed in certain species, thereby strengthening the raised portion of the frontal surface, and causing the avicularium itself to be slightly more raised at the surface. In more calcified zoaria, the oral avicularium sinks into the

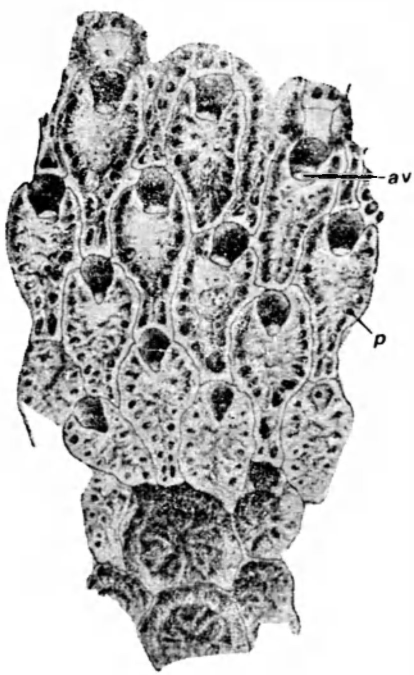


Figure 297. *Porella compressa* (Sowerby). Part of a zoarium. Barents Sea.

orifice and becomes totally unnoticeable. The ovicells are hyperstomial, round, less raised, and have a smooth surface. There are 4 to 5 pore plates with a few pores in the lateral wall, and 2 in the distal septum.

The species lives on shells and stones, at a depth of 6 to 280 m, more often at 50 to 200 m, on a bed of stone, shells, and silt with sand, under temperatures varying from —1.9 to 3.0°C, in a salt concentration of 32.72 to 34.63‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, Chukotsk, Bering, and Okhotsk seas, and in the waters off Labrador, Baffin Bay, and the Davis Strait. *Reports in literature:* Barents Sea (Danielssen, 1861; Smitt, 1868c; Bidenkap, 1897, 1900a; Waters, 1900; Andersson, 1902; Kluge, 1906; Kluge in Deryugin, 1915; Nordgaard, 1918), White Sea (Bidenkap, 1900a; Kluge, 1908a; Kluge in Deryugin, 1928; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Nordgaard, 1912b), East Siberian and Chukotsk seas (Kluge, 1929), Archipelago of the Canadian Islands (Osburn, 1923, 1936), Hudson Bay (Osburn, 1932), western Greenland (Smitt, 1868c; Norman, 1906; Kluge, 1908b; Levinsen, 1914; Osburn, 1916), eastern Greenland (Levinsen, 1916), Yan-Maien Island (Lorenz, 1886), Iceland (Nordgaard, 1924), western Norway (Smitt, 1868b; Norman, 1894; Nordgaard, 1896, 1906b, 1918; Kluge, 1906), the Faeroes (Nordgaard, 1907b) and British Islands (Hincks, 1880a).

This is an Arctic-boreal, circumpolar species.

2. **Porella struma** (Norman, 1868) (Figure 298)

Eschara cervicornis forma *lepraliae* Smitt, 1868b : 23, 150 (part.), pl. 26, f. 136, 137; *Hemeschara struma* Norman, 1868 : 221, pl. 7, f. 6-8; *Porella struma* Hincks, 1880a : 329, pl. 39, f. 3-5; Marcus, 1940 : 270, f. 138; *P. glaciata* Nordgaard, 1905 : 168, pl. V, f. 5-7.

The zoaria are partly prostrate, partly free-growing, and unilateral, and consist of zooids arranged in regular, straight and oblique rows. The zooids are large (length 0.75 to 1.13 mm, width 0.50 to 0.70 mm), hexagonal or rectangular in shape, sometimes more oblong and narrow, and sometimes shorter and broader. The frontal surface is weakly raised and granulated; it has a thin, raised margin along which wedge-shaped depressions with pores at the bottom are located, which lead to the formation of short rebra. The primary orifice, located at the distal margin, is semi-circular and broad; it has a straight proximal margin, and barely noticeable condyles along its sides. The secondary orifice is semi-circular in the distal half and slightly narrows, by straight lateral margins, toward the proximal margin; a large and transversely oval avicularium with a broad semi-circular mandible is almost suspended from the proximal

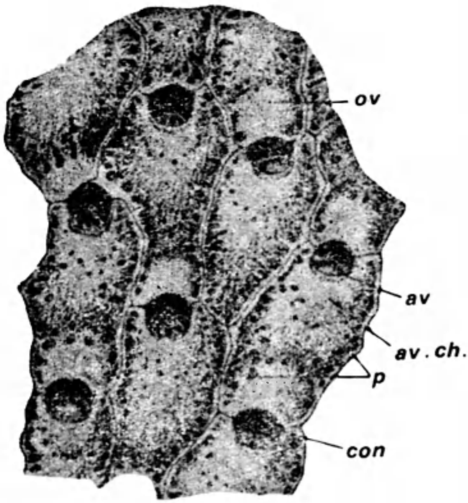


Figure 298. *Porella struma* (Norman). Part of a zoarium. Barents Sea (Kola Bay).

margin. Behind the avicularium is a broad, saccate, slightly distended, avicularian chamber; 6 to 10 small pores are located along the margins. The ovicells are hyperstomial, small, round, and slight raised; they have a smooth or granulated surface surrounded by larger pores along the margin. There are 6 pore plates with a few pores in the lateral wall, and up to 15 uniporous plates in the lower half of the distal septum. The basal surface of the zooids often has protuberances for attaching the zoarium to the substrate.

The species lives on calcareous Bryozoa, shells, and stones, at a depth varying from 12 to 378 m, more often from 50 to 300 m, on a bed of stone, shells, and silt with sand, under temperatures ranging from −1.24 to 4.95°C, in a salt concentration of 34.27 to 34.96‰.

Distribution. The species was found by me in the Barents and Kara seas, and off Labrador and western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868b; Urban, 1880; Vigelius, 1881-82; Nordgaard, 1896, 1900, 1905, 1912a, 1918; Kluge, 1906; Kluge in Deryugin, 1915; Kuznetsov, 1941), White Sea (Gostilovskaya, 1957), Kara Sea (Nordgaard, 1912b), Hudson Bay (Osburn, 1932), western Greenland (Smitt, 1868c; Norman, 1906; Levinsen, 1914; Osburn, 1916), Gulf of St. Lawrence (Whiteaves, 1901; Norman, 1903b), New Scotland (Osburn, 1913), Iceland (Nordgaard, 1924), western Norway (Norman, 1903a; Nordgaard, 1905, 1918), and the regions of the Faeroes and Shetland Islands (Norman, 1868; Hincks, 1880a; Nordgaard, 1907b).

This is an Arctic-boreal, Atlantic species.

3. **Porella aperta** (Boeck, 1862) (Figure 299)

Lepralia aperta Boeck, 1862 : 50; *Porella laevis* forma *Lepraliae* Smitt, 1868b : 21 (part.), t. 26, f. 112-114; *P. inflata* Waters, 1900 : 83, pl. 10, f. 6-7; *P. concinna* Bidenkap, 1900b: 516 (part.), t. IX, f. 6; Andersson, 1902 : 544.

The zoarium, prostrate in the form of a white crust, consists of zooids arranged in regular, straight and oblique rows in a checkered pattern. The zooids, average in size, vary in dimensions (length 0.63 to 1.0 mm, width 0.50 to 0.83 mm) and are rhombic-hexagonal in shape. The frontal surface is raised and coarsely granulated; it has a thin, raised margin along which a few small orifices are arranged. The primary orifice located at the distal margin of the zooid, is transversely oval; it has a raised proximal margin, as a result of which, the orifice appears fabiform (bean-shaped). A raised oval avicularium is located between the lateral lobes of the peristome near the proximal margin of the secondary orifice, and its broad avicularian chamber occupies the entire frontal surface. Spines are absent. The ovicells are hyperstomial, small, semi-circular, and slightly oblong on the sides; they have a concave, proximal margin which bends upward and narrows. The surface of the ovicells is coarsely granulated. There are 2 pore plates with many pores in the lower half of the lateral wall and in the distal septum.

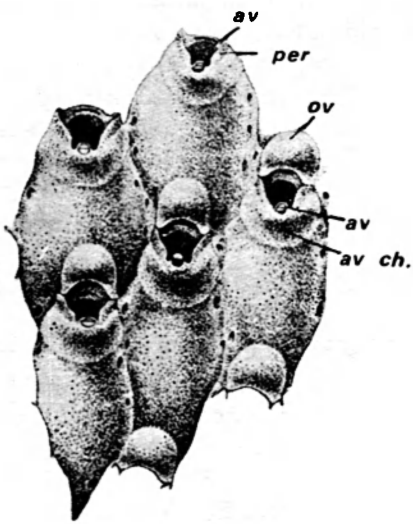


Figure 299. *Porella aperta* (Boeck). Part of a zoarium (from the collection of Andersson, coll., 1900).

This species is quite close to *P. acutirostris*, but differs from it by a larger sized zooid, the shape of its secondary orifice (distinctly raised in the zooids carrying ovicells), which is triangular in form with the top inverted at the base, corresponding to the distal margin of the orifice, and finally, the posterior half of the almost horizontally lying avicularium rises strongly into the cavity of the orifice.

The species lives on shells of mollusks and stones, at a depth of 19 to 160 m, on a bed of shells, silt, and stone, under temperatures ranging from −1.67 to −1.38°C, in a salt concentration of 34.29 to 34.76‰.

Distribution. The species was found by me in the Barents, Kara, and Laptev seas, and in the Davis Strait. *Reports in literature:* Barents Sea (M. Sars, 1851; Smitt, 1868b; Waters, 1900; Norman, 1903b), along the northern coast of North America (Osburn, 1923), western Greenland (Smitt, 1868b; Norman, 1906), Gulf of St. Lawrence (Norman, 1903b), and eastern Greenland (Andersson, 1902).

This is an Arctic, Atlantic species.

4. **Porella acutirostris** Smitt, 1868 (Figure 300)

Porella acutirostris Smitt, 1868b : 21, 132, pl. 26, f. 106-108; Waters, 1900 : 83, pl. 10, f. 1-5; *et auctt.*

The zoaria, prostrate in the form of a thin white crust, consist of zooids arranged in radial rows starting from the ancestrula. The zooids are small (length 0.65 mm, width 0.38 mm), and oblong-rhombic-hexagonal in shape. The frontal surface is raised; it has a thin and barely raised margin along which are located a few depressions with small pores at the bottom. The surface is coarsely granulated. The primary orifice of the zooid is semi-circular and broad; it has a mildly raised, proximal margin near which small, barely noticeable condyles are located on the sides. Spines are absent at the distal margin. A raised, oval avicularium is located between the lateral lobes of the peristome, which are more developed in the zooids carrying ovicells. The proximal end of the avicularian mandible is sharply pointed. The raised, wide avicularian chamber occupies the entire frontal surface. The ovicells are peristomial, round, and raised; they have a coarsely granulated surface. Two pore plates with a few pores are located along the basal margin of the lateral wall, as well as in the distal septum.

The species lives on laminaria, stones, and calcified Bryozoa, at a depth of 0 to 395 m, more often from 50 to 150 m, on a bed of stone, silt, and shells, under temperatures varying from −1.61 to 2.56°C, in a salt concentration of 32.18 to 34.96‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and off western Greenland, and in the Davis Strait. *Reports in literature:* Barents

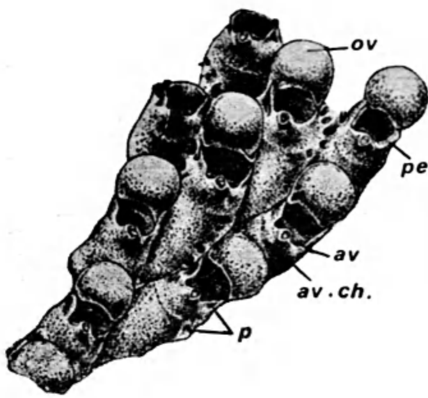


Figure 300. *Porella acutirostris* Smitt. Part of a zoarium. Barents Sea.

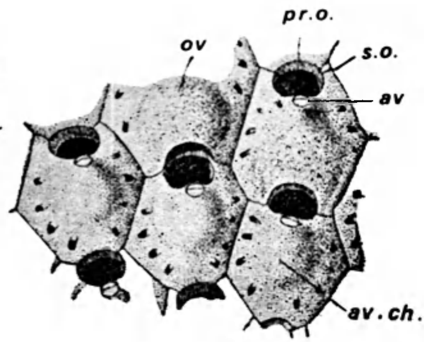


Figure 301. *Porella tumida* Kluge. Part of a zoarium (from Kluge, 1955a).

Sea (Smitt, 1868b; Waters, 1900; Andersson, 1902; Nordgaard, 1923), Kara Sea (Nordgaard, 1912b), Laptev Sea (Kluge, 1929), Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1923, 1932, 1936), western Greenland (Smitt, 1868b; Norman, 1876, 1906; Kluge, 1908b; Levinsen, 1914), Gulf of St. Lawrence (Hincks, 1889; Whiteaves, 1901), eastern Greenland (Levinsen, 1916), Yan-Maien Island (Lorenz, 1886), Lofoten Islands (Nordgaard, 1905, 1918), along the eastern coast of North America from Cape Cod to the Gulf of St. Lawrence (Osburn, 1912, 1933), and along the western coast of North America in the region of Queen Charlotte Islands (Hincks, 1884).

This is an Arctic-boreal, circumpolar species.

5. **Porella tumida** Kluge, 1955 (Figure 301)

Porella tumida Kluge, 1955a : 96, f. 42.

The zoaria, prostrate in the form of crust-like outcroppings, consist of zooids arranged in a checkered pattern. The zooids are small (length 0.53 mm, width 0.35 mm), rhombic-hexagonal in shape, hyaline, and a translucent, milk-white color.

The frontal surface is convex and the zooids are separated by a deep margin; a row of marginal pores, numbering 7 to 9 or more, is located on both sides of this margin. Initially, the surface is smooth, but with further calcification it becomes granulated. The primary orifice of the zooid in the distal half is semi-circular; its proximal margin, whose width is greater than its height, is slightly raised in the distal direction. Very slightly raised and rounded condyles are located on the sides of the orifice in the proximal part, which support the operculum. The thickness of the wall, facilitates the formation of the secondary orifice, which is short and fabiform. The distal margin of the secondary orifice is formed by the proximal margin of the frontal wall of the overlying daughter zooid. The avicularium has an unusually well-developed avicularian chamber, which follows directly after the proximal margin of the zooidal orifice. The avicularian chamber is markedly raised above the remaining frontal surface. The avicularium is located perpendicular to the frontal plane; it is round with a semi-circular mandible whose free margin is directed upward.

The wall of the avicularian chamber thickens with time in the most raised part and, in most zooids, forms an entire conical protuberance. The lower part of the wall of the avicularian chamber has a few (about 4) pores.

With further thickening in the frontal wall and, particularly, in the zooids carrying ovicells, the avicularian chamber narrows and does not rise above the remaining surface; only the thickened part of the frontal surface and the conical protuberance located on it are raised; the avicularium appears to be wholly submerged in the oral orifice. The ovicells are hyperstomial, round, and slightly flat; their frontal wall is granular.

There are 2 rosette-like plates with 3 to 4 pores each in the lateral wall, as well as in the distal septum.

The species lives on stones and shells of *Mya* and *Saxicava*, at a depth of 40 to 50 m, on a bed of sand.

Distribution. The species was found by me in the Bering Strait.

6. **Porella minuta** (Norman, 1869) (Figure 302)

Porella minuta Hincks, 1880a : 326, pl. XXXVI, f. 6; Norman, 1930b : 113.

The zoaria, small and prostrate in the form of a crust, consist of zooids arranged in regular, straight and oblique rows. The zooids are very small (length 0.41 mm, width 0.21 mm) and oblong-rectangular or oval in shape. The frontal surface is weakly raised in the distal half, due to a raised avicularian chamber; one row of pores is arranged along the deep margin. The primary orifice, located at the distal margin of the zooid, has a straight or mildly raised, proximal margin. A round avicularium with a convex, semicircular avicularian chamber, is located between the narrowing, lateral lobes of the peristome, at the proximal margin of the secondary orifice. As calcification of the frontal wall increases, the latter becomes less raised and the zoarial surface more even. The ovicells are hyperstomial, round, and slightly raised. The lateral wall of the zooid and the distal septum have 2 pore chambers each.

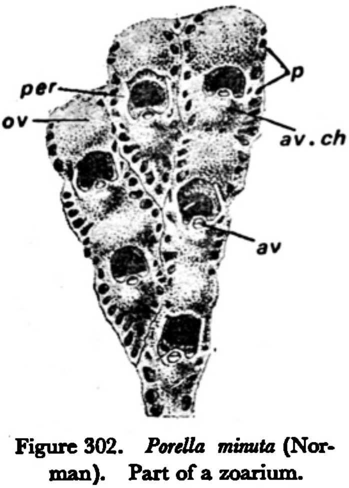


Figure 302. *Porella minuta* (Norman). Part of a zoarium.

This species lives on laminaria, shells, and stones, at a depth of 0 to 55 m, on a bed of stone and silt, under a temperature of 1.6°C, in the White Sea at 10.4°C.

Distribution. The species was found by me in the coastal waters off western Murmansk and western Spitsbergen. *Reports in literature:* Barents Sea (Norman, 1903b; Kluge in Deryugin, 1915; Kuznetsov, 1941), White Sea (Kluge, 1908a; Gostilovskaya, 1957), Archipelago of the

Canadian Islands (Nordgaard, 1906a), Gulf of St. Lawrence (Whiteaves, 1901), northern Norway (Nordgaard, 1905, 1918), and the Shetland and British Isles (Norman, 1869; Hincks, 1880a).

7. **Porella groenlandica** Norman, 1894 (Figure 303)

Porella bella var. *groenlandica* Norman, 1894 : 126; *P. groenlandica* Kluge, 1908b : 551; *Schizoporella bidenkapi* Nordgaard, 1906a : 19, pl. II, f. 22-24.

The zoarium, prostrate in the form of a thin crust, consists of zooids arranged in irregular rows. The zooids are large (length 0.95 mm, width 0.50 mm), oblong-rhombic-hexagonal in shape, and slightly raised; they have a thin, raised margin. The frontal surface is uniformly covered with pores, which are often enlarged along the margins. The primary orifice, located at the middle of the distal margin, is semi-circular with either a straight or slightly pointed proximal margin in the middle, and lateral condyles at its ends. The secondary orifice is roundish, sometimes narrowing toward the center of the proximal margin. A small, round avicularium is located in the middle between the proximal margins of the primary and secondary orifices. Usually unobservable from the surface, when this avicularium is situated closer to the frontal surface, it becomes noticeable. The ovicells are hyperstomial and strongly submerged; their oecial coating is divided by 2 sutures into 3 parts: 1 larger, upper part which forms a continuation of the frontal surface of the overlying zooid, and 2 smaller, lower parts which form the lateral parts of the frontal surface of the 2 adjoining zooids. A large, oval orifice is located in the larger, upper part near the juncture of the sutures. There are 6 pore plates with a few pores in the lateral wall, and 2 in the distal septum.

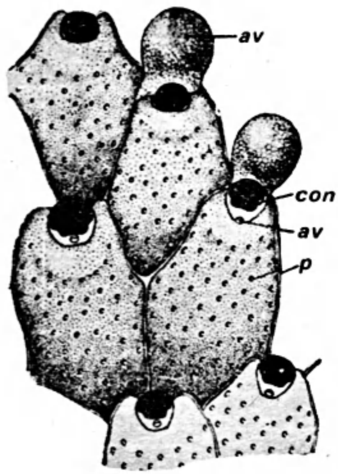


Figure 303. *Porella groenlandica* Norman. Part of a zoarium.

The species lives on stones and shells, at a depth of 14.5 to 280 m, more often from 50 to 150 m, on a bed of stone, shells, and silt, under temperatures ranging from —1.9 to 3.4°C, in a salt concentration of 31.6‰.

Distribution. The species was found by me in the Barents, Kara, Chukotsk, Bering, and Okhotsk seas, and off western and eastern Greenland, and in the Gulf of St. Lawrence. *Reports in literature:* Barents Sea (Smitt, 1868b; Nordgaard, 1918), White Sea (Gostilovskaya, 1957), Kara Sea (Levinsen, 1887; Nordgaard, 1912b), Archipelago of the Canadian Islands (Nordgaard, 1906a), western Greenland (Hennig, 1896; Norman, 1906; Kluge, 1908b), eastern Greenland (Andersson, 1902), northern Norway (Nordgaard, 1918).

This is an Arctic, circumpolar species.

8. **Porella princeps** Norman, 1903 (Figure 304)

Porella princeps Norman, 1903b : 114, pl. IX, f. 8-11; Nordgaard, 1905 : 168, pl. IV, f. 21-23; *Monoporella spinulifera* var. *praeclara* Hincks, 1892 : 152, pl. VIII, f. 3; *Discopora megastoma* Smitt, 1872a : 1128 (part.), pl. 21, f. 25-26; 1879b : 30.

The zoarium, prostrate in the form of thick crusts, sometimes consists of short, regular, oblique rows of zooids, and sometimes of irregularly arranged zooids, which sometimes fuse with under-developed zooids of smaller size. The live zoaria are rose colored and remain so for a long time even after preservation in alcohol. The zooids are large (length 1.00 to 1.25 mm, width 0.63 to 0.75 mm), thick-walled, rhombic-hexagonal or oval in shape, mildly convex, and separated by deep furrows. The frontal surface is comparatively uniformly covered with pores which, being larger along the margin, give it a wavy appearance when greater calcification occurs. Often a large, umbilical protuberance is found under the proximal margin of the orifice. The primary orifice is semi-circular; its proximal margin is straight or mildly concave, and sometimes appears to have a very low, broad tooth; small condyles are located on the sides, at a certain distance from the proximal margin. The thickening of the frontal wall forms a secondary orifice. A fairly large and round avicularium is located between the primary and secondary orifices in the middle of the proximal margin which, situated closer to the margin

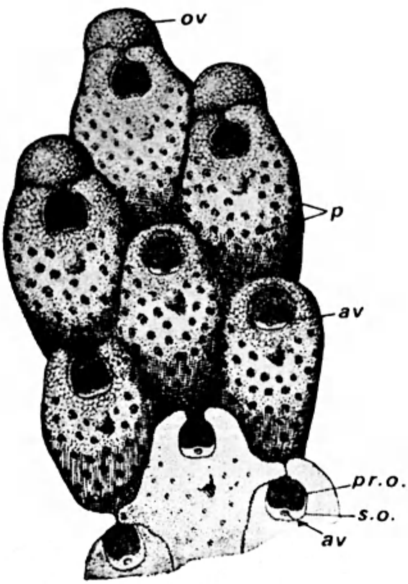


Figure 304. *Porella princeps* Norman. Part of a zoarium with an umbilical protuberance at the surface of the zooids.

of the primary orifice, thereby becomes unnoticeable from the surface, and can easily escape detection by the observer. The distal margin of the orifice is either continuous, or consists of 2 halves which either fuse to form a suture, or have the proximal margin of the distally located zooid, or even the proximal part of the ovicell, wedged between them. Spines are not present. The operculum is chitinized in the form of a hemisphere; its height is slightly larger than its width; it has a straight proximal margin; on each corner of this margin, thick, chitinous strips are located just on the inner side, which serve to attach the occlusor muscles.

The ovicells are hyperstomial, small, semi-circular, slightly raised above the surface, and covered with a thick wall. There are 5 to 6 simple pore chambers along the basal margin of the lateral wall, and 2 simple pore plates along the distal septum.

The species lives on stones and shells, at a depth of 14.5 to 145 m, on a bed of stone, shell, and silt, under temperatures ranging from −1.7 to 2.7°C, in a salt concentration of 32.20‰.

Distribution. The species was found by me in the Barents, Kara, and Chukotsk seas. *Reports in literature:* White Sea (Kluge, 1908a; Gostilovskaya, 1957), western Greenland (Norman, 1903b), Gulf of St. Lawrence (Hincks, 1892), eastern Greenland (Levinsen, 1914, 1916), and northern Norway (Nordgaard, 1905, 1918).

This is an Arctic, Atlantic species.

9. **Porella smitti** Kluge, 1907 (Figure 305)

Porella smitti Kluge, 1907 : 186; *Eschara verrucosa* forma *verrucosa* Smitt, 1868b : 22, 142, t. 26, f. 135; *Porella proboscidea* Nordgaard, 1896 : 25, pl. I, f. 4; 1905 : 169, pl. III, f. 8-11; Osburn, 1912 : 249, pl. 27, f. 71, pl. 31, f. 101.

The zoarium is sometimes prostrate, single-layered, and overgrowing the substrate, and sometimes free-growing and double-layered in the form of small, broad, sinuate lobes. The zooids are arranged in short, straight and oblique rows; they are small (length 0.47 to 0.63 mm, width 0.33 to 0.38 mm),

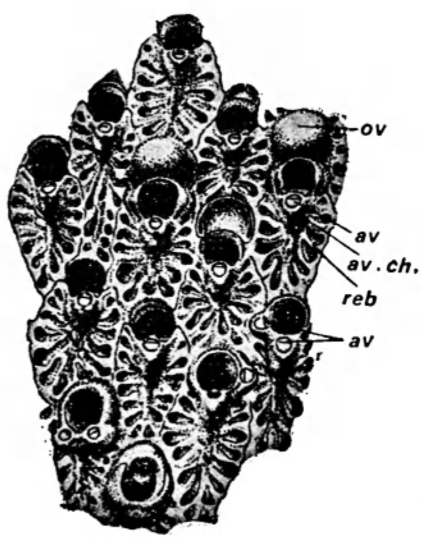


Figure 305. *Porella smitti* Kluge. Part of a zoarium. Barents Sea.

rectangular in shape, slightly broader in the distal half, and narrower in the proximal. The frontal surface is raised, smooth, and translucent in a young stage; it is bordered by a thin, raised margin along which are located depressions with pores at the bottom; short, radially arranged rebra are usually located between these depressions, which sometimes reach up to the base of the avicularian chamber. As further calcification occurs, the frontal wall becomes thicker, the raised margin and the rebra become even, and the surface becomes more or less continuous and smooth, although the depressions remain noticeable. The primary orifice, located at the distal margin of the zooid, is semi-circular; it has a straight, proximal margin, and small, blunt condyles at the sides. A raised, conical, avicularian chamber is located between the lateral lobes of the peristome, which narrows toward the proximal margin of the secondary orifice. The avicularian chamber has an avicularium on the side which is directed toward the orifice. The mandible is semi-circular. In young zooids, located near the growing margin of the zoarium, the tip of the avicularian chamber is usually sharp, but as it comes closer to the center of the zoarium, this tip gradually becomes rounded. With further calcification of the frontal surface, the avicularian chamber becomes more and more raised, until it is almost even with the surface, and the avicularium sinks into the orifice. In some zoaria, besides the aforementioned pre-oral avicularium, usually 1 to 2, sometimes even 3, small avicularian chambers are located near the orifice, along with the round avicularia, and directed toward the side of the orifice; but sometimes entire zoaria are found which have no additional (adventitious) zoaria. The ovicells are hyperstomial, large, round, and raised; they have a smooth or granulated surface. The peristome is usually well-developed in the zooids carrying ovicells and, being located on each side of the ovicell, fuses in the middle to form a thin, rebral comb along the proximal margin of the ovicell. There are 2 multiporous plates in the lateral wall, and 2 pore chambers in the distal septum.

The species lives on hydroids, Bryozoa, ascidia, and shells, at a depth of 9 to 293 m, more often from 50 to 100 m, on a bed of shells, stones, and sand, under temperatures ranging from 0.08 to 4.75°C, in a salt concentration of 33.87 to 34.36‰.

Distribution. The species was found by me in the Barents, Kara, and Okhotsk seas. *Reports in literature:* Barents Sea (Smitt, 1879b; Nordgaard, 1896; Bidenkap, 1900a; Kuznetsov, 1941), White Sea (Bidenkap, 1900a; Kluge, 1908a; Gostilovskaya, 1957), Kara Sea (Levinsen, 1887), Archipelago of the Canadian Islands (Nordgaard, 1906a), Hudson Bay (Osburn, 1932), Labrador (Osburn, 1913), western Greenland (Smitt, 1868c), Gulf of St. Lawrence (Hincks, 1888; Whiteaves, 1901), northern Norway (Nordgaard, 1918), German Sea (Nordgaard, 1907b), Iceland

(Nordgaard, 1924), and the region of Woods Hole (Osburn, 1912).
This is an Arctic species.

10. **Porella proboscidea** Hincks, 1888 (Figure 306)

Porella proboscidea Hincks, 1888 : 224, pl. 14, f. 4; Levinsen, 1916 : 465; *P. skenei* var. *proboscidea* Waters, 1900 : 79, pl. 11, f. 17-18; *P. umbonata* Nordgaard, 1906a : 25, pl. III, f. 40-42; 1923 : 13, f. 4.

The zoaria, prostrate and overgrowing in the form of a crust, consist of zooids arranged in regular, oblique rows. The zooids are minute (length 0.63 mm, width 0.40 mm) and rhombic or oval in shape. The frontal surface is raised, rising in the direction of the orifice; it is smooth in young zooids and granulated in the older; in the young, a row of oblong depressions with pores at the bottom, are radially located from the margin to the base of the avicularian chamber. These pores lead to the formation of rebral structures on the surface. But these rebral formations disappear very soon with further calcification, and in most of the zooids, the frontal surface is simply surrounded by a row of pores. The primary orifice, located at the distal margin, is semi-circular with a straight, proximal margin; barely noticeable, blunt condyles are located at the sides of the latter. The raised avicularian chamber is situated proximal to the orifice; it has a broader base which slightly narrows toward the upper side, and bends toward the side of the orifice; the round avicularium at the end is sometimes followed by a raised tubercle. In many zooids, a few smaller avicularia are often found on the margins of this avicularium on one or both sides; their number sometimes reaches up to 4. Besides these probosciform avicularia, there are orifices on some zooids, or sometimes, short avicularia of varying size located on the ovicell. The ovicells are hyperstomial and round; their width is slightly greater than their height; they have a smooth and shiny surface in a young stage, which later becomes granulated. Sometimes both halves of the outer layer do

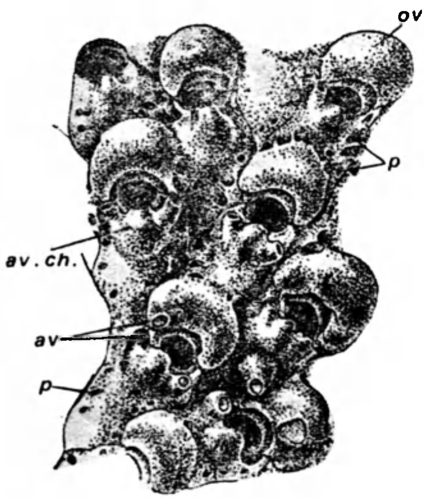


Figure 306. *Porella proboscidea* Hincks. Part of a zoarium with a variable number of avicularia in the zooids.

not fully fuse with each other, in which case either an orifice or an oblong slit is found in the middle of the frontal surface of the ovicell. In the zooids carrying ovicells, the lateral lobes of the peristome are usually developed. There are 4 pore chambers along the basal margin of the lateral wall, and 2 in the distal septum.

The species lives on shells and calcareous Bryozoa, at a depth of 14.5 to 325 m, more often from 50 to 150 m, under temperatures ranging from −1.9 to 2.7°C, in a salt concentration of 34.27 to 34.85‰.

Distribution. This species was found by me in the Barents, Kara, Laptev, and East Siberian seas, and in Baffin Bay. *Reports in literature:* Barents Sea (Smitt, 1868b; Bidenkap, 1900a; Waters, 1900; Kluge, 1906; Kluge in Deryugin, 1915; Nordgaard, 1923), White Sea (Gostilovskaya, 1957), Kara Sea (Nordgaard, 1912b), Archipelago of the Canadian Islands (Nordgaard, 1906a), western Greenland (Kluge, 1908b), Gulf of St. Lawrence (Hincks, 1888; Whiteaves, 1901), eastern Greenland (Levinsen, 1916), and Yan-Maien Island (Lorenz, 1886).

This is an Arctic species.

11. **Porella plana** Hincks, 1888 (Figure 307)

Porella skenei forma *plana* Hincks, 1888 : 221, pl. 14, f. 6-6c; *P. plana* Waters, 1900 : 79, pl. 11, f. 11-13 : *et auctt.*

The zoaria are free-growing as bilateral lobes, sometimes broad and short, sometimes narrow and long, or as cylindrical, lateral stems which reach up to 2 cm in height. The zooids are located in regular, straight and oblique rows; their size fluctuates; in the flat zoaria, sometimes they are slightly smaller and broader (height 0.63 to 0.88 mm, width 0.50 mm) than those in the cylindrical zoaria (height 1.00 mm, width 0.53 mm), which are usually more oblong. The zooids are irregularly rectangular in shape, the short ones being uniform in width throughout their length, the longer ones usually broader in the distal part and narrower in the

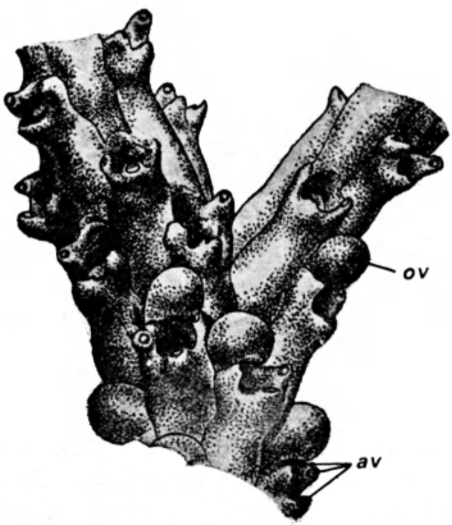


Figure 307. *Porella plana* Hincks. A part of a cylindrical, double-branched stem.

proximal. The frontal wall is strongly thickened and granulated; the primary orifice, located along the margins, usually near the distal end, is roundish with a straight, proximal margin, devoid of a lyrule, and complete with less noticeable condyles on the sides. The avicularium is usually located in the middle of the proximal margin of the secondary orifice, which is initially slightly raised, but due to the fast calcification of the frontal wall, soon submerges, becoming finally, almost unnoticeable. From each side of the frontal wall, the orifice rises along the thicker lateral protuberance, which carries the avicularium and opens into the cavity of the orifice. In addition to the usual oral avicularia, a few more are often arranged at the margin of the secondary orifice. In this respect, the different zoaria demonstrate great variation: pieces were found in which the zooids had only one avicularium in the middle of the proximal margin of the orifice; other pieces had one in the middle of the proximal margin and one on each side; and lastly, there were pieces in which the zooids had 5 to 6 avicularia around the orifice. The first two types are often found in cylindrical zoaria, the latter more often in the flatter ones. In addition to these avicularia, often 1 to 2 avicularia of a smaller size are found at the margin of the frontal surface, which can be distinguished from the pre-oral ones by their raised, roundish avicularian chambers.

The ovicells are hyperstomial and small, and sometimes barely noticeable because of the strong calcification of the body wall.

There are 7 to 8 pore chambers along the basal margin of the lateral wall, and 3 with a few pores each in the distal septum.

The species lives on stones, shells, and calcareous Bryozoa, at a depth of 75 to 698 m, on a bed of stone, silt, and shells, under temperatures ranging from -1.63 to 4.25°C, in a salt concentration of 34.27 to 34.96‰.

Distribution. This species was found by me in the Barents, Kara, Laptev, and East Siberian seas, and in the waters off western Greenland and Labrador. *Reports in literature:* Barents Sea (Smitt, 1879b; Marenzeller, 1877; Bidenkap, 1900a; Waters, 1900; Andersson, 1902; Kluge, 1906; Nordgaard, 1918), Kara Sea (Smitt, 1879a; Kluge, 1929), Archipelago of the Canadian Islands (Nordgaard, 1906a), western Greenland (Smitt, 1868c; Norman, 1906; Levinsen, 1914), Gulf of St. Lawrence (Hincks, 1889; Whiteaves, 1901), eastern Greenland (Andersson, 1902; Levinsen, 1916), eastward of Iceland (Nordgaard, 1918), and the Bay of Fundy on the eastern coast of North America (Osburn, 1933).

This is an Arctic, Atlantic species.

12. **Porella laevis** (Fleming, 1828) (Figure 308)

Cellepora laevis Fleming, 1828 : 532; *Porella laevis* forma *escharae* Smitt, 1868b : 21, 134, pl. 47, f. 10, 11; *et auctt.*

A free-growing, cylindrical, dichotomously branched stem, colored yellow in a live state, and reaching up to 3 to 4 cm in height and 2 to 3 mm in thickness at the base, rises from a small, prostrate crust. The zooids are arranged in straight rows in a checkered manner. Their thickness and form vary, depending upon their position; they are broader in the prostrate part (length 0.83 mm, width 0.60 mm), and more oblong in the free-growing part (length 0.85 mm, width 0.50 mm). They are either rhombic or oval and their wall is thick. The frontal surface is weakly raised, granulated, and surrounded by a row of relatively large pores along the margin; a transverse, slightly convex row of smaller pores often stretches proximal to the orifice in young zooids. A semi-circular, primary orifice is located near the distal margin, which slightly narrows above its proximal margin; its height is greater than its width, and the proximal margin is straight. A large and round avicularium with a semi-circular mandible is situated between the primary and secondary orifices, nearer to the latter. The ovicells are hyperstomial, large, round, and convex; they have a granulated surface. The peristome is developed in the zooids carrying ovicells, and located on the sides of the frontal surface of the ovicell, enclosing its proximal, straight margin. Because calcium deposits quickly, the frontal wall thickens to such an extent that the avicularia are submerged in the cavity of the orifice and become less noticeable; finally, the orifices themselves are fully covered and, as a result, the surface of the entire lower half of the zoarium usually becomes continuous and smooth—a characteristic feature of this species.

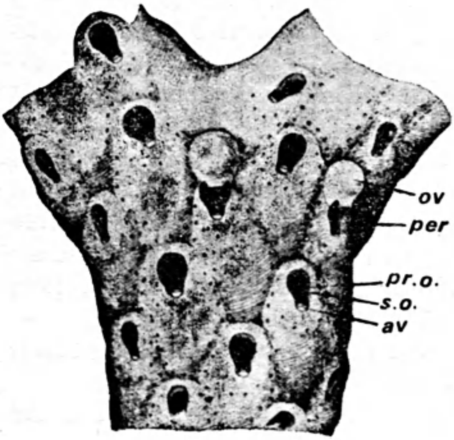


Figure 308. *Porella laevis* (Fleming). A part of a cylindrical branch near the point of bifurcation

The species lives on stones and shells, at a depth of 54 to 753 m, on a bed of silt, stone, and shells, under temperatures ranging from −1.0 to 5.0°C.

Distribution. The species was found by me along the eastern coast of Greenland. *Reports in literature:* Barents Sea, in the region of northern Finmark (M. Sars, 1851; Danielssen 1861; Nordgaard, 1896, 1907b, 1918), northern coast of North America (Osburn, 1923), western Greenland (Levinsen, 1914), Gulf of St. Lawrence (Whiteaves, 1901), Yan-

Maien Island (Lorenz, 1906), Atlantic Ocean, in the region of the Thompson Rapids (Nordgaard, 1900, 1907b), Shetland Islands (Norman, 1869), western coast of Norway from Bergen to Hammerfest (M. Sars, 1851; Danielssen and S. Sars, 1856; Nordgaard, 1896, 1905, 1918, 1927), and the Bay of Fundy on the eastern coast of North America (Verrill, 1875).

This is an Arctic-boreal species.

13. **Porella saccata** (Busk, 1856) (Figure 309)

Eschara saccata Busk, 1856b : 33, pl. I, f. 5; *E. elegantula* Smitt, 1868b : 24 (part.), t. 26, f. 140-146; *Porella elegantula* Hincks, 1888 : 222, pl. XV, f. 5a; *P. saccata* Waters, 1900 : 81, pl. 10, f. 8-12, 14-17; *P. elegantula* var. *palmata* Bidenkap, 1897 : 627, pl. 25, f. 7; 1900a : 516, 533, pl. 9, f. 7.

The zoarium is free-growing, usually in the form of cylindrical, narrow, straight, flat, often dichotomously branched lobes, and sometimes in the form of shorter, broader, and bent lobes. The lobes are bilateral, and the zooids of one side adjoin by their basal sides to the basal sides of the zooids of the other. The zooids are arranged in regular, straight and oblique rows in a checkered pattern. The zooids are rhombic-oblong, medium in size (length 0.88 to 1.00 mm, width 0.30 to 0.40 mm), and slightly raised; however, their bulging tends to increase because of the avicularian chamber. The primary orifice, located at the distal end, is semicircular, and its height is greater than its width; it has a straight, proximal margin, and small condyles at the sides. Spines are absent. A more or less broad avicularium is situated between the low, lateral lobes of the peristome. The hind portion of the avicularium is slightly raised and juts into the cavity of the orifice in the form of a flat segment; the front portion is covered by a semi-circular, broad mandible. The avicularian chamber is broad and stretches almost the entire length of the zooid; sometimes it divides into 2 lobes at the end. The ovicells are hyperstomial, round, and raised; they have a smooth surface. Sometimes the lateral lobes of the peristome overgrow in the zooids carrying ovicells; as

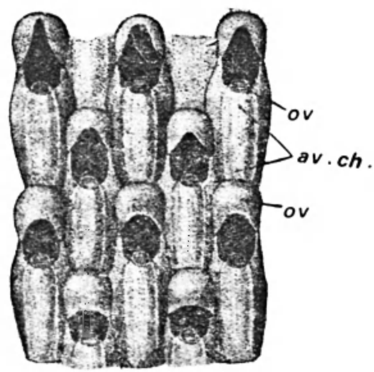


Figure 309. *Porella saccata* (Busk). A part of a zoarial lobe. Waters of northern Norway.

a result, the proximal half of the frontal surface of the neighboring zooids appears submerged. Initially the zooidal walls are thin and the individual avicularian chambers are not distinguishable. The ovicells seem to be covered by a layer of calcium which makes them look like endozooecial ones. At the end of the calcification process, the surface of the lobe becomes continuous, calcareous, and strongly granulated, and the roundish orifices, together with the avicularia, become visible at the proximal margin; the boundaries of the individual zooids are like thin, white strips, and 1 to 2 small, saccate depressions are found near the proximal end of the zooid. These depressions open through pores at the bottom into the avicularian chamber.

There are 2 small pore plates with a few pores in the lateral wall, and 1 large one with many pores in the distal septum.

The aperture in the ancestrula is occupied by 9 spines; spines are absent in both its daughter zooids, but both have a pre-oral avicularium.

This species lives on hydroids, tubes of worms, shells, and stones, at a depth of 1.50 to 288 m, on a bed of silt, stone, and shells, under temperatures ranging from −1.9 to 4.78°C, in a salt concentration of 29.96 to 34.96‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and off western Greenland and Labrador. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879a, 1879b; Marenzeller, 1877; Urban, 1880; Nordgaard, 1896, 1900, 1905, 1907b, 1912b, 1923; Bidenkap, 1897, 1900a, 1900b; Waters, 1900; Andersson, 1902), White Sea (Kluge, 1908a; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Levinsen, 1887; Nordgaard, 1912b; Kluge, 1929), Laptev and East Siberian Sea (Kluge, 1929), Chukotsk Sea (Osburn, 1923; Kluge, 1929), northern coast of North America and the Archipelago of the Canadian Islands (Busk, 1880; Nordgaard, 1906a; Osburn, 1923, 1932, 1936), Labrador (Packard, 1863, 1866-69; Osburn, 1913), Gulf of St. Lawrence (Hincks, 1888; Whiteaves, 1901), western Greenland (Smitt, 1868c; Norman, 1876, 1906; Vanhöffen, 1897; Kluge, 1908b; Levinsen, 1914; Osburn, 1919, 1936), eastern Greenland (Andersson, 1902; Levinsen, 1914), Yan-Maier Islands (Lorenz, 1886), Iceland and east of Iceland (Nordgaard, 1907c, 1924), northern Norway (Smitt, 1868b; Nordgaard, 1905, 1918).

This is an Arctic, circumpolar species.

13a. **Porella saccata** var. **beringia** Kluge, 1929 (Figure 310)

Porella saccata var. *beringi* Kluge, 1929 : 14; *P. saccata* var. *orientalis* Kluge, 1955b : 108, t. XXIII, f. 4.

The zoaria are free-growing in the form of broad, bilateral lobes, and attain a height of up to 2 cm. The zooids have an oblong-rectangular shape that is more or less broad. Their orifice is semi-circular and often has 2 spinules at the lower margin. This form has zooids which are almost equal in size (length 1.00 mm, width 0.38 mm) to those of a typical *P. saccata*, but differs by the structure of its avicularium and avicularian chamber. In contrast to the shorter, semi-circular shape of the mandible

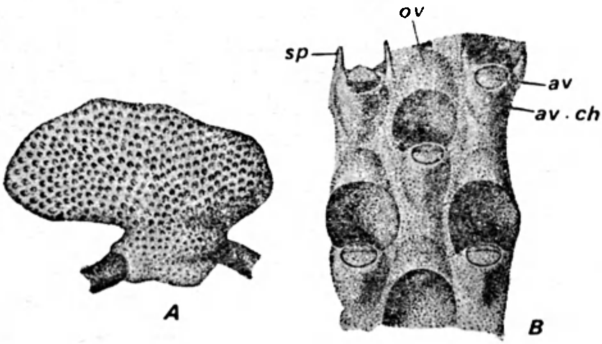


Figure 310. *Porella saccata* var. *beringia* Kluge. *A*—general view of a zoarium; *B*—part of a zoarium (both sketches from Kluge, 1955b).

in *typica*, the mandible in the present form has a broad, tall, and triangular shape, and a rounded tip. While the mandible of *P. saccata* has an average height-to-width ratio of 1 : 2 (height 0.08 mm, width 0.16 mm), in var. *beringia*, the height is almost equal to the width (height 0.19 mm, width 0.21 mm). Consequently, the avicularian chamber in this form markedly differs from that of the typical form. While the avicularian chamber is of uniform height throughout its entire length in the latter (*typica*), in the present form the distal end, covered by the mandible, is strongly raised and the entire distal half is rather acutely depressed up to the level of the common (general), frontal surface of the zoarium. The location of the mandible in relation to the frontal surface is another difference. While in *typica* the mandible is almost suspended toward the frontal surface of the zooid, in the present form it is strongly tilted, and its tip points toward the proximal side.

The species lives on hydroids, tubes of *Polychaeta*, and the shells of mollusks, at a depth of 21.6 to 47 m, on a bed of stone and shells, under temperatures ranging from 0.4 to 9.0°C, in a salt concentration of 31.6 to 33.1‰.

Distribution. The species was found by me in the Chukotsk, Bering, and Okhotsk seas.

This is an Arctic-boreal, Pacific species.

14. **Porella fragilis** Levinsen, 1914 (Figure 311)

Porella fragilis Levinsen, 1914 : 592; 1916 : 464, pl. 22, f. 4-9; *P. elegantula* var. *rostrata* Hincks, 1888 : 223, pl. 15, f. 5; *P. saccata* var. *rostrata* Nordgaard, 1906a : 23; Kluge, 1908a : 551.

The zoarium is free-growing, and reaches up to 1 to 2 cm in height, in the form of narrow, straight or bent, ramose lobes. The lobes are bilateral. The zooids are arranged in straight and oblique rows in a checkered pattern. The zooids are medium in size (height 0.80 mm, width 0.25 mm) but smaller than those of *P. saccata,* and have a rhombic-oblong shape; their length is about 3 times greater than their width, and they are mildly convex. The primary orifice, located at the distal end of the avicularium, is semi-circular; its height is greater than its width; it has a weakly raised proximal margin, and small, lateral condyles. Spines are absent. The avicularium is strongly raised in the middle between the lateral lobes of the peristome. The raised portion of the avicularium extends over one-third to two-thirds of its total length. It seems to consist of 2 parts—the broader, distal, oblong-oval one, and the narrower, proximal one that is almost equal in width throughout its length. The distal part is raised at a more or less sharp angle and almost totally covers the secondary orifice of the zoid; its oval top has a semi-circular mandible. The proximal part is more or less flat, maintains a uniform width throughout its length (although the width varies from specimen to specimen), and has 1 (rarely 2) pore near its proximal end. Sometimes the proximal end is bifurcated into 2 lobes, each of which has a pore. The ovicells are peristomial, round, sometimes slightly stretched, sometimes broader; they have a smooth surface, and a more or less concave, proximal margin. Initially, the zooidal walls are fairly thin and transparent, and the zooids are clearly separated from each other, but later, with further calcification, the isolation (separation) of the zooids becomes

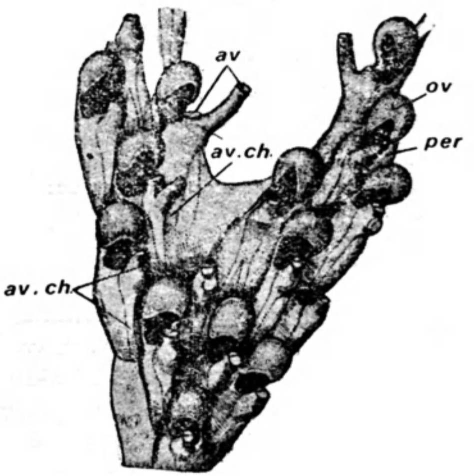


Figure 311. *Porella fragilis* Levinsen. Part of a biramous lobe with a typical arrangement of avicularia and zooids.

less noticeable, the surface of the lobes becomes more or less even and granular, and the avicularium, which was formerly strongly raised, almost submerges in the orifice. There are 2 pore plates with 3 to 5 pores in the lateral wall of the zooid, and from 6 to 8 uni- or multi-porous plates near the basal margin of the obliquely rising distal septum.

The species lives on hydroids, shells of annelids, and stones, at a depth from 3 to 235 m, more often from 50 to 150 m, on a bed of silt, stone, and shells, under temperatures ranging from −1.82 to 1.1°C, in a salt concentration of 31.64 to 34.40‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas. *Reports in literature:* Barents Sea (Smitt, 1868b; Bidenkap, 1897), White Sea (Kluge in Deryugin, 1928; Gostilovskaya, 1957), Kara, Laptev, East Siberian, and Chukotsk seas (Kluge, 1929), Archipelago of the Canadian Islands (Nordgaard, 1906a), western Greenland (Kluge, 1908b; Levinsen, 1914; Busk, 1880), Labrador (Packard, 1866-69; Osburn, 1913), Gulf of St. Lawrence (Hincks, 1888; Whiteaves, 1901), and eastern Greenland (Andersson, 1902; Levinsen, 1914, 1916).

This is a high Arctic, circumpolar species.

4. Genus **Palmicellaria** Alder, 1864

Eschara (part.) Busk, 1854a : 89; *Discopora* Smitt, 1868b : 29; *Palmicellaria* Alder, 1864 : 100; Hincks, 1880a : 378.

The zoaria are free-growing, branched, or prostrate. The zooids are oblong-oval and convex; they have a smooth surface bordered by small pores arranged in a checkered pattern along the deep margin. The primary orifice is either round, semi-circular, or elliptical. A strongly developed peristome forms a secondary orifice; a terminally pointed, raised avicularian protuberance is located in the center of it, and a round avicularium with a semi-circular mandible is located near its base on the sides, and directed toward the orifice. Besides this central protuberance, similar protuberances may be situated on both the sides, and the number of them may reach up to 5. In these additional protuberances, the round avicularia are located at the tips. Ovicells are hyperstomial. There are primary plates with a few pores in the lateral wall, and uniporous plates in the distal septum.

Genus type: *Millepora skenei* Ellis and Solander, 1755.

1 (4). Zoaria free-growing and branched.
2 (3). Zooids have one avicularian protuberance in the middle of the proximal margin of the orifice... 1. *P. skenei* (Ellis and Solander).

3 (2). Zooids usually have 3 protuberances at the proximal margin of the orifice; sometimes 1 protuberance drops out from one or the other side.................... 1a. *P. skenei* var. *tridens* (Busk).

4 (1). Zoaria prostrate. Zooids have 3 to 5 avicularian protuberances. .... 1b. *P. skenei* var. *bicornis* (Busk).

1. **Palmicellaria skenei** (Ellis and Solander, 1786) (Figure 312)

Palmicellaria skenei Hincks, 1880a : 379 (part.), pl. 52, f. 1-3; Levinsen, 1894 : 71, pl. 6, 16-22; non *Porella skenei* Osburn, 1933 : 58.

The zoarium is free-growing, cylindrical or flat, bilateral, and branched, and rises from a single-layered, crustaceous structure; it is yellowish-red in a live state. The zooids are arranged in straight rows in a checkered pattern; they are long (length 1.00 to 1.13 mm, width 0.43 mm), cylindrical in shape, and slightly broader in the middle part. The frontal surface is mildly raised and finely granulated; it has sparse pores along the margins. The primary orifice, located at the distal end of the zooid, is semi-circular, strongly stretched in length, and has a weakly concave, proximal margin which usually has no spines, but sometimes 2 spines appear on its distal margin. It is encircled by a strongly developed peristome, which forms the secondary orifice; a raised, sharp protuberance (rostrum) is located at the proximal margin of the secondary orifice. A round avicularium with a semicircular mandible is located at the base of the rostrum. There are 1 to 2 lateral avicularia in a few zooids, in addition to the one just mentioned, in some zoaria. The ovicells are hyperstomial, small, and round; they have a granulated surface. There are 5 to 6 pore plates with 3 to 8 pores each in the lateral wall of the zooid, and about 15 uniporous plates in the distal septum.

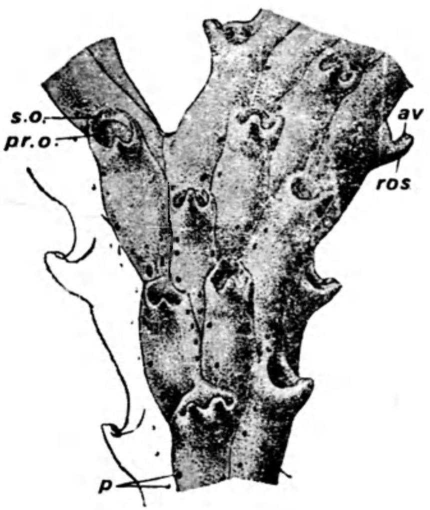


Figure 312. *Palmicellaria skenei* (Ellis and Solander). Part of a cylindrical branch at the junction of ramification. Kara Sea.

The species lives on hydroids, shells, and stones, at a depth of 35 to 360 m, more often from 100 to 200 m, on a bed of silty sand and stones, under a temperature of −1.2°C, in a salt concentration of 34.90‰.

Distribution. The species was found by me in the Kara and Laptev seas, and in the Davis Strait. *Reports in literature:* Barents Sea (Nordgaard, 1912a), coastal waters off western Norway (M. Sars, 1851, 1863a; Nordgaard, 1912a, 1918), Skagerrack and Kattegat (Smitt, 1868b; Levinsen, 1894; Marcus, 1940), and the western coast of France (Joliet, 1877; Fischer, 1970).

This is an Arctic-boreal, Atlantic species.

1a. **Palmicellaria skenei** var. **tridens** (Busk, 1856) (Figure 313)

Eschara skenei var. *tridens* Busk, 1856b : 33, pl. I, f. 3; *Porella skenei* var. *tridens* Waters, 1900 : 80, pl. II, f. 6-7; *Palmicellaria skenei* var. *tridens* Nordgaard, 1905 : 169, pl. IV, f. 12.

The zoaria, free-growing, cylindrical, and dichotomously branched, consists of zooids arranged in straight rows in a checkered pattern around the branch. The zooids are long; their length is 2½ to 3 times greater than their width (length 1.0 to 1.25 mm, width 0.40 mm); they are oblong-hexagonal or oval in shape, and slightly broader in the middle. The

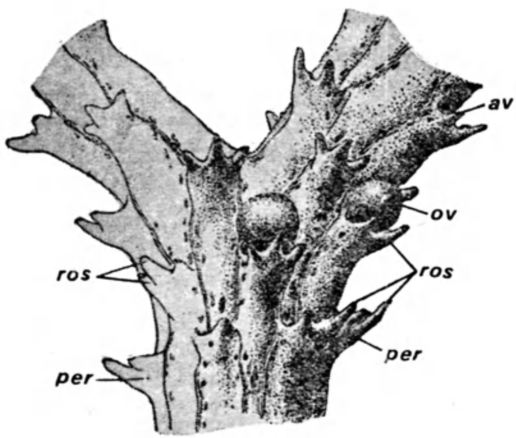


Figure 313. *Palmicellaria skenei* var. *tridens* (Busk). Part of a branch showing ramification. Barents Sea.

frontal surface is raised, finely granulated, and bordered by a slightly raised margin along which sparse, small, slit-like depressions stretch; there are usually 2 (rarely 1) round depressions with a pore at the bottom located near the proximal end. The primary orifice located at the distal end has a straight proximal margin; its length is markedly greater than its width; it is encircled by the peristome to form the secondary orifice. A raised, terminally pointed protuberance (rostrum) is located at the middle of the proximal margin of the latter. A round avicularium with a semi-circular mandible is located at the base of the rostrum on the inner side; a smaller protuberance with a round avicularium at the tip, arises from each side of the larger avicularium. The ovicells are hyperstomial, convex, and broad; they have a smooth frontal surface.

The species lives on hydroids, Bryozoa, shells, and stones, at a depth of 3.6 to 1,000 m, frequently from 50 to 400 m, but mostly from 100 to 250 m, on a bed of silt, stone, and shells, under temperatures ranging from -1.38 to 3.5°C, in a salt concentration of 34.49 to 35.01‰.

Distribution. The species was found by me in the Barents and Kara seas, and in the waters off Labrador and western and eastern Greenland. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Bidenkap, 1897, 1900a; Nordgaard, 1900, 1905, 1907b, 1918; Waters, 1900), Kara Sea (Smitt, 1879a), western Greenland (Norman, 1906; Levinsen, 1914), Gulf of St. Lawrence (Whiteaves, 1901), eastern Greenland (Kirchenpauer, 1874; Andersson, 1902), Iceland (Nordgaard, 1924), and eastward of Iceland (Nordgaard, 1907b), and northern Norway (Nordgaard, 1905, 1918).

This is an Arctic, Atlantic species.

1b. **Palmicellaria skenei** var. **bicornis** (Busk, 1859) (Figure 314)

Lepralia bicornis Busk, 1859 : 47, pl. 8, f. 6-7;
Porella skenei Osburn, 1933 : 58, pl. 12, f. 7-8.

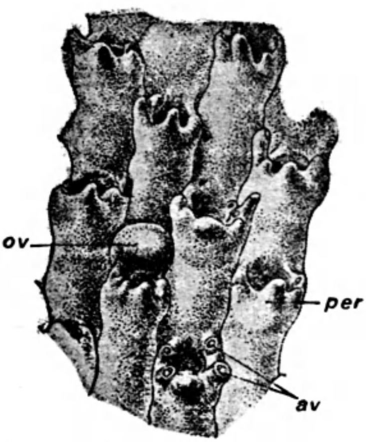


Figure 314. *Palmicellaria skenei* var. *bicornis* (Busk). Part of a zoarium showing a number of protuberances on the peristome, and avicularia. Barents Sea.

The zoarium is prostrate and consists of zooids arranged in short, oblique rows. The zooids are medium in size (length 0.75 mm, width 0.43 mm) and appear to consist of 2 more or less equal parts—the proximal one in the form of a slightly raised, frontal surface which has sparse pores at the margins, and the sharply rising, distal part. There is a strongly developed peristome on the latter, from the sides of which usually 1, but often 2, protuberance projects forward. These protuberances are sometimes short, sometimes longer and cylindrical; each has a round avicularium at the top. In addition to these lateral protuberances, a central protuberance also exists, usually not exceeding the lateral ones in height, and often lacking an avicularium on the inner side. The primary orifice is semi-circular and somewhat oblong; it has a straight, proximal margin with weakly developed condyles at the sides. The ovicells are hyperstomial, small, round, and convex; they have a smooth surface.

The species lives on shells and stones at a depth above 160 m.

Distribution. Reports in literature: Barents Sea along the coast of northern Finmark (Nordgaard, 1896) and toward southwestern Spitsbergen (Bidenkap, 1900b; Kluge, 1906), western coast of Norway (Nordgaard, 1896, 1918), and the Bay of Fundy on the eastern coast of North America (Osburn, 1933).

This is an Arctic-boreal, Atlantic species.

5. Genus **Umbonula** Hincks, 1880

Umbonula Hincks, 1880a : 316; *Lepralia* (part.) Johnston, 1847 : 316; *Discopora* (part.) Gray, 1848 : 126; *Eschara* (part.) Smitt, 1868b : 22.

The zoaria are prostrate or free-growing in the form of a broad lobe. The zooids are medium in size. The primary orifice is roundish or semicircular, with a more or less raised, proximal margin. The peristome and the secondary orifice are absent. A row of depressions with pores at the bottom are located along the raised margin of the frontal surface, and separated by radially stretched rebra, which reach up to the avicularian chamber. A large raised avicularian chamber is present at some distance from the proximal margin of the orifice. An oval avicularium with a semi-circular mandible is located at the top of the avicularian chamber. When the aforementioned chamber is not present, one small, oval avicularium may or may not appear on each margin of the orifice. The lateral and distal walls have pore plates. The ovicells, when present, are hyperstomial and round; they have an incompletely calcified outer layer with pores arranged at the margin and in the center of the calcareous frontal surface of the inner layer.

Genus type: *Cellepora verrucosa* Esper.

1 (4). A large avicularian cavity with an oval avicularium at its top is located proximal to the zooidal orifice.

2 (3). Avicularium suspended toward the plane of the orifice, and only the avicularian cavity visible from the frontal side.......... ....1. *U. verrucosa* (Esper).

3 (2). Avicularium tilted toward the surface of the orifice and easily visible at the frontal surface of the zooid....2. *U. patens* (Smitt).

4 (5). Large avicularian cavity not located proximal to the orifice of

the zooid.

5 (6). An oval avicularium located on each side of the orifice of the zooid.................................3. *U. arctica* (M. Sars).

6 (5). Oval avicularia not present on the sides of the zooidal orifice. ....4. *U. inarmata* Kluge.

*1. **Umbonula verrucosa** (Esper, 1790) (Figure 315)

Lepralia verrucosa Busk, 1854a : 68, pl. 87, f. 3, 4, pl. 94, f. 6; *Umbonula verrucosa* Hincks, 1880a : 317, pl. 39, f. 1.

The zoarium, prostrate in the form of a thick crust, consists of zooids arranged in regular, straight and oblique rows. The zooids are from large (in the British form, length 0.85 mm, width 0.58 mm) to medium in size (in the more southern form from Hernsi Island, length 0.70 mm, width 0.48 mm), and rhombic or oval in shape. The frontal surface is raised, rising toward the center of the proximal margin of the orifice, and bordered with a raised margin along which are located depressions with pores at the bottom. These depressions are sometimes deep (in the British form), and sometimes smaller (in the more southern form). Rays to the base of the avicularian chamber pass in a radial direction between the depressions; this avicularian chamber is very large, semi-circular, and raised in the Biritsh forms. But in the more southern forms, this chamber is small and less raised. The rebra are numerous and comparatively shorter in the British form, and fewer and longer in the southern form. The primary orifice, located at the distal margin of the zooid, is semi-circular in shape, large in the British form, and small in the southern form; its height is greater than its width, and its proximal margin is slightly raised. A raised avicularian chamber directly behind the proximal margin; it has a more or less large avicularium at the top suspended toward the surface of the orifice, which is not visible from the surface. The ovicells are hyperstomial, semi-circular, and convex. The lateral wall of the zooid has 4 to 5

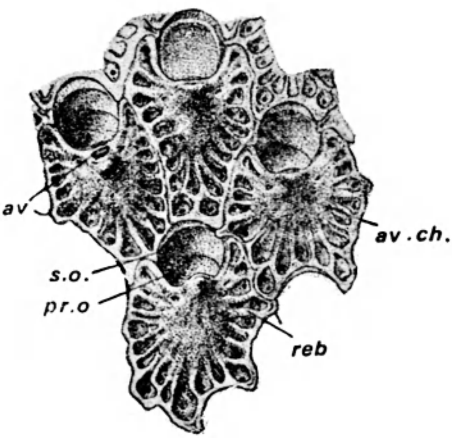


Figure 315. *Umbonula verrucosa* (Esper). Zooids from the frontal side.

(mostly 5) pore plates, while the distal septum has 2 with a few pores.

The species lives on algae, shells, and stones, at a depth from 0 to 72 m, on a bed of rock and shell.

Distribution. Reports in literature: Coastal waters of Lofoten (Nordgaard, 1906b, 1918), Shetland (Norman, 1869), and the British Islands (Hincks, 1880a), Roskova (Joliet, 1877), and the Mediterranean Sea (Waters, 1879; Calvet, 1902).

This is a boreal, Atlantic species.

The reports about the recovery of this species from the Kara Sea (Levinsen, 1887) and western Greenland (Levinsen, 1914, and subsequently even Borg, 1933a) are not correct. They are based on a wrong identification because this species is not found in the Arctic. Nevertheless, I am giving a description and sketch of this boreal species, in order to show how closely it resembles the Arctic species, *U. patens,* in the process of the transformation of the southern form into the more northern one. Although the boreal form is very close to the Arctic form, in spite of the changing position of the avicularium (observed sometimes in both forms)—from suspended to tilted toward the orifice—nevertheless, the boreal form is distinguished by the lesser development of the avicularian chamber and the frequent occurrence of 5 pore plates in the lateral wall of the zooid, while the Arctic form always has 4 such plates.

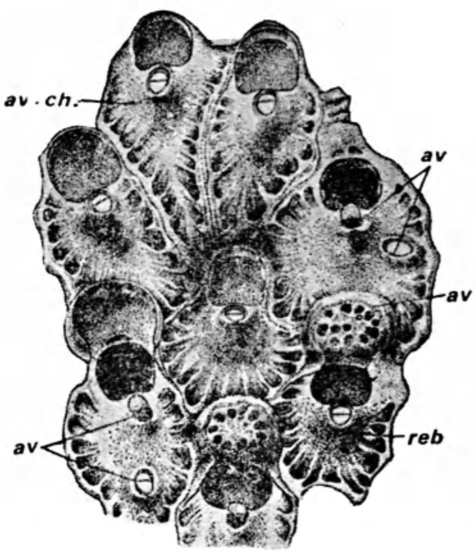


Figure 316. *Umbonula patens* (Smitt). Part of a zoarium with adventitious avicularia in two zooids.

2. **Umbonula patens** (Smitt, 1868) (Figure 316)

Eschara verrucosa I, Eschara patens Smitt, 1868b : 22, 143, t. 26, f. 124-125.

The zoarium, prostrate in the form of a thick crust, consists of zooids arranged in more or less regular, oblique rows. The zooids are large (length 0.88 to 1.05 mm, width 0.63 to 0.65 mm), rhombic or a broad oval in shape, tall, and thin-walled. The frontal surface is convex, and uprises a little short of the center of the proximal margin of the orifice, which has strongly raised margins. One row of depressions with pores at the bottom is located along the margins; these are separated by rebra which radially proceed up to the base of the raised, broad, saccate, avicularian chamber, which has a granulated surface. A comparatively large, oval avicularium with a semi-circular mandible is located at the top of the avicularian chamber. The mandible is pointed toward the orifice but is easily visible from the surface. A similar adventitious avicularium, which adjoins the ovicell of the underlying, neighboring zooid, may often be seen on one or the other side of the frontal surface of the zooids carrying ovicells. The primary orifice, located near the distal margin, has a semi-circular form, and its height is greater than its width; its proximal margin is slightly raised, and only in one instance was a somewhat broad denticle with a straight margin observed by me in the middle of the proximal margin. The ovicells are hyperstomial, large, round, and convex, with an incompletely calcified outer layer with pores arranged along the margin and in the middle of the calcareous, frontal surface of the inner layer. There are 4 pore plates with a few pores in the lateral wall of the zooid, and 2 in the distal septum.

The species lives on shells, calcareous Bryozoa, and stones, at a depth of 9 to 112 m, on a bed of stone and silt with sand.

Distribution. The species was found by me in the Barents and Chukotsk seas, near Disko Island (western Greenland), and in the Gulf of St. Lawrence. *Reports in literature:* Barents Sea (Smitt, 1868b; Bidenkap, 1900a; Kluge in Deryugin, 1915; Nordgaard, 1918), Gulf of Man along the eastern coast of North America (Verrill, 1875).

This is a rarely found Arctic species, closely related to the boreal *U. verrucosa*.

3. **Umbonula arctica** (M. Sars, 1851) (Figure 317)

Lepralia arctica M. Sars, 1851 : 149; *Discopora pavonella* Smitt, 1868b : 28, 178, t. 27, f. 181; *Mucronella pavonella* Hincks, 1880a : 376, pl. 39, f. 8-10; *Umbonula pavonella* Harmer, 1903 : 296, pl. 15, f. 10.

The zoaria, sometimes prostrate and overgrowing the substrate in the form of a thick crust, sometimes free-growing in the form of bent lobes, consist of zooids arranged in regular, straight and oblique rows. The zooids are medium in size (length 0.78 mm, width 0.55 mm), rhombic-hexagonal in shape, broader in the distal half and narrow in the proximal, tall, and thin-walled. The frontal surface, mildly convex, granular, and gradually rising toward the middle of the proximal margin of the orifice, has a raised margin along which are located deep depressions with pores at the bottom. Short and predominantly transverse rebra originate between these depressions. The primary orifice, located at the distal margin of the zoid, is large (height 0.33 mm, width 0.28 mm), and round or slightly oval; there is a small, pointed denticle in the middle of the proximal margin. There is one oval avicularium on each side of the orifice whose semi-circular mandible points upward by its free tip. As of this writing, ovicells have not been reported. There are 2 pore plates with 5 to 6 pores each in the lateral wall of the zooid, and 2 large ones with many marginally arranged pores in the distal septum.

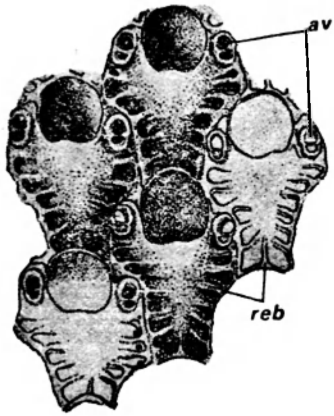


Figure 317. *Umbonula arctica* (M. Sars). Part of a zoarium. Kara Sea.

The species lives on hydroids, Bryozoa, tubes of worms, shells, and stones, at a depth from 1.5 to 345 m, more often from 20 to 75 m, on a bed of shells, stone, and silt, under temperatures ranging from −1.9 to 3°C, in a salt concentration of 29.96 to 34.83‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas. *Reports in literature:* Barents Sea (M. Sars, 1851; Smitt, 1868b, 1879a, 1879b; Nordgaard, 1896, 1912a, 1918, 1923; Bidenkap, 1897, 1900a, 1900b; Kluge, 1906; Kluge in Deryugin, 1915; Kuznetsov, 1941), White Sea (Kluge, 1907, 1908a; Kluge in Deryugin, 1928; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Levinsen, 1887; Nordgaard, 1912b; Kluge, 1929), Laptev, East Siberian, and Chukotsk seas (Kluge, 1929), western Greenland (Hincks, 1877a; Norman, 1906; Kluge, 1908b; Levinsen, 1914), eastern Greenland (Levinsen, 1916), along the eastern coast of North America from Cape Cod to the Gulf of St. Lawrence (Verrill, 1879b; Osburn, 1912, 1933; Whiteaves, 1901), Iceland (Nordgaard, 1924), Yan-Maien Island (Lorenz, 1886), northern Norway (Nordgaard, 1912a, 1918), German Sea (Kirchenpauer, 1875; Borg, 1930a), along the western coast of North America in the region of the Queen Charlotte and Vancouver islands (Robertson, 1908; O'Donoghue, 1923, 1926), and the northern part of the Sea of Japan (Androsova, 1958).

This is an Arctic-boreal, circumpolar species.

4. **Umbonula inarmata** Kluge sp. n. (Figure 318)

The zoarium, prostrate and overgrowing, consists of zooids arranged in regular, oblique rows. The zooids are small (length 0.50 to 0.63 mm,

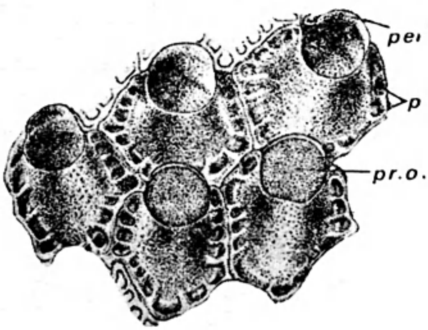


Figure 318. *Umbonula inarmata* Kluge sp. n. Part of a zoarium. Laptev Sea.

width 0.60 mm), short, broad, and hexagonal in shape. The frontal surface is raised, uniformly rising toward the orifice, continuous, and granular; it has strongly raised, thin margins along which are located deep depressions with pores at the bottom; these depressions are separated by short rebra which are transverse in relation to the margin. The distal margin of the zooid has a large, roundish orifice, which occupies almost half of the frontal surface. The peristome and secondary orifice are absent. Avicularia are not found. The lateral wall and the distal septum have 2 pore plates each with a few pores. Ovicells are not known to occur.

The species was found on a tube of *Polychaeta* at a depth of 20 m.

Distribution. This species was found by me in the Laptev Sea near the Nordenshelda Islands.

The species is of Arctic origin and endemic, as of this writing, to the Laptev Sea.

III. Family **Schizoporellidae** Jullien, 1903

Myriozoidae (part.) Smitt, 1868b : 9; Hincks, 1880a : 236, *Escharidae* (part.) Hincks, 1880a : 295; *Escharellidae* (part.) Levinsen, 1909 : 314; Osburn, 1933 : 38, Borg, 1933a : 531; *Stomachetosellidae* Canu and Bassler, 1917 : 44.

The zoaria are prostrate and rarely, free-growing (in our waters, exclusively prostrate). The primary orifice has a sinus at the proximal margin, which is expressed to a different degree—from narrow, straight, and pointed or rounded, to broad and more or less concave; the proximal margin never has a lyrule, being either continuously straight or mildly raised. Therefore, even the chitinized operculum is not semi-circular with a straight, proximal margin; it either has a mildly raised, proximal margin, or a broad or narrow protuberance at the proximal margin. The spines are either present or absent. In most instances, the frontal surface is laden with pores. The avicularia may or may not be present, but if present, they are often lateral. In most cases, the lateral and distal walls have pore plates, and pore chambers are present in many. The ovicells are usually hyperstomial, but in some instances, endozooecial; in the hyperstomial ones, the outer layer is often membranous and calcareous, and the inner layer has pores at the surface.

Key for Identification of the Genera in the Family Schizoporellidae

1 (2). Primary orifice has a narrow, straight, and pointed or rounded sinus at the proximal margin. Condyles present. Avicularia, when present, situated at the margins of the orifice or in the middle of the proximal margin...1. *Schizoporella* Hincks (see below).

2 (1). Primary orifice has a broad, concave sinus at the proximal margin. Condyles present. Avicularia, when present, situated in the middle of the proximal margin of the orifice, or slightly below it.........................2. *Hippodiplosia* Canu (see p. 598).

1. Genus **Schizoporella** Hincks, 1877

Schizoporella Hincks, 1877b : 527; 1880a : 237; *Lepralia* (part.) Johnston, 1838 : 277; 1847: 300; *Escharella* subgenus *Herentia* (part.) Smitt, 1868b: 12; (*Schizoporella*+*Schizomavella* +*Stephanosella*) Canu and Bassler, 1917 : 40; 1920 : 338, 343, 353.

The zoaria, prostrate and overgrowing, consist of zooids characterized by one feature common to all the species—the presence of a relatively small sinus in the middle of the proximal margin of the primary orifice. This sinus varies in shape: it may be rounded or in the form of a pointed incision, or often, in the form of a narrow, straight slit. The operculum is chitinized. Spines may be present. In most cases, the frontal surface is covered with pores. The avicularia are present or absent. If present, they are located at the margins of the orifice, or at the medial line of the zooid directly near the proximal margin of the orifice, or even below it. In most species, the lateral wall and the distal septum have uni- or multi-porous plates. The ovicells are hyperstomial or endozooecial; in the hyperstomial ones the outer layer is membranous and the surface of the calcareous, inner layer is usually covered with pores.

Genus type: *Lepralia unicornis* Johnston, 1847.

1 (24). Avicularia present.

2 (11). Avicularia arranged on both sides of the orifice, but sometimes they drop out from one or the other side.

3 (6). Avicularia have pointed mandibles.

4 (5). Mandibles of avicularia point toward the distal and lateral sides. Sinus at the proximal margin of the primary orifice in the form of a small, pointed incision...1. *Sch. unicornis* (Johnston).

5 (4). Mandibles of avicularia point to the proximal and lateral

sides. Sinus at the proximal margin of the orifice straight and narrow.............................7. *Sch. alderi* (Busk).

6 (3). Avicularia have a semi-circular mandible.

7 (8). Sinus in the middle of the proximal margin of the orifice rounded.......................2. *Sch. biaperta* (Michelin).

8 (7). Sinus in the middle of the proximal margin in the form of a short and narrow slit.

9 (10). Frontal surface alveolate with pores at the bottom of the alveoli............................3. *Sch. crustacea* (Smitt).

10 (9). Frontal wall appears to consist of double rebra; in the middle of it is located a marginal orifice with a groove originating from it..............................4. *Sch. costata* Kluge.

11 (2). Avicularia located at the medial line of the zooid or a little away from it, but at (or below) the proximal margin of the zooidal orifice.

12 (19). Avicularia located directly near the proximal margin of the orifice.

13 (14). Avicularium enclosed from the sides by the lobes of the peristome, which are particularly well-developed in the zooids carrying ovicells...................10. *Sch. ortmanni* Kluge.

14 (13). Avicularium not enclosed on the sides by the lobes of the peristome.

15 (16). Avicularium located in the plane of the orifice of the zooid. Frontal surface uniformly covered with pores and has no rebral formations........................9. *Sch. porifera* (Smitt).

16 (15). Avicularium lies suspended, or at an angle, to the plane of the orifice. Pores arranged along the margin of the zooid, and sometimes on the surface. Surface has more or less rebral formations.

17 (18). Avicularium lies suspended or almost suspended to the plane of the orifice. Zooids small. Frontal surface tubular or grumous........................8. *Sch. auriculata* (Hassall).

18 (17). Avicularium lies at an angle to the plane of the orifice. Zooids larger. Frontal surface has a more raised margin and larger, marginal pores, which are separated by short septa..........
................8a. *Sch. auriculata* var. *lineata* (Nordgaard).

19 (12). Avicularium located below the proximal margin of the orifice.

20 (21). Large avicularium with a long, pointed mandible, located at the middle line; mandible points in different directions; the large avicularian chamber under it reaches up to the margin of one or the other side. Two spines are usually present, but sometimes they are absent...5. *Sch. bispinosa* Nordgaard.

21 (20). Small, oval avicularium, with a sharp mandible, located

slightly away from the middle line; mandible directed to different sides; avicularian chamber smaller and placed at a lower position. Sometimes no avicularia appear throughout the zoaria. Spines present.

22 (23). Ovicells have a smooth surface and no umbilicus.. 6. *Sch. elmwoodiae* Waters.

23 (22). Ovicells have an umbilicus at the surface... 6a. *Sch. elmwoodiae* var. *mamillata* Kluge.

24 (1). Avicularia absent.

25 (26). Zoarium branched; branches single-rowed, and dichotomously divided.......................... 18. *Sch. thompsoni* Kluge.

26 (25). Zoarium continuous, consists of many zooidal rows.

27 (28). Pore plates arranged along the margins of the basal wall of the zooid. Zooids large, and their surface covered with numerous pores. Orifice transversely oval; its width twice larger than its height................. 17. *Sch. smitti* Kluge.

28 (27). Lateral and distal walls have uni- and multi-porous plates. Orifice semi-circular or circular.

29 (30). Primary orifice circular with a rounded sinus in the middle of the proximal margin. Secondary orifice circular. Frontal surface has a raised margin along which are located a few pores......................... 16. *Sch. hexagona* Nordgaard.

30 (29). Primary orifice semi-circular with a narrow or broader sinus. Secondary orifice roundish with a sharp incision, has no incision at the proximal margin. Zooids thick-walled or thin-walled.

31 (36). Zooids thick-walled. Surface has large or smaller pores. Primary orifice has a rounded sinus or one in the form of a pointed incision.

32 (33). Zooids have smaller pores at the surface. Primary orifice has a sinus in the form of a sharp incision.. 13. *Sch. incerta* Kluge.

33 (32). Zooids have large pores at the surface. Primary orifice has a rounded sinus.

34 (35). Ovicells have a large, round orifice in the middle of the surface......................... 11. *Sch. magniporata* Nordgaard.

35 (34). Ovicells have no orifice at the surface.. 12. *Sch. pachystega* Kluge.

36 (31). Zooids thin-walled. Surface with or without minute pores. Primary orifice has a rounded sinus.

37 (38). Primary orifice has a narrow, semi-circular sinus in the middle of the straight, proximal margin, which becomes deeper due to the presence of broad, rectangular condyles, which approach

its margins..........................14. *Sch. limbata* Lorenz.

38 (37). Primary orifice has a shallow and broader sinus, which becomes broader due to the presence of condyles with blunt corners.

39 (40). Frontal surface of the zooid bordered with a raised margin, along which are located large depressions with pores at the bottom. Ovicells have no orifice at the surface...15. *Sch. stylifera* (Levinsen).

40 (39). Frontal surface covered with small pores. Ovicells often have a round orifice in the middle of the surface.................................15a. *Sch. stylifera* var. *perforata* Kluge.

*1. **Schizoporella unicornis** (Johnston, 1847) (Figure 319)

Schizoporella unicornis Hincks, 1880a : 238, pl. 35, f. 1-5; Nordgaard, 1905 : 165, pl. V, f. 23-25, 27; 1918 : 56; ? Levinsen, 1916 : 452, pl. XXIII, f. 12-13; ? Osburn, 1932 : 13; Marcus, 1940 : 237 (part.), f. 121.

The zoarium, prostrate and reddish in a living state, consists of zooids arranged in regular, oblique rows. The zooids are medium in size (length 0.58 to 0.68 mm, width 0.45 to 0.58 mm), a broad, rhombic-hexagonal or rectangular shape, and separated by a deep, straight margin. The frontal surface is mildly raised, granulated, and entirely covered with minute pores; often a small, round, calcareous tubercle is located proximal to the orifice. The primary orifice, located near the distal margin, is semi-circular; it has a straight, proximal margin, in the middle of which is located a small, pointed incision; along its margins are located the broad, straight condyles, which slope toward the sinus and cause it to increase in size and become clearly triangular with its sharp tip pointing in the proximal direction. The avicularia are situated on one or both sides of the orifice; their rostrum is raised and the raised tops of the triangular, sharp mandibles are directed forward and to one side. In addition to the above-mentioned avicularium, similar avicularia of slightly larger size, are found at the margins of the frontal surface. The ovicells are

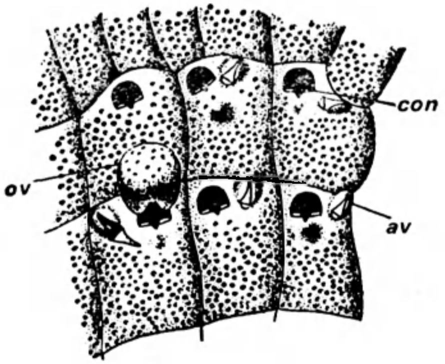


Figure 319. *Schizoporella unicornis* (Johnston). Part of a zoarium. Mediterranean Sea.

hyperstomial, comparatively small, round, and raised; they have a finely granulated surface, which is covered with small pores. Identical uniporous chambers are located along the entire margin.

The species lives on algae, tubes of worms, shells, and stones, at a depth from the belt of ebb and flow up to 300 m.

Distribution. Reports in literature: Waters off western Norway from Lofoten Islands to Bergen (Nordgaard, 1905, 1918), Shetland (Norman, 1869) and British Islands (Hincks, 1880a), western coast of France (Fischer, 1870), Mediterranean Sea (Waters, 1895; Calvet, 1902), Cape Zeleny (Waters, 1918), along the eastern coast of North America from Cape Cod to Florida (Osburn, 1912, 1914), Pacific Ocean and the Chinese Sea (Kirkpatrick, 1890), and the Sea of Japan (Okada, 1929; Androsova, 1958).

This is an amphiboreal species.

2. **Schizoporella biaperta** (Michelin, 1841-42) (Figure 320)

Lepralia biaperta Busk, 1859 : 47, pl. 7, f. 5; *Escharella linearis* forma *biaperta* Smitt, 1868b : 14, pl. 24, f. 70, 73; *Schizoporella biaperta* Hincks, 1880a : 255, pl. 40, f. 7-9; *Stephanosella biaperta* Osburn, 1933 : 39, pl. 15, f. 5-6.

The zoarium, in the form of a thin crust with a smooth, shiny surface, consists of zooids arranged in regular, oblique rows. The zooids are small (length 0.65 mm, width 0.50 mm), hexagonal or oval, and broader in the distal half. The frontal surface is weakly raised, translucent, and granular; in a young stage, it is covered with small pores, but later, after further calcification, it becomes thicker and the pores less noticeable. The primary orifice, located at the distal margin of the zooid, is semi-circular with a straight, proximal margin; a semi-circular sinus is located in the middle of this margin. An oval avicularium with a semi-circular mandible is located sometimes on one side, sometimes on the other, at the level of the sinus. Rarely, the frontal surface has a larger avicularium with a sharp mandible. The ovicells are hyperstomial, round, and raised; they have an incomplete outer layer which is strongly calcified, and forms a slit at the frontal surface

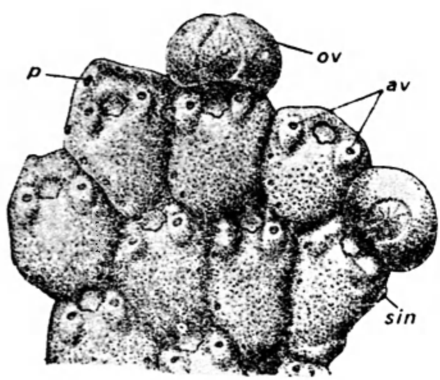


Figure 320. *Schizoporella biaperta* (Michelin). Part of a zoarium Barents Sea.

that is sometimes semi-circular, sometimes narrow and oblong; the smooth surface of the inner layer, situated under the membrane, has a weakly expressed radial striation at the margins.

This species lives on hydroids, calcareous algae, shells of lamellibranched mollusks, and stones, at a depth of 20 to 160 m, more often from 75 to 100 m, on a bed of stone, shells, and silt, under temperatures varying from −1.3 to 3°C, in a salt concentration of 32.38‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, Chukotsk, and Okhotsk seas. *Reports in literature:* Barents Sea (Smitt, 1868b; Bidenkap, 1900a), White Sea (Gostilovskaya, 1957), Kara Sea (Smitt, 1879a), Archipelago of the Canadian Islands (Nordgaard, 1906a), western Greenland (Smitt, 1868c; Norman, 1906; Kluge, 1908b; Levinsen, 1914), Gulf of St. Lawrence (Whiteaves, 1901), Woods Hole and Desert Island on the eastern coast of North America (Osburn, 1912, 1933), Yan-Maien Island (Lorenz, 1886), Sea of Japan (Androsova, 1958), along the western coast of North America from Alaska to California (Hincks, 1883; Robertson, 1900, 1908).

3. **Schizoporella crustacea** (Smitt, 1868) (Figure 321)

Myriozoum crustaceum Smitt, 1868b : 18, 114, t. 25, f. 88-91; Robertson, 1908 : 295, pl. 21, f. 54; *Schizoporella crustacea* Lorenz, 1886 : 87 (5), t. 7, f. 2; Waters, 1900 : 64, pl. 8, f. 11-13.

The zoarium is prostrate and usually consists of one layer of zooids arranged in regular, oblique rows. In older zoaria, slightly overgrowing layers can be found. The zooids are small (length 0.60 mm, width 0.50 mm), short, hexagonal or rectangular, and not clearly separated from each other; usually, the transverse rows do not adjoin by their lateral walls, and are separated by the proximal part of the zooids of the overlying, transverse row. The frontal surface is mildly raised and largely alveolate in the young zoaria; there are small pores at the bottom of the alveoli; in the older and strongly calcified zoaria, the surface is smooth with visible or open pores. The primary orifice, located near the distal end of the zooid, is semi-circular; it has a

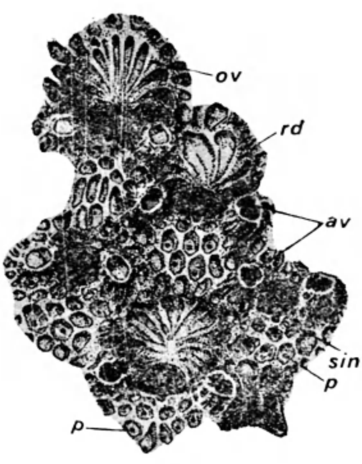


Figure 321. *Schizoporella crustacea* (Smitt). Part of a zoarium. Kara Sea.

straight, proximal margin in the center of which is located a straight and narrow sinus. Compared to the proximal margin, the distal one of the orifice is usually lower. The primary orifice is placed deeper in the more calcified zooids, and it has a thick frontal surface. One avicularium is located on each side of the orifice, which has a semi-circular mandible whose free margin is raised and pointed toward the proximal and lateral sides. The ovicells are hyperstomial, round, and convex; in the less calcified zooids, their surface is covered with radially divergent rebra stretched toward the margin. These rebra originate from the walls of the alveoli of the frontal surface of the neighboring zooids; in the more calcified zooids they are covered with an entire layer at the level of the frontal surface of the neighboring zooids, but because they are visible, the ovicells appear endozooecial. There are many (more than 20) uniporous chambers along the entire basal margin.

The species lives on *Alcyonidium,* ascidia, shells, and stones, at a depth of 1.5 to 406 m, more often from 50 to 150 m, on a bed of silt, shells, and stones, under temperatures ranging from −1.9 to 6.3°C, in the White Sea up to 10°C, in a salt concentration of 31.15 to 34.83‰, in the White Sea up to 28.22‰.

Distribution. This species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and in the waters off western Greenland and the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Ridley, 1881; Nordgaard, 1896, 1900, 1912a, 1918; Bidenkap, 1897, 1900a; Waters, 1900; Andersson, 1902; Norman, 1903a; Kluge in Deryugin, 1915), White Sea (Kluge in Deryugin, 1928; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Levinsen, 1887; Nordgaard, 1912b; Kluge, 1929), Laptev Sea (Kluge, 1929), East Siberian Sea (Kluge, 1929; Nordgaard, 1929), Chukotsk Sea (Kluge, 1929), Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1923), Labrador (Osburn, 1913), western Greenland (Norman, 1906; Kluge, 1908b; Levinsen, 1914; Osburn, 1919), Gulf of St. Lawrence (Hincks, 1892; Dawson, 1894; Whiteaves, 1901), eastern Greenland (Levinsen, 1916), Yan-Maien Island (Lorenz, 1886), Iceland (Nordgaard, 1924), and northern Norway (Smitt, 1868b; Nordgaard, 1918).

This is an Arctic, circumpolar species.

4. **Schizoporella costata** Kluge sp. n. (Figure 322)

Myriozoum crustaceum Smitt, 1868b : 18, 114 (part.).

The zoarium is prostrate and overgrows the substrate in the form of a thin, yellowish colored layer consisting of zooids arranged in short, regular, oblique rows. The zooids are small (length 0.53 mm, width

0.43 mm) and rhombic or oval in shape. The frontal surface is slightly raised with a clearly visible, mildly depressed margin; relatively large orifices are located along this margin, from which grooves arise toward the center and gradually narrow. Depressions are stretched toward the center of the surface between the orifices, and every 2 neighboring depressions form rebral structures on the surface, giving it the appearance of consisting of 2 rows of rebra arising at each lateral side in a transverse direction, and almost joining at the center of the surface. From this description it follows that the rebra do not constitute the interstices between the orifices, as might appear at first glance, but rather the orifices are located within the rebra which were initially, therefore, tubular structures originating from the margin of the zooid. In other words, these structures were initially hollow spines which, surrounding the zooidal aperture at the margins, after bending toward the cavity of the zooid and fusing with each other, gave rise to a rebral, frontal surface. This may serve as an example of one of the means by which the entire calcareous, frontal surface is formed in *Ascophora*. The primary orifice, located near the distal margin of the zooid, is semi-circular; it has a straight, proximal margin with a narrow sinus located in the center. The distal margin of the orifice is lower in relation to the proximal one. Below the orifice, usually on one side rarely on both, a small, oval avicularium is located which has a semi-circular mandible whose raised, free margin points toward the proximal side and the medial line. The ovicells are hyperstomial, round, slightly raised, and covered with barely noticeable and radially divergent rebra. A large number (above 20) of uniporous chambers are located along the basal margin.

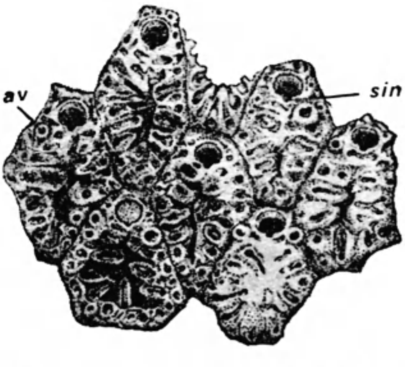


Figure 322. *Schizoporella costata* Kluge sp. n. Part of a zoarium.

The species lives on stones and shells, at a depth of 10 to 80 m, on a bed of stones.

Distribution. The species was found by me in the Barents Sea, in Isfjorden at Spitsbergen. *Reports in literature:* Tatarsky Proliv (Androsova, 1958).

5. **Schizoporella bispinosa** Nordgaard, 1906 (Figure 323)

Schizoporella bispinosa Nordgaard, 1906a : 17, pl. II, f. 15; *Escharina vulgaris* Levinsen, 1916 : 454, pl. XXIII, f. 8-11.

The zoarium, prostrate in the form of a white crust, consists of zooids arranged in more or less regular, oblique rows. The zooids are small (length 0.63 mm, width 0.55 mm), rhombic-hexagonal or oval in shape, and broad. The frontal surface is convex and granulated, and bordered by a thin and slightly raised margin; small depressions with pores at the bottom are located along this margin; the surface is covered with a few smaller pores. Sometimes a calcareous protuberance (knob) is formed at the frontal surface under the orifice, which tapers toward the upper end. The primary orifice (height 0.13 mm, width 0.18 mm), located near the distal margin of the zooid, is semi-circular; its width is greater than its height, and it has a straight, proximal margin; a straight and narrow sinus is located in the middle of this proximal margin, and there are usually 2 spines, rarely 3 or 4, situated in the distal margin in the majority of the zooids. There are 9 spines around the aperture of the primary zooid or ancestrula, and the aperture occupies almost the entire frontal surface; the daughter zooids arising from this have 4 or 5 spines, and the zooids of later generations usually have 2 each. The avicularium with its sharp mandible is located proximal to the orifice, almost at the medial line, and bent at an angle of 45° toward the surface. A long, oval avicularian chamber, which starts from the avicularium either perpendicular to the length of the zooid or, more often, in an oblique direction, up to the margin of the zooid at one or the other side, gradually lowers toward the margin. The ovicells are hyperstomial, round, raised, coarsely granulated, and surrounded by a row of pores at the base, between which rebra form that surround the ovicell from the sides. There are 2 large pore chambers along the basal margin of the lateral wall, and 3 along the distal margin.

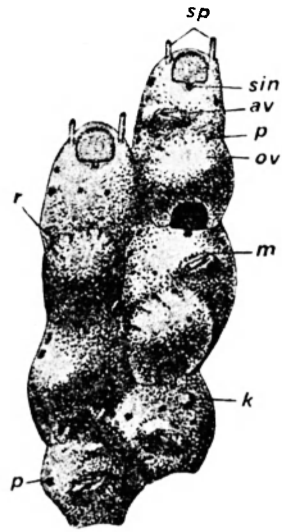


Figure 323. *Schizoporella bispinosa* Nordgaard. Part of a zoarium with knob, and without it, on the frontal wall of the zooids.

The species lives on laminaria and calcareous Bryozoa at a depth of 9 to 30 m.

Distribution. This species was found by me in the Barents and Kara seas. *Reports in literature:* The Archipelago of the Canadian Islands (Nordgaard, 1906a).

This is an Arctic, Atlantic species.

6. **Schizoporella elmwoodiae** Waters, 1900 (Figure 324)

Schizoporella elmwoodiae Waters, 1900 : 66, pl. 9, f. 1, 13; *Sch. stormi* Nordgaard, 1905 : 166, pl. 5, f. 1-2; *Mollia vulgaris* forma *ansata* Smitt, 1868b : 15 (part.), t. 25, t. 80.

The zoarium, prostrate in the form of a thin, white crust, consists of zooids arranged either in short, oblique rows, or irregularly. The zooids are small (length 0.68 mm, width 0.55 mm), rhombic-hexagonal or oval in shape, and more or less oblong. The frontal surface is raised and granulated; it has a mildly noticeable raised margin along which one row of pores is located, and a few pores are spread over the surface. The primary orifice (height 0.10 mm, width 0.13 mm), located near (rarely at) the distal margin of the zooid, is semi-circular; its width is very slightly greater than its height; it has a straight, proximal margin in the middle of which there is a straight, not-so-wide, and short sinus; spines are absent from the distal margin. An oval avicularium with an apically raised and pointed mandible lies proximal to the orifice, slightly to one side of the medial line, the oval avicularian chamber is usually small and located either perpendicular to the length of the zooid, or in an oblique direction. The ovicells are hyperstomial, large, and round, and barely separated from the frontal wall of the overlying zooid. There are 2 large pore chambers along the basal margin of the lateral wall, and 3 smaller ones along the distal septum.

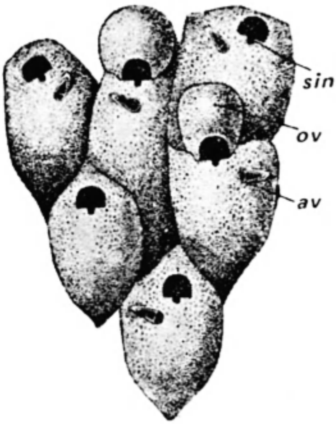


Figure 324. *Schizoporella elmwoodiae* Waters. Part of a zoarium. Barents Sea.

The species lives on shells and stones, at a depth from 11 to 450 m, more often from 30 to 160 m, on a bed of stone, silt, and shells, under temperatures ranging from −1.9 to 3.7°C, in a salt concentration from 34 to 35‰.

Distribution. The species was found by me in the Barents and Kara seas, and on the eastern coast of Greenland. *Reports in literature:* Barents Sea (Smitt, 1868b; Bidenkap, 1900a; Waters, 1900; Nordgaard, 1905; Kluge in Deryugin, 1915), White Sea (Gostilovskaya, 1957), Kara Sea (Nordgaard, 1912b), Archipelago of the Canadian Islands (Verrill, 1879a, 1879b; Nordgaard, 1906a), western Greenland (Norman, 1876, 1906; Kluge, 1908b), and eastern Greenland (Levinsen, 1914, 1916).

This species is very close to *Sch. bispinosa,* but differs from it by the absence of spines at the distal margin of the orifice, a smaller and narrower orifice, a smaller avicularian chamber, and finally, by being distributed at greater depths.

This is an Arctic species.

6a. **Schizoporella elmwoodiae** var. **mamillata** Kluge var. n. (Figure 325)

Mollia vulgaris forma *papillata* Smitt, 1868b : 15, 106; non *Lepralia papillata* Busk, 1859 : 52, pl. V, f. 5.

The zoarium, prostrate in the form of a crust, consists of zooids arranged in irregular rows. The zooids are small and irregularly hexagonal or oval in shape. The frontal surface is more or less convex, smooth, and covered with small pores. The primary orifice, located near the distal margin of the zooid, is semi-circular; it has a straight, proximal margin which has a narrow, straight sinus located at its center. The avicularium with its sharp mandible, whose apex points downward and to one side, is located at the frontal surface below the orifice on one or the other side. The ovicells are hyperstomial, large, round, and raised; there is a round papilla in the middle of the smooth, frontal surface.

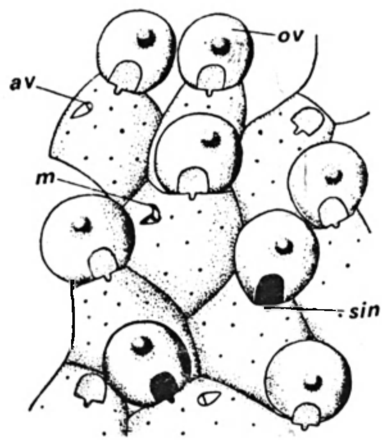


Figure 325. *Schizoporella elmwoodiae* var. *mamillata* Kluge var. n. Part of a zoarium with ovicells typical to this form.

The species lives on shells; the depth is not known.

Distribution. Reports in literature: Barents Sea, Isfjorden at Spitsbergen (Smitt, 1868b).

According to the structure of the zooids and their orifices, this form is closest to *Sch. elmwoodiae* Waters.

7. **Schizoporella alderi** (Busk, 1856) (Figure 326)

Alysidota alderi Busk, 1856a : 311, pl. IX, f. 6-7; *Mollia vulgaris* forma *ansata* and *Hippothoa* forma Smitt, 1868b : 15 (part.), t. 25, f. 81; *Schizoporella alderi* Hincks, 1880a : 243, pl. 36, f. 9-10.

The zoarium, prostrate and ramose, consists of zooids arranged in one row. The branching is often dichotomous. The branches are frequently short and originate from the distal margin of the zooid. The zooids are medium in size (length 0.78 mm, width 0.58 mm) and oval in shape. The frontal surface is mildly raised, finely granulated, shiny, and sometimes covered with a few very small pores; often a round knob is located under the orifice. The primary orifice, located near the distal margin of the zooid, is semi-circular with a straight, proximal margin; a straight, short, and narrow sinus is located in the middle of this margin. Oval avicularia are often found to occur proximal to the orifice, either on one or both sides; the free end of their sharply pointed mandible points downward and to one side. The ovicells are hyperstomial, round, and raised; they have a smooth surface which often has a round knob in its center.

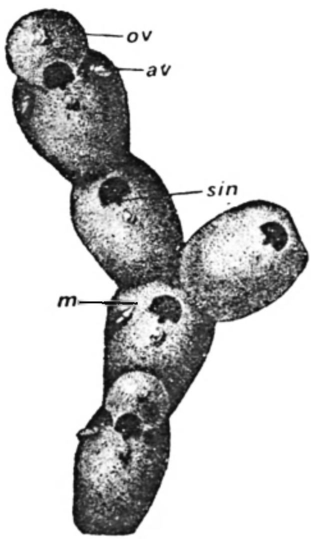


Figure 326. *Schizoporella alderi* (Busk). Part of a zoarium showing ramification.

The species lives on stones and shells, at a depth of 45 to 300 m, on a bed of stones.

Distribution. The species was found by me in the Barents Sea (northern Finmark). *Reports in literature:* Barents Sea (Smitt, 1868b; Nordgaard, 1896, 1918), waters off the western coast of Norway from Bergen up to Sverholt in Finmark (Norman, 1894; Nordgaard, 1918), Shetland Islands (Norman, 1869), and eastern Greenland (Levinsen, 1914).

This is an Arctic-boreal species.

*8. **Schizoporella auriculata** (Hassall, 1842) (Figure 327)

Lepralia auriculata Hassall, 1842 : 412; Hincks, 1880a : 260, pl. XXIX, f. 3-5; Osburn, 1912 : 237, pl. XXV, f. 50; Marcus, 1940 : 242, f. 1.

The zoarium prostrate and overgrowing, consists of zooids arranged in short and oblique rows. The zooids are small (length 0.38 to 0.45 mm, width 0.35 to 0.50 mm), short, broad, and rectangular in shape; the young have a raised margin along which, in addition to the surface, pores are located. The wall between the pores is not calcified uniformly, and as a result, the surface becomes tubular and the margins less noticeable. The wall is hyaline and transparent. A roundish, primary orifice, located near the distal margin of the zoid, has a small sinus in the middle of the proximal margin which becomes deeper due to the condyles located at its ends. A raised, conical, avicularian chamber is situated directly behind the sinus, and its avicularium, suspended or almost suspended to the orifice, has a semi-circular mandible. The ovicells are hyperstomial, round, and convex; their incompletely calcified outer layer, and the calcareous, frontal wall of the inner layer, are covered with pores. There are 6 simple pores on each of the lateral and distal walls arranged along the basal side.

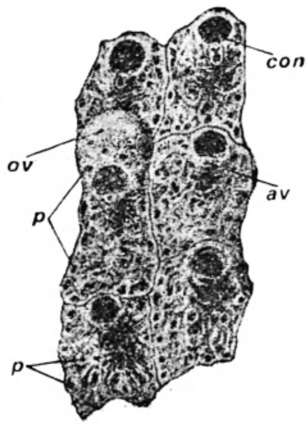


Figure 327. *Schizoporella auriculata* (Hassall). Part of a zoarium.

The species is found on algae, hydroids, shells, and stones, at a depth of 5 to a few hundred meters.

Distribution. Reports in literature: Coastal waters of the British Isles (Hincks, 1880a), around Woods Hole on the eastern coast of North America (Osburn, 1912), and the waters of California (Robertson, 1908). Because the present species varies a great deal, it is widely distributed and many authors have taken it to be almost universal; it is therefore difficult to delineate the approximate limits of the distribution of the individual forms.

The species is boreal.

8a. **Schizoporella auriculata** var. **lineata** (Nordgaard, 1896) (Figure 328)

Smittia lineata Nordgaard, 1896 : 27, pl. 1, f. 2; Norman, 1903b : 192, pl. IX, f. 15; *Schizoporella lineata* Nordgaard, 1905 : 167, pl. V, f. 33-34; *et auctt.*; *Escharella auriculata* Smitt, 1868b : 12, pl. 24, f. 8-9; *Schizoporella auriculata* Osburn, 1912 : 297, pl. XXV, f. 50-50a; *et auctt.*

The zoarium, prostrate like a crust, is usually round in shape and reddish-brown in color in a living state; it consists of zooids arranged in regular, straight rows, which diverge radially from the center. The zooids are small (length 0.50 to 0.63 mm, width 0.40 to 0.63 mm), usually rectangular, and gradually broaden toward the distal end, but sometimes they are oblong, and sometimes broad. The frontal surface is mildly raised, hyaline, transparent, and surrounded by a markedly raised margin, which has more or less large, deep depressions with pores at the bottom; short rebra start from the margin between these depressions.

The primary orifice, located near the distal margin of the zooid, is oval, with a broad, shallow, roundish sinus; small, mildly noticeable, triangular condyles are located at the corners of this sinus, making it slightly deeper and giving it a more definitive shape. A small, semi-circular, conical, avicularian chamber is located directly behind the sinus; a round avicularium is located at its top, which has a semi-circular mandible; the avicularium is strongly bent toward the orifice. The ovicells are hyperstomial, round, and raised; the slightly flat, frontal surface of the endooecium is laden with pores and completely surrounded by an incompletely calcified, outer layer. There are 6 to 8 uniporous plates in the lateral wall, and 6 in the distal septum.

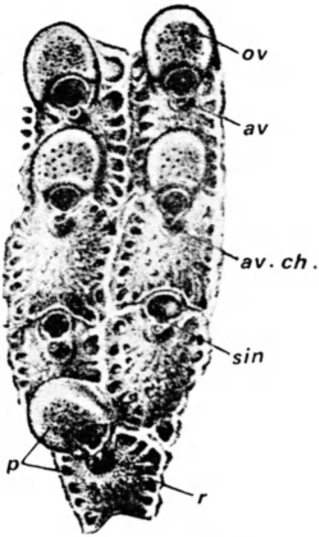


Figure 328. *Schizoporella auriculata* var. *lineata* (Nordgaard). Part of a zoarium. Barents Sea.

The species lives on algae, hydroids, shells, and stones, at a depth of 5.5 to 198 m, more often from 50 to 150 m, under temperatures ranging from 0.08 to 4°C, in a salt concentration from 34.0 to 34.5‰.

Distribution. This species was found by me in the Barents, Kara, Bering, and Okhotsk seas, and in the waters off Labrador and western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868b; Nordgaard, 1896, 1918; Bidenkap, 1900b; Norman, 1903b; Kluge, 1906; Kluge in Deryugin, 1915; Kuznetsov, 1941), White Sea (Kluge, 1907, 1908a; Kluge in Deryugin, 1928; Gostilovskaya, 1957), Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1923, 1932), Labrador (Packard, 1863, 1866-69), western Greenland (Smitt, 1868c; Norman, 1903b, 1906; Kluge, 1908b; Levinsen, 1914), Gulf of St. Lawrence (Whiteaves, 1901), Iceland (Smitt, 1868b), and northern Norway (Smitt, 1868b; Nordgaard, 1918).

This is an Arctic form.

9. **Schizoporella porifera** (Smitt, 1868) (Figure 329)

Escharella porifera forma *typica* Smitt, 1868b: 9, 70, pl. 24, f. 30-32; *Lepralia porifera* Hincks, 1877a : 102, pl. 10, f. 1-2; Waters, 1900 : 75, pl. 8, f. 14-15; non *Smittia landsborovii* forma *porifera* Hincks, 1888 : 225; non Osburn, 1912 : 245.

The zoarium, prostrate like a thin, pink crust, consists of zooids arranged in regular, oblique rows. The zooids are small (length 0.63 mm, width 0.38 mm), rhombic in shape, and separated by a deep margin. The frontal surface is raised and entirely covered with small pores. The primary orifice, located at the distal margin of the zooid, is round; it has a roundish, more or less broad sinus at the proximal margin, which has 2 sharply pointed condyles on its sides. A short and round avicularian chamber is located directly behind the sinus; the distal end of its avicularium is tilted toward the orifice. The ovicells are hyperstomial, round, and raised; they have an incompletely calcified outer layer and a smooth, calcareous surface on the inner layer; the middle is covered with a semi-circle of small pores. There are 6 pore plates with a few pores in the lateral wall, and 2 in the distal septum.

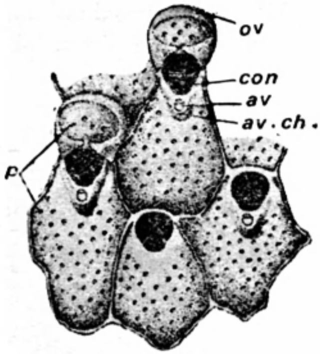


Figure 329. *Schizoporella porifera* (Smitt). Part of a zoarium.

The species lives on algae, acorn barnacles (*Balanus* sp.), shells, and stones, at a depth from 5 to 360 m, more often from 50 to 150 m, on a bed of stone, silt, and shells, under temperatures ranging from −1.9 to 6.3°C, in a salt concentration of 34.10 to 34.90‰.

Distribution. This species was found by me in the Barents, Kara, Laptev and Bering seas, and in Baffin Bay. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Nordgaard, 1896, 1918; Bidenkap, 1900b; Waters, 1900; Kluge, 1906; Kluge in Deryugin, 1915; Kuznetsov, 1941), White Sea (Smitt, 1879b; Kluge in Deryugin, 1928; Gostilovskaya, 1957), Archipelago of the Canadian Islands (Nordgaard, 1906a), ?Hudson Bay and Labrador (Osburn, 1913, 1932), western Greenland (Smitt, 1868c; Norman, 1876, 1903b, 1906; Hincks, 1877a; Vanhöffen, 1897; Kluge, 1908b; Levinsen, 1914; Osburn, 1936), eastern Greenland (Levinsen, 1916), Gulf of St. Lawrence (Hincks, 1892; Whiteaves, 1901; Norman, 1903), Iceland (Nordgaard, 1924), Yan-Maien Island (Lorenz, 1886), and northern Norway (Smitt, 1868b; Nordgaard, 1905, 1918).

This is an Arctic species.

*10. **Schizoporella ortmanni** Kluge, 1955 (Figure 330)

Schizoporella ortmanni Kluge, 1908b : 550; 1955a : 91, f. 35.

The zoarium, prostrate in the form of a white crust loosely overgrowing the substrate, consists of zooids arranged in oblique rows. The zooids are medium in size (length 0.68 mm, width 0.45 mm), and rhombic-hexagonal in shape. The raised frontal surface has a thin, raised margin whose entire surface is covered with pores, but with further calcification, this surface becomes alveolate with pores at the bottom of the alveoli. The primary orifice, located at the distal margin of the zooid, is roundish; its width is greater than its height. A semi-circular sinus is located in the middle of the proximal margin, and there are small, blunt condyles at the margins of the sinus. Directly behind the sinus is located a raised avicularian chamber, at the top of which one finds the round avicularium with its semi-circular mandible. The avicularium is markedly tilted in the direction of the orifice. Rarely, it happens that the avicularian chamber is round, almost conical; in most cases it is broad and asymmetrical, reaching up to the lateral margin with any single side, while the other half remains undeveloped. The peristome is not present in the zooids which have no ovicells, but as soon as the ovicell begins developing, the lateral lobes of the peristome develop simultaneously and, with the growth of the ovicell, become tall and enclose the avicularium; their distal ends are located at the ovicell and, rarely, by coming closer and fusing, they form a thin, transverse cylinder at the surface of the ovicell and enclose its proximal margin. The ovicells are hyperstomial, round, and raised, or mitriform; the outer layer is not completely calcified, and its frontal side is membranous; under it lies the calcified inner layer with pores arranged on the surface in a semi-circle. There are 4 pore plates with a few pores in the lateral wall of the zooid, and 2 uniporous plates in the distal septum.

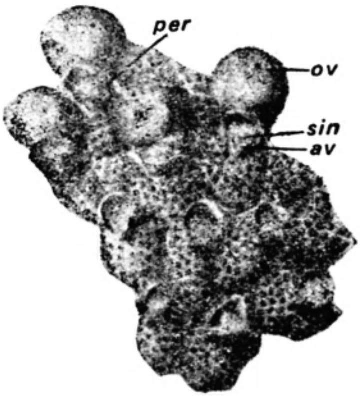


Figure 330. *Schizoporella ortmanni* Kluge. Part of a zoarium (from Kluge, 1955a).

The species lives on Bryozoa, more often on hydroids and shells, at a depth of 35 to 70 m.

Distribution. The species was found by me in the coastal waters of Labrador. *Reports in literature:* Baffin Bay (Kluge, 1908b).

This is an Arctic species.

11. **Schizoporella magniporata** Nordgaard, 1906 (Figure 331)

Schizoporella magniporata Nordgaard, 1906a: 21, pl. II, f. 25-27; *Sch. sinuosa* var. *magniporata* Nordgaard, 1918 : 56; *Sch. sinuosa* Levinsen, 1894 : 66, pl. V, f. 42-43; *Sch. perforata* Canu and Bassler, 1929 : 318, pl. 35, f. 9.

The zoarium, prostrate in the form of a thin crust, is yellow in a live state, red-brown when dried, and consists of zooids arranged in more or less regular, straight and oblique rows. The zooids are small (length 0.48 mm, width 0.33 mm) and oblong-rhombic-hexagonal in shape. The frontal surface is flat and translucent, and bordered by a raised margin, which has one row of large pores. The entire surface, except a broad strip adjoining the orifice, is covered with pores. The primary orifice, located near the distal margin of the zooid, is semi-circular with a straight, proximal margin that has a sinus in the middle; this sinus tapers and is rounded at the end, and the broad, straight condyles on its sides make it appear deeper. The secondary orifice consists of a distal half which is semi-circular, and a proximal half which is a more or less acute angle formed by the lateral lobes of the peristome, which narrow toward the middle of the proximal margin. The ovicells are hyperstomial, round, mildly raised in a young stage and lowering as age advances, coming to the level of the frontal surface of the overlying zooid. A large, round orifice is located in the middle of their frontal surface. The lateral wall of the zooid has 3 to 4 uniporous plates, and the distal septum has 2 large ones with many pores.

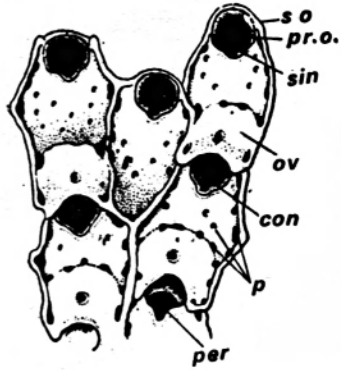


Figure 331. *Schizoporella magniporata* Nordgaard. Part of a zoarium.

The species lives on shells at a depth of 81 m.

Distribution. This species was found by me in the Barents Sea on the eastern coast of Murmansk. *Reports in literature:* Archipelago of the Canadian Islands (Nordgaard, 1906a), coastal waters of western Norway (Nordgaard, 1918), Denmark (Levinsen, 1894), Sangarsky Proliv (Canu and Bassler, 1929), and Tatarsky Proliv (Androsova, 1958).

This is an Arctic-boreal species.

12. **Schizoporella pachystega** Kluge, 1929 (Figure 332)

Schizoporella pachystega Kluge, 1929 : 18; *Escharella linearis* forma *secundaria* Smitt, 1868b : 14 (part.), pl. 25, f. 75.

The zoaria, prostrate in the form of a thick crust, consist of zooids arranged sometimes in longitudinal rows in a checkered pattern, and sometimes irregularly. The zooids are medium in size (length 0.83 mm, width 0.43 mm) and rectangular or irregular in shape. The frontal surface is mildly raised and bordered by a thin, straight, raised margin. The entire surface is more or less uniformly covered by depressions with pores at the bottom. Sometimes these depressions are larger along the margins and around the ovicells. The deeply placed primary orifice, located near the distal margin of the zooids, is semi-circular; it has a straight, proximal margin with a roundish sinus in the middle. The secondary orifice consists of 2 halves—the distal, semi-circular one, which belongs to the proximal margin of the daughter zooid, and the proximal half, which belongs to the given zooid and tapers toward the middle of the proximal margin, where it forms a thin, sharp slit, due to which the secondary orifice assumes a triangular shape. A transverse margin arises on each side from the juncture of the 2 halves; this margin borders both the adjoining zooids. The margins of the orifice are thick. Avicularia are not present. The ovicells are hyperstomial and roundish; they have a mildly raised, continuous surface which is devoid of orifices, and is surrounded by large, marginal pores.

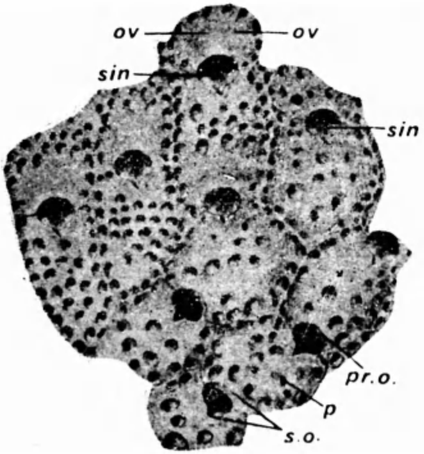


Figure 332. *Schizoporella pachystega* Kluge. Part of a zoarium. Kara Sea.

There are 6 uniporous chambers along the basal margin of the lateral wall, and 3 along the distal septum.

The species lives on shells and stones, at a depth of 11 to 325 m, more often from 30 to 150 m, on a bed of stone, shells, and silty sand, under temperatures ranging from −1.56 to 3.7°C, in a salt concentration of 34.63‰.

Distribution. This species was found by me in the Barents, Kara, and Chukotsk seas, and in the waters off western Greenland and in the Gulf of St. Lawrence.

This is an Arctic species.

13. **Schizoporella incerta** Kluge, 1929 (Figure 333)

Schizoporella incerta Kluge, 1929 : 17; 1946 : 202, t. IV, fig. 2.

The zoarium, prostrate in the form of a thin, white crust, consists of zooids arranged in regular, straight and oblique rows. The zooids are small (length 0.68 mm, width 0.38 mm), and oblong-rhombic-hexagonal, or irregular polygonal in shape. The frontal surface is raised and coarsely granulated; it has a barely raised, thin margin with sparse depressions which are sometimes larger, sometimes smaller, but always have pores at the bottom. The surface is covered with more or less uniform depressions with pores at the bottom. The primary orifice, located near the distal margin of the zooid, is semi-circular; its width is greater than its height. It has a straight, proximal margin with a sharp sinus in the middle. On further calcification and thickening in the frontal wall, a secondary orifice of transversely oval shape forms with a narrow, sharp sinus in the middle of the proximal margin; this orifice is surrounded on the sides by the thick lobes of the peristome. Spines and avicularia are absent. Ovicells are not known to occur. There are 6 simple pore plates in the lateral wall of the zooid, and 2 large plates with 3 to 4 pores each in the distal septum.

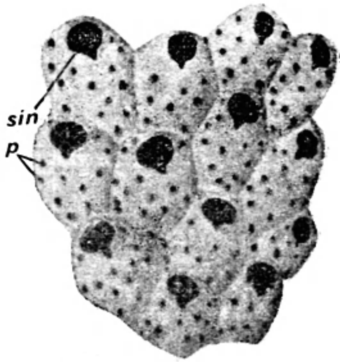


Figure 333. *Schizoporella incerta* Kluge. Part of a zoarium (from Kluge, 1946).

The species lives on stones and shells of mollusks, at a depth of 20 to 162 m, under temperatures ranging from —1.6 to 3°C, in a salt concentration of 34.27‰.

Distribution. The species was found by me in the Barents, Kara, and Laptev seas, and in the waters off western Greenland, and in the Gulf of St. Lawrence. *Reports in literature:* Tatarsky Proliv (Androsova, 1958).

This is an Arctic species.

14. **Schizoporella limbata** Lorenz, 1886 (Figure 334)

Schizoporella limbata Lorenz, 1886 : 88, pl. VII, f. 3; *Sch. levinseni* Nordgaard, 1905 : 166, pl. V, f. 3-4.

The zoarium, prostrate in the form of a thin, light pink crust, consists of zooids arranged in more or less regular, oblique rows. The zooids are small (length 0.62 mm, width 0.45 mm), and rhombic-hexagonal in shape. The frontal surface is mildly raised and bordered by a thin, even, raised margin which has a few pores; the surface itself is covered sometimes with denser, sometimes with fewer, small pores. The primary orifice, located near the distal margin of the zooid, is semi-circular; it has a straight, proximal margin with a shallow, round sinus in the middle. Broad, straight condyles at the corners of the sinus deepen it. Spines and avicularia are absent. The ovicells are hyperstomial; the outer layer consists of 3 parts joined by 3 sutures, which form parts of the frontal walls of the neighboring zooids. There are 6 pore plates with a few pores in the lateral wall, and 2 in the distal septum.

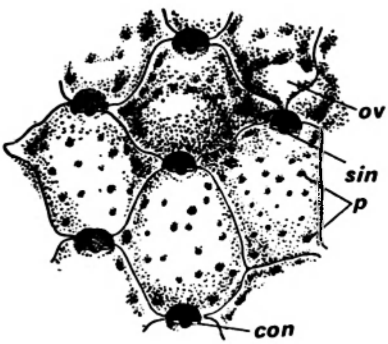


Figure 334. *Schizoporella limbata* Lorenz. Part of a zoarium. Waters off Yan-Maien Island.

The species lives on the shells of *Pecten*, and stones, at a depth of 20 to 315 m, more often from 75 to 150 m, on a bed of stone, silt, and shells, under temperatures ranging from —1.61 to 2.38°C.

Distribution. The species was found by me in the Barents, Kara, Bering, and Okhotsk seas, and in the waters off western Greenland, as well as in the Gulf of St. Lawrence. *Reports in literature:* Barents Sea (Smitt, 1868b; Kluge in Deryugin, 1915), White Sea (Gostilovskaya, 1957), Kara Sea (Nordgaard, 1912a), Laptev Sea (Kluge, 1929), Archipelago of the Canadian Islands (Nordgaard, 1906a), waters off Yan-Maien Island (Lorenz, 1886), and in northern Norway, Quenangen Fiord (Nordgaard, 1905).

This is an Arctic species.

15. **Schizoporella stylifera** (Levinsen, 1887) (Figure 335)

Escharella stylifera Levinsen, 1887 : 321, pl. 27, f. 8-10; *Schizoporella (Emballotheca) stylifera* Levinsen, 1916 : 453 (part.), pl. 23, f. 4-7; *Sch. condylata* Nordgaard, 1906a : 18, pl. II, f. 16-18.

The zoarium, prostrate in the form of a white crust, consists of zooids arranged in regular, straight and oblique rows. The zooids are medium in size (length 0.85 mm, width 0.60 mm) and rhombic in shape. The frontal surface is slightly raised and granulated; it has a strongly raised, thin margin around which large depressions with pores at the bottom are scattered in one row. The primary orifice, located near the distal margin of the zooid, is semi-circular; its width is greater than its height; it has a straight, proximal margin with a broad, shallow, and round sinus in the middle. Broad, triangular condyles, located along the margins of the sinus, deepen and broaden it. The operculum, markedly chitinized, has a thick margin and 2 dot-like thickenings for the attachment of the occlusor muscles. Spines and avicularia are absent. The ovicells are hyperstomial, round, and slightly raised; their outer layer consists of 3 parts, 2 lateral and 1 distal, joined by 3 sutures; these form parts of the frontal surfaces of the neighboring zooids. There are 4 to 6 pore plates in the lateral wall, and 2 larger plates with 1 to 4 pores each in the distal septum.

The species lives on shells and stones, at a depth of 42 to 252 m, on a bed of stone and silt, under temperatures ranging from −1.68 to 1.71°C, in a salt concentration of 34.18 to 34.83‰.

Distribution. This species was found by me in the Barents, Kara, Chukotsk, Bering, and Okhotsk seas, and in the waters off western Greenland, as well as in the Gulf of St. Lawrence. *Reports in literature:* Barents Sea (Smitt, 1868b), Kara Sea (Levinsen, 1887), Laptev Sea (Kluge, 1929), Archipelago of the Canadian Islands (Nordgaard, 1906a), western Greenland (Kluge, 1908b), and northeastern Greenland (Levinsen, 1914, 1916).

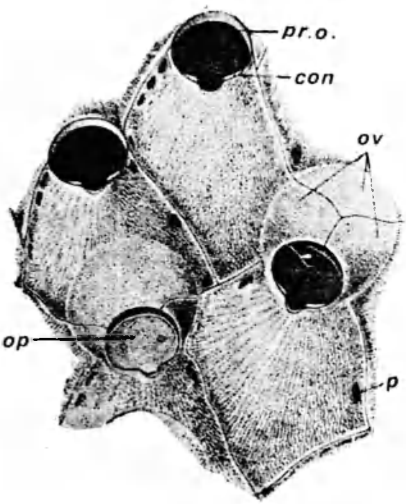


Figure 335. *Schizoporella stylifera* (Levinsen). Part of a zoarium. Laptev Sea.

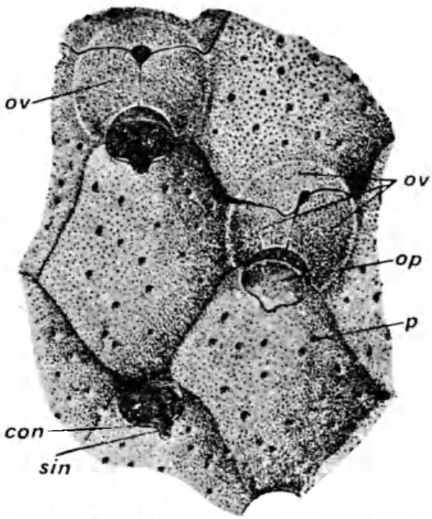


Figure 336. *Schizoporella stylifera* var. *perforata* Kluge. Zooids and ovicells (from Kluge, 1952).

This is an Arctic, circumpolar species.

15a. **Schizoporella stylifera** var. **perforata** Kluge, 1952 (Figure 336)

Schizoporella (*Emballotheca*) *stylifera* Levinsen, 1916 : 453 (part.), pl. 23, f. 3; *Sch. condylata* Nordgaard, 1906a : 18, pl. II, f. 16-18; *Sch. stylifera* var. *perforata* Kluge, 1952: 153, fig. 9; 1955a: 90, fig. 34; 1955b: 107, t. XXIII, fig. 9.

The zoaria, prostrate in the form of crustaceous overgrowths of lilac-tinged-red, consist of zooids arranged in more or less regular, oblique rows. The zooids are medium in size (length 0.63 mm, width 0.58 mm), irregular rhombic in shape, and sometimes strongly broadened in the middle. The frontal surface is mildly raised and finely granulated; there is a definite patterning on the margin, which is slightly deep, white, and uneven. A few small pores are scattered on the surface. The primary orifice, located near the distal margin of the zooid, is semi-circular; it has a slightly convex, proximal margin with a round, shallow sinus in the middle. The triangular and blunt condyles located along the margins of the sinus, make it seem deeper. The ovicells are hyperstomial, round, and mildly raised. Their outer, calcareous layer consists of 3 parts, 2 lateral and 1 distal, fused by 3 sutures; these form parts of the frontal walls of the neighboring zooids. Often a round orifice is located in the middle of the frontal surface at the juncture of the sutures. There are 5 to 6 pore plates with 2 to 4 pores in the lateral wall, and 9 plates with 4 to 5 pores in the distal septum.

The species lives on shells and stones, at a depth of 46 to 54 m, on a bed of silt and sand, under temperatures ranging from 0.63 to 4.90°C.

Distribution. This species was found by me in the Bering Strait.

16. **Schizoporella hexagona** Nordgaard, 1905 (Figure 337)

Schizoporella hexagona Nordgaard, 1905 : 166, pl. V, f. 12-13.

The zoarium, prostrate in the form of a small, thin crust, consists of zooids arranged in regular, oblique rows. The zooids are small (length 0.5 mm, width 0.4 mm) and hexagonal in shape. The frontal surface is mildly raised and granulated; it has a slightly wavy, raised margin along which 4 to 6 pores are scattered. The primary orifice, located near the distal margin of the zooid, is round; there is a semi-circular sinus located in the middle of its proximal margin. The operculum is chitinous with a semi-circular proximal lobe that corresponds to the sinus. Two, small, round thickenings are located in the middle of the inner surface of the operculum for the attachment of the

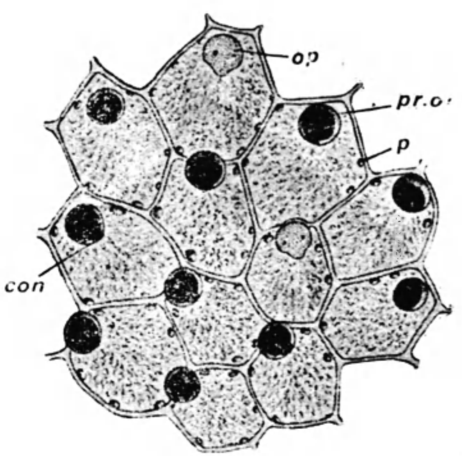


Figure 337. *Schizoporella hexagona* Nordgaard. Part of a zoarium.

occlusor muscles. Ovicells are not known to exist. Spines and avicularia are absent.

The species lives on shells and stones, at a depth of 15 to 95 m.

Distribution. This species was found by me in the Barents Sea, Kola Bay, and eastern Litsa. *Reports in literature:* Northern Finmark (Nordgaard, 1905).

This is a low Arctic species.

The sketch given here differs markedly from that given by Nordgaard in his paper, because it was drawn from the preparation sent to me by Nordgaard for examination.

17. **Schizoporella smitti** Kluge nom. n. (Figure 338)

Mollia vulgaris forma *candida* Smitt, 1868b : 16, 107, t. 25, f. 83; *Schizoporella candida* Nordgaard, 1896 : 22; 1905 : 165, pl. 4, f. 6-7.

The zoarium, prostrate in the form of a thin crust, consists of zooids arranged in more or less regular, oblique rows. The zooids are medium in size (length 0.70 mm, width 0.58 mm), rhombic-hexagonal in shape, sometimes oblong, sometimes broader, and separated by straight, deep margins. The frontal surface is slightly raised and entirely covered with small pores. The primary orifice, located at the distal end of the zooid, is broad and semi-circular; its width is 3 times greater than its height; it has a straight, proximal margin with a short, straight, and narrow sinus in the middle. Spines, avicularia, and ovicells are probably absent. Similar pore chambers are located all along the basal margin of the zooid.

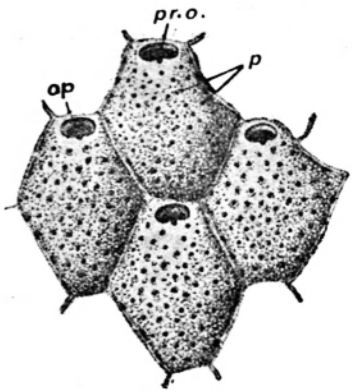


Figure 338. *Schizoporella smitti* Kluge, nom. n. Zooids with closed and open orifices. Barents Sea.

The species lives on stones and shells of madiolaria, at a depth of 72 to 200 m.

Distribution. Reports in literature: Barents Sea, Hammerfest (Smitt, 1868b; Nordgaard, 1896), and northern Norway (Nordgaard, 1905).

This is probably a low, Arctic species.

18. **Schizoporella thompsoni** Kluge sp. n. (Figure 339)

The zoarium is prostrate and ramose. The branches uprise from the distal margin of the zooid, either on one or both sides. The zooids are large (length 1 mm, width from 0.05 mm at the proximal end to 0.50 mm at the distal end), oblong-oval in shape, fairly narrow at the proximal end, and gradually broadening along the lower one-third length into a wider two-thirds. The frontal surface is mildly raised, white, shiny, and granulated. The primary orifice, located near the distal end of the zooid, is semi-circular; it has a straight, proximal margin with a straight, narrow sinus in its center. Six long, strong spines are located along the distal, semi-circular margin. The ovicells are hyperstomial and semi-circular.

Figure 339. *Schizoporella thompsoni* Kluge sp. n.

The species lives on stones at a depth of 450 m.

Distribution: This species was found by me in the waters off eastern Greenland.

This is an Arctic species.

2. Genus **Hippodiplosia** Canu, 1916

Lepralia (part.) Busk, 1854a : 80; *Eschara* (part.) Smitt, 1868b : 22; *Schizoporella* (part.) Waters, 1900 : 65; *Porella* (part.) Waters, 1900 : 84.

The zoaria are prostrate and overgrowing. The zooids usually have a raised margin. In most cases, the frontal surface is raised, covered with pores, or smooth, and surrounded by one row of marginal pores. The primary orifice is roundish; it has a more or less concave, proximal margin. Avicularia are present in most species. Pore plates with a few pores are present in the lateral and distal walls. The ovicells are hyperstomial and have an incompletely calcified ectooecium; the calcareous wall of the endooecium has an oecial coating, and may or may not have pores.

Genus type: *Cellepora pertusa* Esper, 1797.

1 (2). Avicularia absent. Frontal surface covered with pores. Primary orifice roundish and broader. Ovicells hyperstomial. ....1. *H. pertusa* (Esper).

2 (1). Avicularia present.

3 (4). Avicularium located between the secondary and primary orifices. Frontal surface has 2 rows of marginal pores around the central surface. Ovicells have no pores.................

................................9. *H. ussowi* (Kluge).

4 (3). Avicularium located on the frontal surface near the proximal margin of the zooidal orifice.

5 (12). Frontal surface covered with pores.

6 (7). Avicularium oblong with a pointed mandible whose free end is directed forward and toward one side. Frontal surface reticulate, except the oblong (stretched), central, smooth surface on which the avicularium is located. Ovicells have no pores..........................8. *H. harmsworthi* (Waters).

7 (6). Avicularium oval or round, and its semi-circular mandible is directed downward, or downward and to one side.

8 (9). Frontal surface raised, translucent, and laden with small pores joined by lines that look like cracks. Orifice of the zooid is roundish. A small, round avicularium is located proximal to the margin of the sinus on a low, broad, and conical avicularian chamber........................6. *H. tschukotkensis* Kluge.

9 (8). Frontal surface reticulate with more or less large pores at the bottom of the alveoli. Avicularium oval, located in the plane of the frontal surface, or round and located on the raised avicularian chamber.

10 (11). Avicularian chamber, located near the mildly concave, proximal margin of the orifice, is in the form of a raised, semi-circular cone, at which a round avicularium is located which bends markedly toward the orifice. Avicularium often absent, however.....................4. *H. murdochi* Kluge.

11 (10). Avicularian chamber not raised, and the oval avicularium located in the plane of the frontal surface under the concave margin of the orifice........2. *H. reticulato-punctata* (Hincks).

12 (5). Frontal surface of the zooid surrounded by a row of marginal pores.

13 (14). Frontal surface flat. A small, round avicularium located slightly away from the proximal margin of the orifice on a slightly raised, saccate, avicularian chamber, the upper, lateral parts of which narrow and reach up to the lateral margins............................7. *H. borealis* (Waters).

14 (13). Frontal surface raised. Avicularian chamber raised near the proximal margin of the orifice.

15 (16). Zooids and zooidal orifice large. Oval avicularium, located at the semi-circular, conical avicularian chamber, tilts toward the orifice with its distal end. Besides this avicularium, sometimes larger, oval avicularia are found at the frontal surface. Peristome strongly developed in the zooids carrying ovicells, in the form of 2 raised, lateral lobes...................

. . . . .3. *H. propinqua* (Smitt).

16 (15). Zooids and zooidal orifice small. Avicularian chamber broad and strongly raised in the young zooids. In the more calcified ones it levels off with the remaining part of the surface, and the avicularium located on it tilts more toward the orifice. Degree of development of the avicularian chamber and the marginal pores varies. . . . . .5. *H. obesa* (Waters).

*1. **Hippodiplosia pertusa** (Esper, 1797) (Figure 340)

Lepralia pertusa Busk, 1854a : 80, pl. 78, f. 3, pl. 79; Hincks, 1880a : 305, pl. XLIII, f. 4-5; Osburn, 1912 : 241, pl. XXVI, f. 56a-c; ? *Hippoporina pertusa* Nordgaard, 1918 : 59; *Hippodiplosia pertusa* Osburn, 1933 : 41, pl. 14, f. 8.

The zoaria, prostrate and overgrowing, consist of irregular rows of zooids. The zooids are small (length 0.63 to 0.75 mm, width 0.38 to 0.50 mm), often short, broad, hexagonal, oval, or rectangular in shape. The frontal surface is mildly raised with a thin, raised margin, small alveoli, and pores at the bottom of the alveoli. Only a small surface near the proximal margin of the orifice is free of alveoli; it is often separated from the remaining surface by prominent, thickened alveoli walls. The primary orifice, located near the distal margin, is transversely oval (width 0.18 mm, height 0.13 mm); the proximal margin is very slightly depressed and separated from the remaining part of the orifice by small, triangular condyles located at the margins of the depression. Spines are absent. Very often avicularia are also absent throughout the zoaria, but sometimes oval avicularia are found at the sides of the orifice, and the free ends of their mandibles are directed downward and outward. The ovicells are large, round, and convex; the outer layer is membranous and calcified only on the margins; the inner layer is calcified and entirely covered with numerous small pores. There are 6 simple pores in the lateral wall, and 6 to 8 in the distal septum.

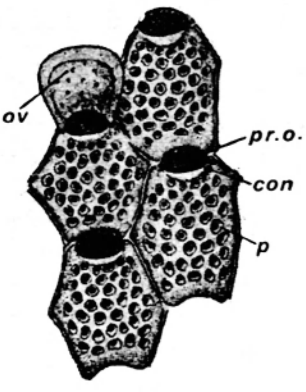


Figure 340. *Hippodiplosia pertusa* (Esper). Zooids without avicularia.

The species lives on shells and stones usually, but sometimes on algae, at a depth of 10 to 180 m.

Distribution. Although this species has been reported a number of times as being found in Arctic waters (Dawson, 1859; Kirchenpauer, 1874; Lorenz, 1886; Whiteaves, 1901; Nordgaard, 1918; Osburn, 1919), I never located it in our waters. On verifying the identifications made by most of the aforementioned authors, I became convinced that they had confused this species with *Hippodiplosia reticulato-punctata* Hincks, to which it is greatly similar in external appearance, but strongly differs in the structure of its pore plates. This is a boreal species found in the coastal waters of the Shetland (Norman, 1869) and British Islands (Hincks, 1880a), northwestern coast of France (Joliet, 1877), Mediterranean Sea (Calvet, 1902), and from Cape Cod to the Bay of Fundy on the eastern coast of North America (Osburn, 1912, 1933).

This is a boreal species.

2. **Hippodiplosia reticulato-punctata** (Hincks, 1877) (Figure 341)

Lepralia reticulato-punctata Hincks, 1877a : 103, pl. 10, f. 3-4; Levinsen, 1887 : 318, pl. 27, f. 4 (*Escharella*); Nordgaard, 1905 : 166, pl. IV, f. 16-17 (*Schizoporella*); *Escharella porifera* forma *edentata* Smitt, 1868b : 9, pl. 24, f. 39; *Lepralia pertusa* Kirchenpauer, 1874 : 421; *Hippodiplosia reticulato-punctata* Osburn, 1933 : 41, pl. 10, f. 2, pl. 13, f. 6.

The zoaria, overgrowing in the form of a white crust, consist of irregular rows of zooids arising from the ancestrula. The zooids are small (length 0.75 mm, width 0.38 mm), rhombic, or oval in shape; they have a moderately raised, frontal surface bordered by a thin, raised margin. The surface is alveolate, and there are pores at the bottom of the alveoli. The primary orifice, located at the distal end of the zooid, is semi-circular; it has a broad sinus at the proximal margin, and there are thin, sharply pointed, lateral condyles at the very tips of the sinus. Spines are absent. An oral avicularium with a semi-oval mandible is often directed proximally and toward one side. Although these oral avicularia are found quite frequently in the zooids, cases are found in which the entire zoaria is nearly or totally devoid of them. On the other hand, true very rarely, it is possible to find a similar avicularium behind or by the side of the oral one. The ovicells are large, round, and convex; they have a membranous outer layer that is calcified only at the margins, and the smooth, calcareous inner layer is covered with numerous small pores.

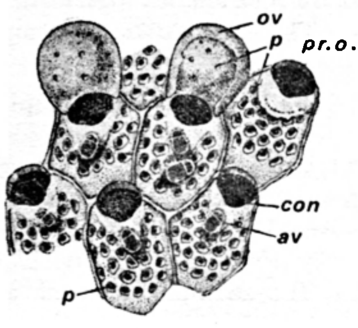


Figure 341. *Hippodiplosia reticulato-punctata* (Hincks). Part of a zoarium with an adventitious avicularium in one zooid (from the collection of Bidenkap).

There are 4 pore plates with several pores in the lateral wall of the zooid, and about 10 pores arranged along the lateral and basal walls in the distal septum. Furthermore, the lateral and distal walls are joined to the basal wall by short, transversely standing septa in the form of equal sections, which give the impression of chambers at first glance. The ancestrula has a raised margin on the aperture, which has no spines.

The species lives on algae, Bryozoa, and tubes of worms, at a depth of 9 to 306 m, on a bed of silt, stone, and shells, under temperatures ranging from −1.9 to 3.2°C, in the White Sea from −1.4 to 10°C, in a salt concentration of 29.96 to 34.83‰, in the White Sea 26.9 to 29.33‰.

Distribution. This species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and in the waters of Labrador, western and eastern Greenland, and the Davis Strait. ***Reports in literature:*** Barents Sea (Smitt, 1868b, 1879b; Nordgaard, 1896, 1905, 1912a, 1918; Bidenkap, 1897, 1900a; Andersson, 1902; Norman, 1903b; Kluge, 1906; Kluge in Deryugin, 1915; Kluge, 1929), White Sea (Kluge, 1907, 1908a, 1928; Gostilovskaya, 1957), Kara Sea (Levinsen, 1887; Nordgaard, 1912b; Kluge, 1929), Laptev and East Siberian seas (Kluge, 1929), Chukotsk Sea (Osburn, 1923; Kluge, 1929), Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1923), western Greenland (Smitt, 1868c; Hincks, 1877a; Norman, 1903b, 1906; Kluge, 1908b; Levinsen, 1914; Osburn, 1919, 1936), Gulf of St. Lawrence (Dawson, 1859; Whiteaves, 1901; Norman, 1903b), eastern Greenland (Kirchenpauer, 1874; Andersson, 1902; Levinsen, 1914, 1916), Yan-Maien Island (Lorenz, 1886), Iceland (Nordgaard, 1924), northern Norway (Nordgaard, 1905, 1918), and the Bay of Fundy on the eastern coast of North America (Osburn, 1933).

This is an Arctic, circumpolar species.

3. **Hippodiplosia propinqua** (Smitt, 1868) (Figure 342)

Eschara verrucosa forma *propinqua* Smitt, 1868b : 22 (part.), t. 26, f. 126-129; *Lepralia propinqua* Hincks, 1877a : 103, pl. X, f. 5-7; *Porella propinqua* Nordgaard, 1905 : 168, pl. 4, f. 18-20; Osburn, 1912 : 248, pl. 27, f. 70.

The zoarium, prostrate and sometimes tightly, sometimes loosely, overgrowing the substrate, consists of tall zooids arranged in more or less regular, oblique rows. The zooids are medium in size (length 0.75 mm, width 0.50 mm), rhombic-hexagonal in shape, sometimes more oblong, and sometimes broader. The frontal surface is raised and bordered by a raised margin along which depressions stretch with pores at the bottom; rebra originate from the margin between the depressions in a radial direction toward the raised, conical, semi-circular avicularian chamber. An oval avicularium, located at the top of the avicularian chamber, has a semi-circular mandible tilted toward the base. The primary orifice, located at the distal margin of the zooid, is round; it has a slightly more concave and broader sinus at the proximal margin, and blunter condyles at the margins of the sinus. The avicularian chamber follows directly behind the proximal margin of the orifice, and 3 to 4 pores are locatd at its base. Zooids are often found in which the avicularian chamber is not developed. In the zooids without ovicells, the peristome is in the form of lateral lobes and barely visible, but as soon as ovicells begin to form, the lateral lobes of the peristome develop rapidly and become strongly raised in the zooids carrying ovicells. Their distal ends are located at the ovicells and the proximal end encircles the avicularian chamber, making it appear deeply submerged. Besides the oral avicularium, larger, oval, and low avicularia with oblong, semi-oval mandibles often appear at the frontal surface of the zooid. The ovicells are hyperstomial, round, and convex; the outer layer is calcified only at the margins, and a few small pores are located in the center of the calcareous surface of the inner layer, in addition to those pores sprinkled along the margin. The lateral wall of the zooid has 4, and the distal septum 2 pore plates with a few (3 to 5) pores in each. The basal wall and the lower half of the lateral wall are laden with numerous white spots or pseudopores.

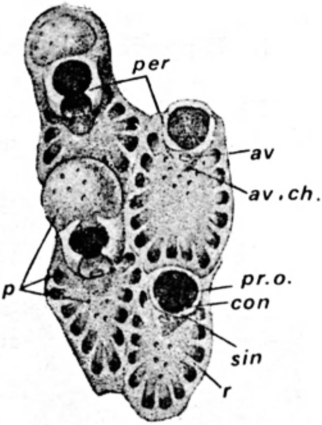


Figure 342. *Hippodiplosia propinqua* (Smitt). Zooids with greatly and poorly developed peristomes.

The species lives on hydroids, Bryozoa, and shells, at a depth of 1.5 to 210 m, on a bed of silt, stones, and shells, under temperatures ranging from −1.63 to 3.2°C, in the White Sea up to 12°C, in a salt concentration of 34.23‰, in the White Sea 25.9 to 29‰.

Distribution. This species was found by me in the Barents, Kara, Bering, and Okhotsk seas. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879a, 1879b; Nordgaard, 1896, 1918; Bidenkap, 1897, 1900a, 1900b; Kluge, 1906, 1929; Kluge in Deryugin, 1928), White Sea (Gostilovskaya, 1957), Kara Sea (Smitt, 1879a), Labrador (Hincks, 1877a), western Greenland (Smitt, 1868c; Hincks, 1877a; Norman, 1906; Kluge, 1908b; Levinsen, 1914), eastern Greenland (Levinsen, 1916), in the vicinity of Woods Hole on the eastern coast of North America (Osburn, 1912), Iceland (Nordgaard, 1924), and northern Norway (Nordgaard, 1905, 1918).

This is an Arctic-boreal species.

4. **Hippodiplosia murdochi** Kluge sp. n. (Figure 343)

The zoarium, prostrate in the form of a thick, gray crust, consists of zooids arranged in more or less regular, short, oblique rows. The zooids are medium in size (length 0.65 to 1.00 mm, width 0.50 to 0.68 mm), and hexagonal or irregularly rectangular in shape, but sometimes they are longer and narrower, and sometimes shorter and broader. The frontal surface is moderately raised and bordered by a straight, raised margin along which, similar to the entire surface, comparatively large pores are uniformly arranged. The primary orifice, located near the distal margin of the zooid, is semi-circular in the distal half, and a broad sinus is located in the proximal margin, which has short, barely noticeable, rounded-angular condyles at its corners. A raised, semi-circular avicularian chamber is located under the proximal margin; a round avicularium which tilts noticeably toward the orifice, is located at the top of the avicularian chamber. However, sometimes neither the avicularian chamber nor the avicularium develops, in which case the entire surface is located under the proximal margin. Ovicells are not known to exist. There are 6 pore plates with a few pores each in the lateral wall, and 2 in the distal septum.

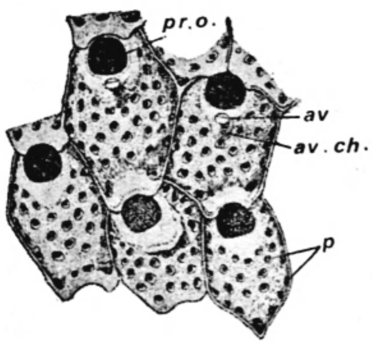


Figure 343. *Hippodiplosia murdochi* Kluge sp. n. Zooids with and without an avicularium.

The species lives on stones and shells, at a depth of 13 to 14 m.

Distribution. The species was found by me in the Chukotsk Sea on the northwestern coast of Alaska.

5. **Hippodiplosia obesa** (Waters, 1900) (Figure 344)

Porella ? obesa Waters, 1900 : 84, pl. 12, f. 22-24; *Porella concinna* Lorenz, 1886 : 89, t. 7, f. 6.

The zoarium, prostrate in the form of a thin crust, consists of zooids arranged in regular, straight and oblique rows. The zooids are small (length 0.45 mm, width 0.30 mm) and rhombic-hexagonal or oval in shape. The frontal surface, mildly raised and granulated, is bordered by a raised margin, which is quite noticeable in the younger parts of the zoarium and disappears in the more strongly calcified parts. A row of small pores lies along the margin. The primary orifice, located near the distal margin of the zooid, is semi-circular; it has a broad and weakly concave, proximal margin; there are 3 small spines at the distal margin in the young zooids. A semi-circular, raised avicularian chamber, strongly raised in the young zooids, is located proximal to the distal margin, and a round avicularium with a semi-circular mandible is located in its center. The avicularian chamber may be either narrow and round, its lateral parts contracting as they approach the margins of the zooid and revealing one small, round pore at each end, or this chamber may be wider and almost touching the lateral margins. In the young zooids, the avicularium is located in the zoarial plane; in the older ones, its distal half is depressed and the avicularium may come closer to the proximal margin of the orifice. In addition to this oral avicularium, 1 to 2 additional (adventitious) oval avicularia are also found in some zooids. The ovicells are hyperstomial, large, round, and convex; they have a granulated surface. Two pore chambers with a few pores each are located at the basal margin of the lateral wall of the zooid, and in the distal septum. This species varies considerably with regard to the degree of development of the avicularian chamber and the marginal pores.

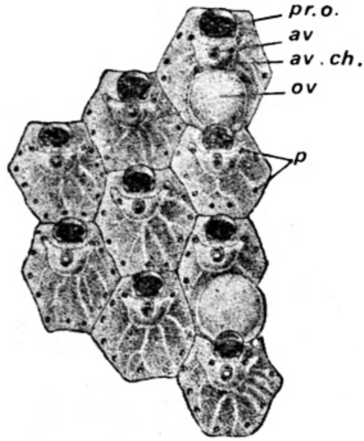


Figure 344. *Hippodiplosia obesa* (Waters). Part of a zoarium.

The species lives on ascidia, shells, and stones, at a depth of 24 to 450 m, more often from 75 to 150 m, on a bed of stone, silt, and sand, under temperatures ranging from −1.9 to 3°C, in the White Sea up to 10.5°C, in a salt concentration of 32.18 to 34.27‰, in the White Sea 25.99 to 29.42‰.

Distribution. This species was found by me in the Barents, Kara, Laptev, Chukotsk, Bering, and Okhotsk seas, and in the waters off western and eastern Greenland, as well as in the Gulf of St. Lawrence. *Reports in literature:* Barents Sea (Waters, 1900; Kluge in Deryugin, 1915), White Sea (Kluge in Deryugin, 1928; Gostilovskaya, 1957), Kara Sea (Kluge, 1929), and the Sea of Japan (Androsova, 1958).

This is an Arctic-boreal species.

6. **Hippodiplosia tchukotkensis** Kluge, 1952 (Figure 345)

Hippodiplosia tchukotkensis Kluge, 1952 : 157, fig. 12; 1955a : 92, fig. 36.

The zoarium, prostrate in the form of a small, milky white crust, consists of zooids arranged in regular, straight and oblique rows. The zooids are medium in size (length 1.00 mm, width 0.9 mm) and rhombic-hexagonal in shape; their length is slightly greater than their width; the walls are thick and translucent. The frontal surface is convex and the zooids are separated by a deep suture which is sharply raised in the more calcified part of the zoarium. The entire frontal surface is densely covered with pores joined by thin lines that look like cracks. The primary orifice, located at the distal end of the zooid, is almost round; its width is slightly greater than its height, and its proximal margin forms a broad, weakly concave sinus with small, sharply pointed denticles located at its lateral ends; these denticles support the operculum. The operculum has corresponding "dots" for the attachment of the occlusor muscles, located on its inner side at the margins, along the obliquely situated rebral strip; a bend occurs between its anterior and posterior parts. A small, round, frontal avicularium is located proximal to the sinus on the low, broad, conical, raised portion of the avicularian chamber, and the free end of its mandible is slightly raised. Each side of the distal part of the tentacular sheath has one gland whose significance is not known. Ovicells are not known to exist. The lateral wall has 5 to 6 pore plates with 2 to 3 pores each, and the distal septum has 2 with 3 to 4 pores each.

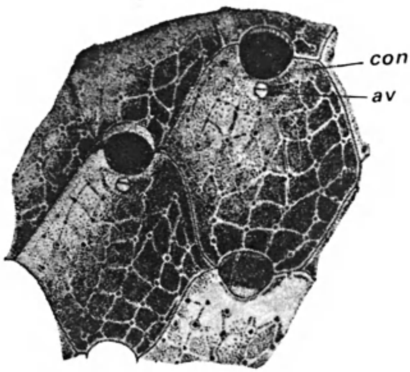


Figure 345. *Hippodiplosia tchukotkensis* Kluge. Zooids (from Kluge, 1952).

The species lives on stones and shells, at a depth of 53 m, on a bed of silt and sand, under a temperature of 4.78°C, in a salt concentration of 31.80‰.

Distribution. The species was found by me in the Chukotsk Sea, in the northern, open part.

Thus far, this species is endemic to the Chukotsk Sea.

7. **Hippodiplosia borealis** (Waters, 1900) (Figure 346)

Lepralia borealis Waters, 1900 : 73, pl. 8, f. 4-6; *Escharella porifera* Smitt, 1879a : 21 (part.).

The zoarium, prostrate in the form of a thin crust, consists of zooids arranged in regular, oblique rows. The zooids are medium in size (length 0.87 mm, width 0.50 mm) and rhombic in shape, sometimes more oblong, sometimes broader; weakly raised, it has a thin, raised margin along which saccate depressions with a small pore at the bottom are located. The frontal surface is granulated and has a very light, radial pattern in the proximal half. The tall, semi-circular, primary orifice, located at the distal end of the zooid, has a proximal margin which is weakly concave, and often, very slightly convex in the middle; there are noticeable, sharp, pointed condyles at the margins near this central part. A little behind the proximal margin of the orifice lies a small, round avicularium, which is very slightly raised above the frontal surface; it has a saccate, depressed, avicularian chamber whose upper, lateral parts gradually narrow and reach up to the lateral margins.

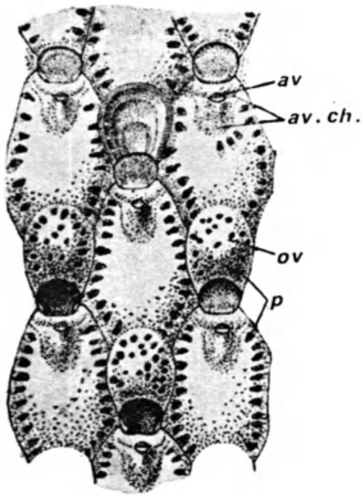


Figure 346. *Hippodiplosia borealis* (Waters). Part of a zoarium. Barents Sea.

The ovicells are hyperstomial, round, slightly broad and flattened; the central part of the inner layer, surrounded by the rim of the outer layer, is uniformly covered with pores. There are 4 pore plates with a few pores near the basal margin in the lateral wall, and 2 pore plates, which sometimes fuse into one, in the distal septum. The basal wall of the zooids is more or less convex, and sometimes forms protuberances for the attachment of the zoarium to the substrate.

The species lives on the shells of bivalved mollusks, at a depth of 54 to 512 m, on a bed of silt, stone, and shells, under temperatures ranging from −1.38 to 2.38°C, in a salt concentration of 34.60 to 34.90‰.

Distribution. This species was found by me in the Barents and Kara seas. *Reports in literature:* Barents Sea (Waters, 1900).

This is an Arctic species.

8. **Hippodiplosia harmsworthi** (Waters, 1900) (Figures 347)

Schizoporella harmsworthi Waters, 1900 : 65, pl. 9, f. 10-12; *Escharella Legentilii* forma *prototypa* Smitt, 1868b : 10, 81 (part.), pl. 24, f. 47-48; *Schizoporella cincta* var. Hincks, 1892 : 154, pl. 8, f. 2.

The zoarium, prostrate and overgrowing, consists of zooids arranged in regular, straight and oblique rows. The zooids are medium in size (length 0.75 to 0.87 mm, width 0.50 to 0.63 mm) and oblong-rhombic-hexagonal in shape. The frontal surface is weakly raised and surrounded by a raised margin; the entire surface, except for the oblong, middle part lying proximal to the orifice, is covered with depressions that have one pore at the bottom. The primary orifice, located near the distal end of the zooid, is semi-circular; it has a broad, shallow sinus at the proximal margin, which has one thin, sharp denticle on each side. Spines are absent. A small avicularium is usually located proximal to the orifice on the continuous surface, and its sharp mandible is directed forward and toward one side. The ovicells are hyperstomial, large, and round; their width is greater than their height. The surface is finely granulated. An oblong orifice is often located slightly below the center of the frontal surface, whose proximal half is frequently covered from the sides by the triangular lobes of the frontal surface of the lateral zooids. There are 6 to 9 pore plates with 2 to 3 pores each in the lateral wall, and 6 to 8 small pore plates with 1 to 2 pores arranged in the lower half, along the basal and lateral margins, in the distal septum.

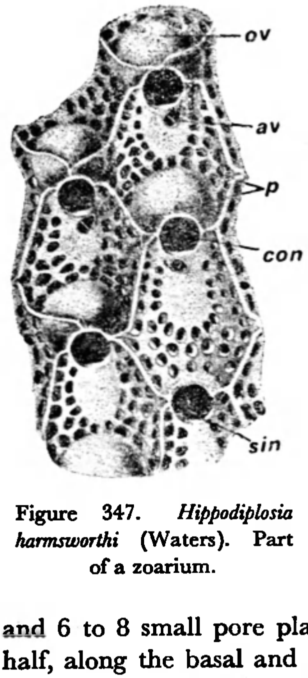


Figure 347. *Hippodiplosia harmsworthi* (Waters). Part of a zoarium.

The species lives on shells and stones, at a depth of 30 to 365 m, frequently from 50 to 200 m, but more often from 100 to 150 m, on a bed of shells, silt, and stones, under temperatures ranging from −1.9 to 2.38°C, in the White Sea from −0.4 to 10.4°C, in a salt concentration of 31.44 to 34.96‰, in the White Sea from 26.9 to 28.59‰.

Distribution. This species was found by me in the Barents, Kara, Laptev, East Siberian, and Chukotsk seas. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Waters, 1900; Andersson, 1902; Kluge in Deryugin, 1915), White Sea (Kluge, 1908a; Gostilovskaya, 1957), Kara Sea (Levinsen, 1887), Laptev Sea and the East Siberian Sea (Kluge, 1929), western Greenland (Smitt, 1868), Gulf of St. Lawrence (Hincks, 1892; Whiteaves, 1901), eastern Greenland (Andersson, 1902), Yan-Maien Island (Lorenz, 1886).

This is an Arctic species.

9. **Hippodiplosia ussowi** (Kluge, 1908) (Figure 348)

Schizoporella ussowi Kluge, 1908a : 527, fig. 2a-c; *Hippodiplosia smitti* Osburn, 1933 : 42, pl. 9, f. 6.

The zoaria, prostrate in the form of a crust, consists of zooids arranged in regular, straight and oblique rows. The zooids are small (length 0.60 mm, width 0.46 mm) and hexagonal or rectangular in shape. The frontal surface is convex; it has a raised margin along which 1 to 2 rows of irregularly shaped depressions are located, which have pores at the bottom. The middle surface has no pores, but is granular. The primary orifice, located near the distal end of the zooid, is round; it has a semi-circular sinus in the middle of the proximal margin, which has 2 thin, sharp condyles at its sides. Directly behind the sinus is located a small, transversely irregular, and oval avicularium with a semi-circular mandible whose free end is pointed sometimes in one direction, sometimes in the other. The ovicells, hyperstomial, round, and flatly raised, have a granulated surface which is intercepted in the proximal half, by the lateral margins of the frontal wall of the neighboring zoids, and in the distal half, by thin, short, and radially arranged rebra uprising from the margin. There are 5 to 6 pore plates with 2 to 3 pores each in the lateral wall, and 10 to 12 with 1 to 2 pores each in the distal septum, arranged along the lower half of the lateral and basal walls.

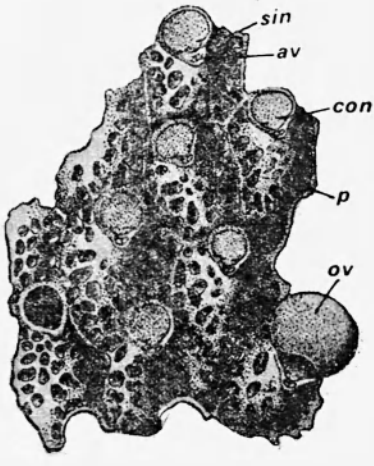


Figure 348. *Hippodiplosia ussowi* (Kluge). Part of a zoarium.

The species lives on laminaria, red algae, *Balanus*, shells, and stones, at a depth of 9 to 45 m, in the White Sea from 1 to 50 m, on a bed of stone, sand, and shells, under temperatures ranging from 9 to 10.7°C, in the White Sea, in a salt concentration of 26.9‰.

Distribution. The species was found by me in the Barents, Kara, Bering, and Okhotsk seas, and the waters off western Greenland. *Reports in literature:* White Sea (Kluge, 1908a; Gostilovskaya, 1957), and the Bay of Fundy on the eastern coast of North America (Osburn, 1933).

This is an Arctic, circumpolar species.

IV. Family **Stomachetosellidae** Canu and Bassler, 1917

Myriozoidae (part.) Hincks, 1880a : 236; *Escharellidae* (part.) Borg, 1933a : 531; *Stomachetosellidae* Canu and Bassler, 1917 : 44; Osburn, 1933 : 35 (part.).

The zoaria are prostrate and overgrowing or free-growing. The zooids are thick-walled. Their frontal surface is often covered with pores. The primary orifice is semi-circular or circular with a broad, concave or narrow, rounded sinus located at the proximal margin. Avicularia are absent. Ovicells are hyperstomial.

Genus **Stomachetosella** Canu and Bassler, 1917

Lepralia (part.) Busk, 1854a : 69; *Escharella* (part.) Smitt, 1868b : 14; *Schizoporella* Hincks, 1880a : 266; *Stomachetosella* Canu and Bassler, 1917 : 45.

The zoaria are overgrowing or free-growing (in our waters, they are overgrowing). Either the frontal surface is covered with a row of larger, marginal pores and a sprinkling of smaller pores throughout, or the entire surface is covered with large pores. The primary orifice is semi-circular or circular; it has a slightly concave or narrow, semi-circular sinus at the proximal margin. The secondary orifice is roundish and stretches at the proximal margin, into a more or less narrow sinus with thick margins. The pore chambers are located along the lateral and transverse margins of the zooid of the basal side.

Genus type: *Lepralia sinuosa* Busk, 1860.

1 (4). Primary orifice semi-circular; sinus on the proximal margin broad.

2 (3). Sinus very broad, almost covering the entire width of the proximal margin, slightly raised, and almost straight. Secondary orifice roundish with a narrow, short sinus at the proximal margin. Frontal surface covered with large pores...2. *S. producta* (Packard).

3 (2). Sinus slightly narrow, but deeper, with a mildly concave, proximal margin. Secondary orifice roundish with a short proximal sinus at the proximal margin. Frontal surface has large marginal pores and smaller pores scattered over the entire surface...1. *S. sinuosa* (Busk).

4 (1). Primary orifice roundish; sinus narrow at the proximal margin (not more than one-third the width of the proximal margin).

5 (6). Calcareous thickenings or tubercles often form at the sides of the sinus of the secondary orifice, and sometimes at the sides of the distal margin. Frontal surface has a row of larger marginal pores and smaller pores scattered over the entire surface . . . . 3. *S. cruenta* (Busk).

6 (5). Primary orifice encircled by a raised, round peristome in the form of a collar. Frontal surface entirely covered with large pores . . . . 4. *S. collaris* (Kluge).

1. **Stomachetosella sinuosa** (Busk, 1860) (Figure 349)

Lepralia sinuosa Busk, 1860 : 125, pl. 24, f. 2-3; *Schizoporella sinuosa* Hincks, 1880a : 266 (part.), pl. 42, f. 1-3; Osburn, 1912 : 238, pl. 25, f. 51; *Stomachetosella sinuosa* Osburn, 1933 : 36, pl. 11, f. 1-2; *Escharella linearis* forma *secundaria* Smitt, 1868b : 14 (part.), pl. 25, f. 77.

The zoaria, prostrate and closely overgrowing the substrate, are reddish colored in a live state; they consist of zooids arranged in regular, oblique rows. The zooids are medium in size (length 0.63 to 0.75 mm, width 0.50 mm), rhombic or rectangular in shape, and thick-walled. The frontal surface is slightly raised, almost flat, granulated, and bordered by a raised margin, which has one row of large pores. Pores are scattered over the surface. The primary orifice, located near the distal margin of the zooid, is semi-circular; it has a broad sinus at its proximal margin. Because of the strong calcification of the frontal wall, the primary orifice is very deeply situated and can be easily distinguished in the younger zooids at the margin of the zoarium. The round secondary orifice, stretching out at the proximal margin into a narrow and sharply pointed sinus, is surrounded by a thick margin. The ovicells are hyperstomial and mildly raised, and often have a round orifice in the middle of their surface. There are 6 pore chambers along the basal margin of the lateral wall, and 3 in the distal septum.

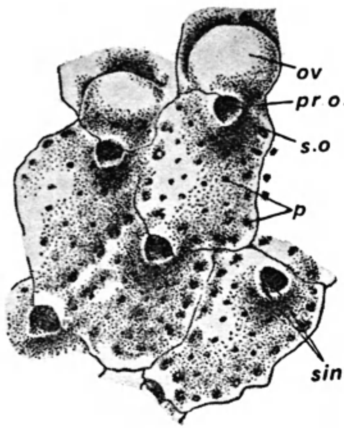


Figure 349. *Stomachetosella sinuosa* (Busk). Part of a zoarium. Barents Sea.

The species lives on shells and stones, at a depth of 5 to 270 m, more often from 75 to 150 m, on a bed of stone, shells, and silt, under temperatures ranging from −1.38 to 2.7°C.

Distribution. This species was found by me in the Barents and Bering seas, and in the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1868b; Urban, 1880; Nordgaard, 1896, 1912a; Kluge in Deryugin, 1915; Kuznetsov, 1941), White Sea (Kluge, 1908a), northern coast of North America (Osburn, 1923, 1932), western Greenland (Smitt, 1868c; Norman, 1906; Levinsen, 1914), eastern Greenland (Levinsen, 1916), Gulf of St. Lawrence (Whiteaves, 1901), New Scotland (Osburn, 1933), Iceland (Nordgaard, 1905, 1918), Shetland Islands (Norman, 1869), Scotland (Hincks, 1880a), along the western coast of North America in the region of Queen Charlotte Islands and Vancouver Island (Hincks, 1883; O'Donoghue, 1923, 1926).

This is an Arctic-boreal species.

2. **Stomachetosella producta** (Packard, 1863) (Figure 350)

Smittia producta Hincks, 1889 : 430, pl. 21, f. 2; *Schizoporella producta* Nordgaard, 1906a: 19, pl. II, f. 19-21; *Stomachetosella producta* Osburn, 1933 : 36, pl. 15, f. 1-3.

The zoarium, prostrate in the form of a dense crust, is reddish-brown in a live state, and consists of zooids arranged in irregular rows. The zooids are medium in size (length 0.75 mm, width 0.58 mm), hexagonal or irregularly rectangular in shape, and thick-walled. The frontal surface is mildly convex and bordered by a slightly raised, but clearly noticeable, margin, which has large depressions with pores at the bottom. The surface is laden with slightly smaller pores. The deeply situated primary orifice, located at the distal margin of the zooid, is semi-circular; it has a mildly concave, almost straight, proximal margin, and condyles situated at its sides. The secondary orifice is roundish; its width is slightly greater than its height; it forms a narrow and pointed sinus in the middle of the proximal margin. The ovicells are hyperstomial, almost unraised, and covered with a granulated surface which has no pores. There are 6 pore chambers located along the basal margin of the lateral wall, and 3 along the distal septum.

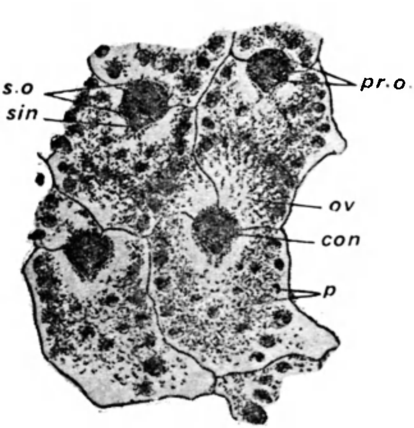


Figure 350. *Stomachetosella producta* (Packard). Part of a zoarium.

The species lives on shells and stones, at a depth of 30 to 136 m, more often from 30 to 50 m, on a bed of stone and shells, under temperatures ranging from -1.23 to -1.56°C.

Distribution. This species was found by me in the Barents and Chukotsk seas. *Reports in literature:* Barents Sea (Smitt, 1868b; Ridley, 1881), Archipelago of the Canadian Islands (Nordgaard, 1906a), western Greenland (Kluge, 1908b; Osburn, 1936), Labrador (Packard, 1863), Gulf of St. Lawrence (Hincks, 1889; Whiteaves, 1901), and the region of the Gulf of Man (Osburn, 1933).

This is an Arctic species.

3. **Stomachetosella cruenta** (Busk, 1854) (Figure 351)

Lepralia violacea var. *cruenta* Busk, 1854a : 69, pl. 110, f. 1; *Schizoporella cruenta* Hincks, 1880a : 270, pl. 30, f. 5.

The zoaria, porstrate in the form of an uneven crust, are colored dark red in a live state, and consist of irregularly arranged zooids. The zooids are medium in size (length 0.63 mm, width 0.45 mm), sometimes hexagonal, sometimes oval, sometimes oblong-rectangular in shape, and thick-walled. The frontal surface is more or less raised, granulated, and surrounded by a raised margin which has comparatively small depressions with pores at the bottom. Rebral structures are absent. In addition to marginal pores, there are a few others scattered over the frontal surface. The transversely oval, primary orifice, located near the distal margin of the zooid, has a small (one-third the width of the orifice), roundish sinus of indefinite form in the middle of the proximal margin, which has no visible condyles, or a somewhat semi-circular sinus with small condyles in its corners, which give it a more definite shape. Often calcareous thickenings or tubercles develop along the sides of the sinus; sometimes similar tubercles also develop at the sides of the distal margin of the orifice.

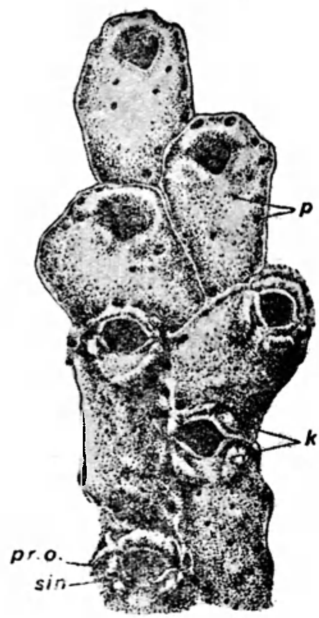


Figure 351. *Stomachetosella cruenta* (Busk). Part of a zoarium with thickenings at the sides of the secondary orifice of the zooids, and without thickenings.

The ovicells are hyperstomial. There are 5 to 6 pore chambers along the basal margin of the lateral wall, and 2 in the distal septum. Avicularia are absent.

The species lives on shells and stones, at a depth of 11 to 324 m, more often from 30 to 100 m, in the White Sea from 9 to 62 m, on a bed of stone, shells, and sand, under temperatures ranging from −1.64 to 2.7°C, in a salt concentration of 34.31 to 34.83‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and in Baffin Bay. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879a; Bidenkap, 1900a, 1900b; Kluge, 1906; Kluge in Deryugin, 1915; Nordgaard, 1912a; Kuznetsov, 1941), White Sea (Kluge, 1907, 1908a; Gostilovskaya, 1957), Kara Sea (Kluge, 1929), western Greenland (Smitt, 1868c; Norman, 1876, 1906; Kluge, 1908b; Levinsen, 1914), Gulf of St. Lawrence (Whiteaves, 1901), Yan-Maien Island (Lorenz, 1886), northern Norway (Guerin-Ganivét, 1911; Nordgaard, 1918), the Shetland (Norman, 1864) and British Islands (Hincks, 1880a).

This is an Arctic-boreal species.

4. **Stomachetosella collaris** (Kluge, 1946) (Figure 352)

Schizoporella collaris Kluge, 1946 : 202, fig. 6.

The zoaria are prostrate and consist of zooids arranged in regular, oblique rows. The zooids are medium in size (length 0.86 mm, width 0.50 mm) and oblong-hexagonal or oval in shape. The frontal surface is raised, and has a raised margin with large depressions with pores at the bottom. The entire surface is covered with smaller pores. The primary orifice, located near the distal end of the zooid, is round; its width is a little greater than its length; it has a narrow, roundish sinus in the middle of the proximal margin. It is encircled by a short peristome in the form of a broad margin or collar. The outer margin of this collar is higher and the plane of the lttaer lowers abruptly toward the orifice in the distal half, but gradually in the proximal. The outer wall of the peristome is almost suspended and passes downward in the distal half, whereas the middle of the proximal margin is depressed and fused with the frontal surface.

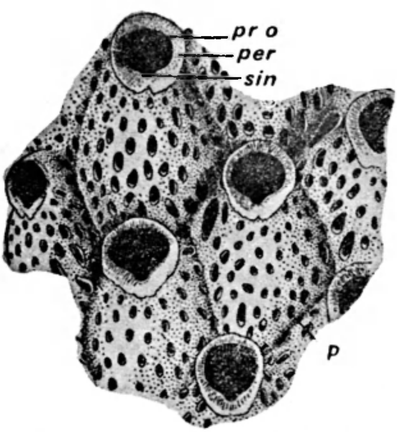


Figure 352. *Stomachetosella collaris* (Kluge). Part of a zoarium (from Kluge, 1946).

Ovicells are not known to occur. It is possible that these are totally absent, for after opening a few zooids, I found one round egg in 4 instances, covered with the peristomial shell and located in the fore part of the body cavity under the vestibule. The lateral wall of the body has 4 pore plates, and the distal septum 2 with 3 to 4 pores each.

The species lives on the shells of lamellibranched mollusks, at a depth of 46 to 59 m, on a bed of silt and sand.

Distribution. The species was found by me in the Laptev Sea. Thus far, it is endemic to the Laptev Sea.

V. Family **Myriozoidae** Smitt, 1868

Myriozoidae Smitt, 1868b : 8; Levinsen, 1909 : 296.

The zoaria are prostrate or free-growing; in the latter case, they are cylindrical, ramose, and sometimes moniliform in thickness. The frontal surface is reticulate with small pores at the bottom of the alveoli, which form long pits in the body wall. The branches consist of zooids arranged in a circle around the central, longitudinal axis; in the adjoining rows they are arranged in a checkered pattern. In all zooids, the primary orifice is semi-circular, and its height is greater than its width; it has a straight, proximal margin with a straight, narrow sinus located in its center. The secondary orifice is roundish. Spines are absent. Avicularia may or may not be present; if present, they are adventitious in most species, arranged either at the level of the distal margin of the orifice on one or both sides, or above the orifice at the medial line between 2 successive zooids. Some forms are found in which avicularia are located on one or both sides of the sinus. The avicularia vary in size; sometimes they are larger than the orifice of the zooid (in *Myriozoum truncatum* Pallas), or a little smaller than the orifice (*Leieschara coarctata* M. Sars), or just small in size (in the remaining forms). When the surface of the zoarium is strongly calcified, the avicularia become barely noticeable; this makes it difficult to identify the species. Uniporous plates are found in the distal and lateral walls of the zooids; rarely, uniporous chambers are also found. The ovicells are hyperstomial, submerged, and covered by the cryptocyst of the overlying zooid. Endozooecial ovicells are also found, but rarely.

Genus **Leieschara** M. Sars, 1863

Leieschara M. Sars, 1863a : 155.

The zoaria, free-growing and ramose, rise from a small, round, and prostrate surface. Branching is dichotomous and the branches cylindrical. The zooids are not separated at the surface. The frontal surface of the zooids is reticulate with minute pores at the bottom of the alveoli, and covered by a membrane (the epitheca) which, in the older parts of the zoarium, causes further calcification of the surface when the orifices of the zooids and the avicularia overgrow. The primary orifice of the zooid is semi-circular; it has a straight, proximal margin with a short, straight, narrow sinus in the middle. Spines are absent. Adventitious avicularia are present. The ovicells are hyperstomial, submerged in the depression of the surface, and mildly raised above the surface. The lateral walls and the distal septum have simple pores.

Genus type: *Leieschara coarctata* M. Sars, 1863.

1 (4). Zooids have one avicularium above the medial line of the orifice.
2 (3). Avicularia large, almost equal to, or a little larger than, the orifice of the zooids. The free margin of the mandible is directed downward.......................... 1. *L. coarctata* M. Sars.
3 (2). Avicularia small, the free end of the mandible points downward or a little to one side.................. 2. *L. orientalis* Kluge.
4 (1). Zooids have one small, round avicularium on one or both sides, at the level of the distal margin of the secondary orifice................................ 3. *L. subgracilis* (d'Orbigny).

1. **Leieschara coarctata** M. Sars, 1863 (Figure 353)

Leieschara coarctata M. Sars, 1863a : 155; *Myriozoum coarctatum* Smitt, 1868b : 18, 119, t. 25, f. 92; Waters, 1900 : 68, pl. 9, f. 2-3; non Robertson, 1908 : 295, pl. 21, f. 55-57; *Myriozoum subgracile* O'Donoghue, 1926 : 76, pl. V, f. 50.

The zoaria are free-growing and ramose, and treach upo 6 to 8 cm and more in height. Branching is usually dichotomous, and the branches separate at an angle of 60 to almost 90°. But when the branching is irregular and dense, the branches often fuse with each other. The branches are cylindrical; their thickness varies from 5 mm at the base of the zoarium to 1.5 mm at its top. Rarely, the branches are of uniform thickness throughout their length; often they form

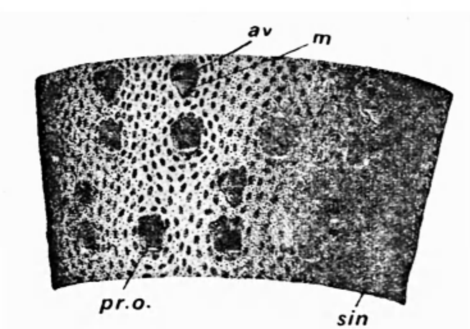


Figure 353. *Leieschara coarctata* M. Sars. A small part of a branch.

graduations which are sometimes so frequent and uniformly distributed that the branch acquires a beaded (moniliform) appearance. The branch consists of zooids arranged in a circle radially along the central axis; the number of zooids may be up to 10 or more in a transverse row. The zooids are arranged in regular, straight and oblique rows in a checkered pattern, and are medium in size. The frontal surface is reticulate; it has small pores at the bottom of the shallow alveoli, and is covered by the epitheca. The primary orifice is semi-circular; its height is greater than its width; its straight, proximal margin has a small, narrow, straight sinus in the middle, which is slightly broadened in the distal part. An oval avicularium is located above the orifice with a slightly oblong, semi-circular mandible whose free end is proximally directed. The size of the avicularium varies; usually its width is a little less than the width of the orifice, but sometimes its width is greater. The sharp rostral outgrowths are well-developed. The ovicells are hyperstomial in the form of large, semi-circular, and slightly raised structures that submerge into the depression. The thickened portions with an orifice, usually alternate with the narrower ones that have no orifice in the upper half of the zoarium; orifices are found more rarely in the lower half because of the increasing calcification of the surface. Avicularia are almost never found.

The species lives on stones and shells, at a depth of 24 to 432 m, more often from 100 to 200 m, on a bed of stone, sand, and silt, under temperatures ranging from −1.38 to 4.95°C, in a salt concentration of 34.63 to 34.83‰.

Distribution. The species was found by me in the Barents, Kara, and Bering seas, and in Baffin Bay. *Reports in literature:* Barents Sea (M. Sars, 1851; Smitt, 1868b, 1879b; Nordgaard, 1896, 1900, 1907b, 1918; Bidenkap, 1897, 1900a; Waters, 1900; Andersson, 1902; Kluge in Deryugin, 1915; Grieg, 1925), White Sea (Bidenkap, 1900a; Gostilovskaya, 1957), Labrador (Osburn, 1913), western Greenland (Fabricius, 1780; Smitt, 1868c; Hincks, 1877a; Norman, 1906; Levinsen, 1914), Gulf of St. Lawrence (Whiteaves, 1901), Yan-Maien Island (Lorenz, 1886), Iceland (Nordgaard, 1924), northern Norway (M. Sars, 1863; Smitt, 1868b; Nordgaard, 1918), and in the Pacific Ocean along the western coast of North America (O'Donoghue, 1923, 1926).

This is an Arctic-boreal species.

2. **Leieschara orientalis** (Kluge, 1929) (Figure 354)

Myriozoum orientale Kluge, 1929 : 20; *M. subgracile* Robertson, 1908 : 296, pl. 21, f. 58; *Leieschara orientalis* Kluge, 1955b : 107, t. XXIII, fig. 10.

The zoarium is free-growing and ramified. Branching is dichotomous and, very often, a definite regularity is found in the fact that each successive branch originates at a plane perpendicular to that of the preceding branch, due to which more or less dense, frequently branched, and bushy zoaria develop, which attain up to 5 to 6 cm and more in height. The branches are cylindrical, 2 to 3 mm thick, and have noticeable thickenings and thinnings throughout their length; their thick, free ends are rounded and capitate. Due to frequent ramification, these cylindrical branches often fuse with each other. The zooids are arranged in straight, regular and oblique rows in a checkered pattern. The frontal surface is reticulate and covered with the epitheca. The primary orifice is semicircular with a straight, proximal margin; a narrow, straight sinus,

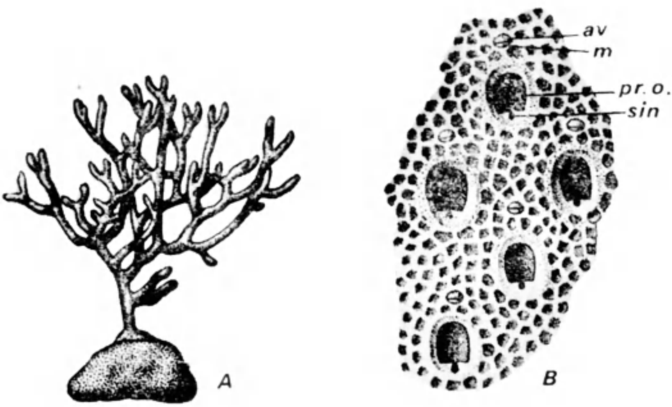


Figure 354. *Leieschara orientalis* (Kluge). *A*—general view of the zoarium; *B*—part of a branch (from Kluge, 1955b).

which slightly broadens at its distal end (like that in *L. coarctata*) is situated in the center of the proximal margin. A small, oval avicularium is located above the orifice of the zooid; its semi-circular mandible's free end is directed proximally or slightly to one side. The size of the avicularium also varies in this species, sometimes reaching up to the size of the avicularium in *L. coarctata*. The rostral outgrowths are also well-developed, as in the latter species. The ovicells are hyperstomial in the form of large, semi-circular, and slightly raised structures, which submerge in the depressions of the surface, and hang by their proximal margin above the distal margin of the orifice. Further calcification of the frontal wall and the overgrowth of the zooidal orifices and avicularia, occur at different times in different parts of the zoarium, sometimes all around the stem, sometimes only on one or the other side; the process is almost identical in the upper and lower halves of the zoarium.

The species lives on stones and shells, at a depth of 7 to 53 m, on a bed of stone, silt, and sand, under temperatures ranging from 1.3 to 4.78°C, in a salt concentration of 31.80 to 31.92‰.

Distribution. The species was found by me in the Chukotsk, Bering, and Okhotsk seas. *Reports in literature:* Laptev, East Siberian, and Chukotsk seas (Kluge, 1929), Smith Bay in Baffin Bay (Busk, 1880), and the western coast of North America (Robertson, 1908).

This is an Arctic-boreal, Pacific species.

3. **Leieschara subgracilis** (d'Orbigny, 1852) (Figure 355)

Myriozoum subgracile d'Orbigny in Smitt, 1868b : 18, 119; Waters, 1900 : 69, pl. 9, f. 4-9; *Leieschara subgracilis* Norman, 1876 : 206; *Myriozoum coarctatum* O'Donoghue, 1926 : 76, pl. V, f. 49.

The zoarium, free-growing and ramose, rises from a small, roundish, prostrate surface, and reaches up to a height of 5 cm or more. Branching is dichotomous, sometimes in one, sometimes in different planes. The branches often originate at an angle of 40 to 70°. The branches are cylindrical and have a thickness of 3.5 to 2 mm; usually the stem between the uprising branches, thins out gradually and smoothly from the zoarial base toward the top. Graduations are rarely found on the stem, and when they occur, they are far less noticeable than in other species of this genus. The branches have a round cross section and are radially arranged around the central axis of the zooids. The zooids are medium in size and arranged in regular, straight and oblique rows in a checkered pattern. The frontal surface, a reticulate with small pores at the bottom of the alveoli, is covered by a thin membrane or the epitheca. The primary orifice is semi-circular, its width is usually slightly greater than its height, and its straight, primary margin has a short, straight sinus at the middle, which deepens because of the straight condyle reaching up to its margins. The secondary orifice is roundish and, encircling the primary orifice, seems to submerge it; the margins of its sinus are slightly thickened. One small avicularium is usually located on one or both sides at the bud of the distal margin of the secondary orifice. The avicularium has a mandible whose free end is directed forward and toward one side. The rostral outgrowths are barely developed and noticed with great difficulty. The

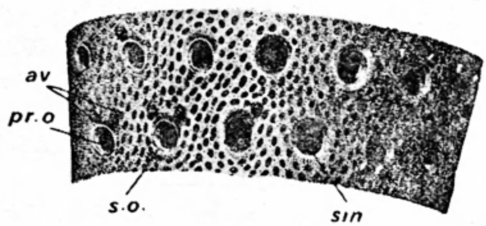


Figure 355. *Leieschara subgracilis* (d'Orbigny). Part of a branch. Barents Sea.

ovicells are hyperstomial in the form of a few round, semi-circular structures submerged in the depressions of the surface, and more prominently raised at the surface than those in *L. coarctata.* The surface in this species is very often calcified to such an extent that even the zooidal orifices cannot be found over a large length of the zoarium, not to speak of the avicularia, in which case the uniform thickness of the branches and the absence of graduations serve, to a certain extent, as criteria for identifying one or the other preparation as belonging to this species.

The species lives on stones and shells, at a depth of 1.5 to 520 m, more often from 50 to 100 m, on a bed of stone, silt, and shells, under temperatures ranging from −1.9 to 2.22°C, in a salt concentration of 27.92 to 34.70‰.

Distribution. This species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and in the waters off Labrador and the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879a; Marenzeller, 1877; Urban, 1880; Ridley, 1881; Nordgaard, 1912b; Bidenkap, 1897, 1900a, 1900b; Waters, 1900; Andersson, 1902; Kluge, 1906), Kara Sea (Smitt, 1879a; Levinsen, 1887; Nordgaard, 1912b; Kluge, 1929), Laptev and East Siberian seas (Kluge, 1929), Chukotsk Sea (Murdoch, 1885; Kluge, 1929), northern coast of North America and the Archipelago of the Canadian Islands (Busk, 1880; Nordgaard, 1906a; Osburn, 1932, 1936), Labrador (Packard, 1863, 1866-69), Gulf of St. Lawrence (Dawson, 1894; Whiteaves, 1901), western Greenland (Smitt, 1868a; Norman, 1876; Hincks, 1877a; Busk, 1880; Hennig, 1896; Kluge, 1908b; Levinsen, 1914), eastern Greenland (Andersson, 1902; Levinsen, 1914), and Newfoundland (d'Orbigny, 1852; Jullien and Calvet, 1903).

This is an Arctic, circumpolar species.

VI. Family **Hippothoidae** Levinsen, 1909

Hippothoidae Levinsen, 1909 : 274; *Myriozoidae* Smitt, 1868b : 8 (part.); Hincks, 1880a: 236 (part.); *Diazeuxidae* Jullien, 1888c : I, 27.

The zoaria, prostrate and overgrowing, consist of oblong or broad, thin-walled, hyaline, and glassy zooids. The frontal surface is either smooth with a transverse pattern or covered with numerous pores. The primary orifice is round with a rounded sinus at the proximal margin, or semi-circular with a straight or slightly concave, proximal margin. Spines are absent. Avicularia are not present in most species. Ovicells are present. The zooids communicate through pore chambers or pore plates.

Key for Identification of the Genera of the Family Hippothoidae

1 (2). Zooids oblong, cylindrical, or fusiform, have a smooth frontal surface with a transverse pattern. Avicularia may be present. Zooids have pore chambers..1. *Hippothoa* Lamouroux, (see below).

2 (1). Zooids broad with an oval surface on the frontal surface, and covered with a large number of pores. Spines, avicularia, and ovicells absent. Zooids communicate through pore plates.........................2. *Harmeria* Norman, (see p. 626).

1. Genus **Hippothoa** Lamouroux, 1821

Cellepora Linnaeus, 1767 : 1286; *Lepralia* Busk, 1854a : 63 (part.); *Celleporella* Gray, 1848 : 128; *Mollia* Smitt, 1868b : 16; *Schizoporella* Hincks, 1880a : 237 (part.).

The zoaria are prostrate, entire, or branched. The zooids are oblong-oval or almost cylindrical in shape, thin-walled, and translucent; their surface has a transverse pattern. The primary orifice is almost round with a semi-circular sinus at the short, proximal margin. Spines and avicularia are absent. The zooids carrying ovicells are much smaller than the normal ones. The ovicells are hyperstomial, raised, smooth surfaced, and either with or without pores.

Genus type: *Hippothoa divaricata* Lamouroux, 1821.

1 (2). Zoaria entire, either unbranched, or single branches uprise only at the margin of the zoarium. Zooids almost cylindrical in form, have a weak transverse pattern on the surface. Zooids which carry ovicells are dwarfed. Ovicells covered with pores...1. *H. hyalina* (L.)

2 (1). Zoaria branched. Zooids oblong-fusiform, or broad and almost rectangular. Frontal surface arcuate, transverse, or annular in pattern. Ovicells, without pores, have an oblong rebral uprising in the center of their continuous surface.

3 (6). Zooids oblong-fusiform in shape.

4 (5). Broad, distal part of the zooid constitutes one-third to one-fifth its length, and the transition of the broad part into the narrow, takes place more or less abruptly. Frontal surface has a weak transverse pattern, and its broad part has a longitudinal keel in the middle...................2. *H. divaricata* Lamouroux.

5 (4). Broad, distal part constitutes half of the zooidal length, and the transition into the narrow, proximal part takes place gradually.

Frontal surface smooth with a transversely annular pattern. There is no longitudinal keel. . . . 3. *H. divaricata* var. *arctica* Kluge.

6 (3). Zoids broadly oval or almost rectangular. Branches uprise terminally as well as from the very distal part of the lateral side, deviating at an acute angle. . . . . .4. *H. expansa* Dawson.

1. **Hippothoa hyalina** (Linnaeus, 1767) (Figure 356)

Lepralia hyalina Busk, 1854a : 84, pl. 82, f. 1-3; pl. 101, f. 1-2; *Mollia hyalina* forma *hyalina* Smitt, 1868b : 16, t. 25, f. 84-85; *Schizoporella hyalina* Hincks, 1880a : 271, pl. 18, f. 18-20; Levinsen, 1894 : 66, pl. 5, f. 47-57; *Hippothoa hyalina* Osburn, 1912 : 235, pl. 24, f. 47; 1933 : 33, pl. 9, f. 1-3.

The zoaria, prostrate, small, and roundish in shape, consist of radially divergent, regular rows of zooids arranged in a checkered pattern. The zooids are small (length 0.53 mm, width 0.25 mm), oblong-oval, or almost cylindrical in shape, thin-walled, and translucent, although more calcified and opaque ones are also found. The frontal surface is convex and smooth; it has a transverse pattern and, frequently, a raised tubercle (knob) under the orifice. Often certain structures, which are initially saccate and later funnel-shaped, are found in the proximal part of the zooids, situated close to the margin of the zoarium, either on one or both sides, and consequently between the 2 neighboring zooids; these structures are the early formations of the future saccate and ovicell-carrying zooids. The primary orifice, situated near the distal margin of the zooid, is almost round; it has a short, straight proximal margin which has a semi-circular sinus in the center. The short zooids carrying ovicells are much smaller than the normal ones (length 0.17 mm) and are sharply pointed toward the proximal end; the straight, proximal margin of their orifice has no sinus. The zooids with ovicells are situated above the normal ones in old zoaria. The ovicells are almost round, large, and broad (height 0.23, width 0.30 mm); they have a smooth, glassy surface and are covered with pores. There are 5 to 6 pore chambers located along the lateral

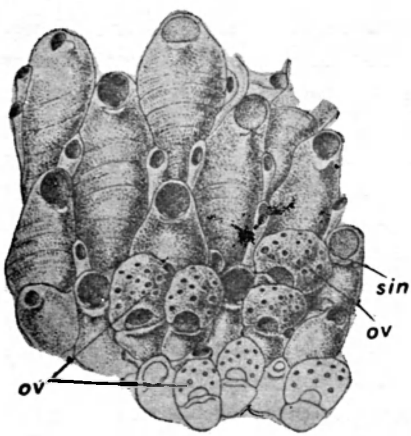


Figure 356. *Hippothoa hyalina* (L.). Part of a zoarium with saccate structures, and simple and ovicell-carrying zooids.

margin of the basal side, and 2 to 3 along the distal septum.

The species lives on all possible substrates such as laminaria, red algae, hydroids, Bryozoa, ascidia, shells, and stones.

Distribution. This species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, in the waters off western Greenland, and in the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879a, 1879b; Urban, 1880; Vigelius, 1881; Bidenkap, 1897, 1900a, 1900b; Nordgaard, 1907a, 1918, 1923; Waters, 1900; Andersson, 1902; Kluge, 1906; Kluge in Deryugin, 1915), White Sea (Gostilovskaya, 1957), Laptev, East Siberian, and Chukotsk seas (Kluge, 1929), northern coast of North America and the Canadian Islands (Busk, 1855; Verrill, 1879a, 1879b; Nordgaard, 1906a; Osburn, 1923, 1932, 1936), Labrador (Hincks, 1877a; Osburn, 1913), Gulf of St. Lawrence (Dawson, 1859; Whiteaves, 1901), western Greenland (Busk, 1855; Smitt, 1868c; Norman, 1876; Hincks, 1877a; Kluge, 1908b; Levinsen, 1914; Osburn, 1919, 1936), eastern Greenland (Kirchenpauer, 1874; Andersson, 1902; Levinsen, 1916), Yan-Maien Island (Lorenz, 1886), Iceland (Nordgaard, 1924), along the entire coast of the Atlantic Ocean from northern Norway to the Mediterranean Sea (Smitt, 1868b; Hincks, 1880a; Levinsen, 1894; Nordgaard, 1918; Borg, 1930a), and along the Pacific coast of North America from Alaska to California (Robertson, 1900, 1908).

In addition to the aforementioned places of its recovery, the present species has a broad distribution in the more southern seas, and so most authors have accepted it as a universal species.

*2. **Hippothoa divaricata** Lamouroux, 1821 (Figure 357)

Hippothoa divaricata Lamouroux, 1821 : 82, pl. LXXX, f. 15-16; Hincks, 1880a : 288, pl. XLIV, f. 1-3; Marcus, 1940 : 210, f. 108.

The zoaria, prostrate and ramose, consist of a single row of zooids. The branching is terminal and lateral. When the branching is terminal, sometimes not one zooid arises from the distal end to provide

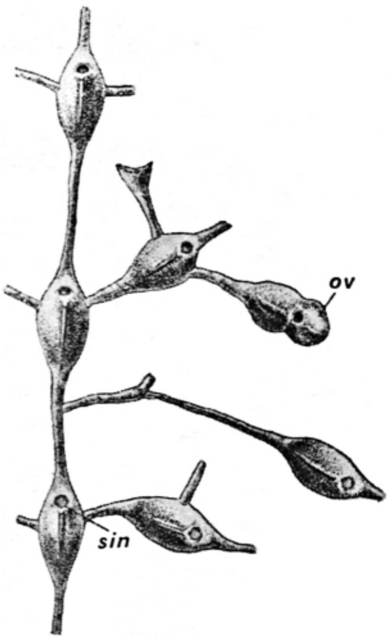


Figure 357. *Hippothoa divaricata* Lamouroux. Part of a branched zoarium.

for the continuation of the given branch, as happens in *H. divaricata,* but two zooids arise, which are separated at a small angle. Under lateral branching also, not one but two zooids often arise on each side of the broader part and, in addition, lateral branches often arise even from the narrow, oblong part; however, I never observed this phenomenon in the var. *arctica.* The zooids vary in length (from 0.50 to 1.38 mm), and the broader part forms one-third to one-fifth of the zooidal length; the width of the broader part is 0.04 mm, and the transition from the broader, distal part to the narrow, proximal one takes place abruptly. The frontal surface of the zooid has a very weak transverse pattern, but the broader part has a strongly expressed longitudinal keel in the center, which is never found in the var. *arctica.* The ovicells are hyperstomial, round, raised, and without keel.

The species lives mainly on shells and stones, from the belt of ebb and flow to considerable depths.

Distribution. Reports in literature: Coastal waters of southwest Norway (Nordgaard, 1906b), British Isles (Hincks, 1880a), western coast of France (Joliet, 1877; Fischer, 1870), Mediterranean Sea (Calvet, 1902), and Woods Hole on the eastern coast of North America (Osburn, 1912).

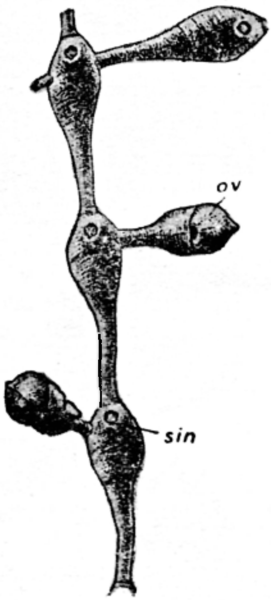


Figure 358. *Hippothoa divaricata* var. *arctica* Kluge. Part of a branched zoarium.

3. **Hippothoa divaricata** var. **arctica** Kluge, 1906 (Figure 358)

Hippothoa divaricata var. *arctica* Kluge, 1906 : 39; *Hippothoa hyalina* var. *divaricata* Smitt, 1868b : 17 (part.), t. 25, f. 87.

The zoarium, prostrate and ramose, consists of one row of zooids. The lateral branches originate from the side of the maternal zooid, almost at a right angle from the broadest distal part. The zooids are large (length 0.9 to 1.2 mm) and oblong, broadest in the distal half (0.25 to 0.38 mm), and narrowest in the proximal (0.08 to 1.10 mm); the distal half gradually transforms into the proximal. The frontal surface is raised with a deep margin, which has a row of small pores; it is smooth with a transverse, arcuate, bent, and annular pattern. The primary orifice, located near the distal margin of the zooid, is semicircular; its height is slightly larger than its width; it has a straight, proximal margin with a semi-circular sinus in the middle. The zooids carrying ovicells are shorter (length 0.70 mm), and the straight, proximal margin of the orifice has no sinus. The ovicells are hyperstomial, large, and semi-circular; their width is greater than their height; they have a smooth surface with a longitudinal, rebral outgrowth in the center, which extends from one end to the other.

The species lives on shells of lamellibranched mollusks and stones, rarely on laminaria, at a depth of 10 to 160 m, under temperatures ranging from −1.2 to 1.7°C.

Distribution. This form was found by me in the Barents, Laptev, Chukotsk, and Bering seas, and off western Greenland, as well as in the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Bidenkap, 1900a; Andersson, 1902; Nordgaard, 1905, 1912b, 1918; Kuznetsov, 1941), White Sea (Kluge, 1907; Gostilovskaya, 1957), Kara Sea (Nordgaard, 1912b), Archipelago of the Canadian Islands (Nordgaard, 1906a), Labrador (Packard, 1863), Gulf of St. Lawrence (Dawson, 1859; Whiteaves, 1901), western Greenland (Smitt, 1868c; Norman, 1876, 1906; Levinsen, 1914), and northern Norway (Nordgaard, 1918).

This is an Arctic, circumpolar species.

4. **Hippothoa expansa** Dawson, 1859 (Figure 359)

Hippothoa expansa Hincks, 1880a : 291, pl. I, f. 1; Waters, 1900 : 69, pl. 8, f. 19; *et auctt.*; *H. hyalina* var. *divaricata* Smitt, 1868b : 17 (part.), t. 25, f. 86.

The zoarium, prostrate and branched, consists of one row of zooids. The branching is often dichotomous, but sometimes the lateral branches arise from the maternal zooid from the very distal part of the lateral side, and directly adjoin the distally originated daughter zooid; consequently, it would seem, at first glance, that the 3 daughter zooids originate simultaneously from the distal end of the zooid. The daughter zooids diverge at a small angle and the zoarium overgrows, due to budding, into newly formed zooids, either terminally, or

Figure 359. *Hippothoa expansa* Dawson. Part of a zoarium. Barents Sea.

both terminally and by the aforementioned lateral process. The zooids, medium in size (length 0.58 to 0.83 mm, width 0.35 mm in the distal half and 0.20 mm in the proximal), broad, and oval in shape, narrow mildly toward the proximal end; as a result of a greater or lesser calcification of the lateral margins of the zooid, the latter often assume a broad, short, and almost rectangular shape. The frontal surface is raised, and has a strongly expressed, transverse, arcuate, bent, and annular pattern. The primary orifice, located near the distal margin of the zooid, is semi-circular; its height is slightly greater than its width; it has a straight, proximal margin with a semi-circular sinus in the center. The zooids carrying ovicells are smaller and thinner, and the straight, proximal margin of the orifice has no sinus. The ovicells are hyperstomial, large, semi-circular, and broad; they have a longitudinal, rebral outgrowth in the center, which extends from one end to the other.

The species lives on shells of lamellibranched mollusks and stones, at a depth of 20 to 136 m, on a bed of silt, stone, and shells, under temperatures ranging from −1.9 to −1.3°C.

Distribution. The species was found by me in the Barents, Kara, and Chukotsk seas, in the waters off western Greenland, and in the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1879b; Waters, 1900; Nordgaard, 1918), White Sea (Gostilovskaya 1957), northern coast of North America, Land of Ellesmere (Nordgaard, 1906a; Osburn, 1932), Labrador (Packard, 1863), western Greenland (Fabricius, 1780; Norman, 1876, 1906; Hincks, 1877a; Levinsen, 1914), Gulf of St. Lawrence (Dawson, 1859; Whiteaves, 1901), Gulf of Man (Osburn, 1933), eastern Greenland (Levinsen, 1916), and Yan-Maien Island (Lorenz, 1886).

This is a high Arctic, circumpolar species.

2. Genus **Harmeria** Norman, 1903

Harmeria Norman, 1903b : 107; Levinsen 1916 : 447; *Lepralia* Busk (part.), 1855 : 255; *Discopora* Smitt, 1868b : 25 (part.).

The zoaria, prostrate and discoidal, consist of 2 types of zooids—the larger, middle, and the smaller, marginal. The zooids are thin-walled, hyaline, hexagonal or oval in shape, and have a well-defined, oval, scutate surface, which is densely covered with pores and occupies the larger part of the frontal surface. The orifice is large and semi-circular; it has a slightly bent, proximal margin. The operculum is weakly chitinized. The peristome has the shape of a more or less developed sub-oral labium, and is situated at the proximal margin of the orifice. Spines, avicularia, and ovicells are absent. There are pore plates in the lateral wall and in the distal septum. The inclusion of the genus *Harmeria* in the family *Hippothoidae* by Levinsen is temporary, and requires further investigation. The bases for its inclusion in the family *Hippothoidae* are: the structure of the body wall which consists of a thin, hyaline, brittle, and calcareous mass, the absence of spines, and the simultaneous occurrence of calcification with growth; on the other hand, the genus *Harmeria* differs from other representatives of the family *Hippothoidae* by the absence of pore chambers and ovicells, and the presence of a porous surface at the frontal wall of the body.

Genus type: *Lepralia scutulata* Busk, 1855.

Harmeria scutulata (Busk, 1855) (Figure 360)

Lepralia scutulata Busk, 1855 : 255, pl. 2, f. 1-2; *Discopora scutulata* Smitt, 1868b : 25, t. 29, f. 160-161; *Harmeria scutulata* Norman, 1903b : 107; Levinsen, 1916 : 447, pl. XIX, f. 15-17.

The zoaria, prostrate and overgrowing the substrate in the form of round, flat cakes with a diameter of 1 to 1½ cm, have yellow-large margins in a live state. The zoarium consists of 2 types of zooids—large and colorless arranged within the zoarium, and small and colored arranged at the margin of the zoarium. The zooids are arranged in radial rows around the ancestrula. The ancestrula is oval, and has an aperture covered by a membrane which occupies the entire frontal surface; spines

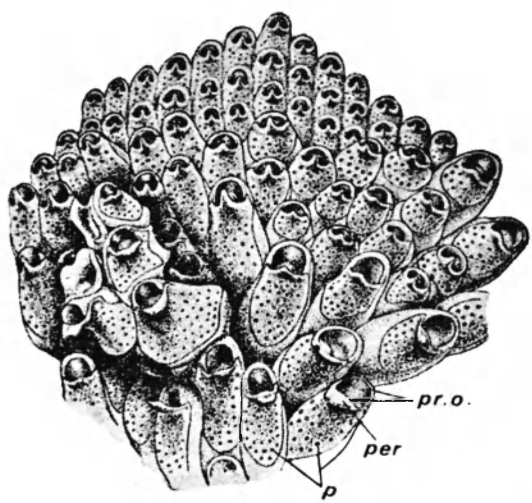


Figure 360. *Harmeria scutulata* (Busk). Part of a zoarium.

are absent from the latter. A series of larger zooids arise from the ancestrula, which produce 3 to 6 subsequent generations of similar zooids in the zoarium; these are followed by 5 to 6 concentric rows of smaller zooids. The larger zooids (length 0.59 mm, width 0.31 mm) are oblong-hexagonal, or rectangular and convex in shape, and have deep, lateral margins. The smaller ones (length 0.28 mm, width 0.18 mm) are broad, hexagonal, and almost flat. The zooidal walls are thin, hyaline, and translucent. A large part of the frontal surface is covered by the oval-shaped surface which is blanketed with pores. The primary orifice, located near the distal end of the zooid, is semi-circular, and has a mildly concave, proximal margin. The orifice of the larger zooids is covered with a more or less developed sub-oral peristome in the form of a broad labium, which narrows toward the distal margin; the margin appears to be thickened, but in actuality is slightly bent toward the inner side; the orifice of the smaller zooids has a more developed peristome, which parallels the lateral margins. Spines, avicularia, and ovicells are absent. There are 2 pore plates with 3 to 6 pores each in the lateral wall, and in the distal septum.

The species lives on laminaria, red algae, shells, and stones, at a depth varying from the belt of ebb and flow up to 48 m, on a bed of stone and laminaria, under temperatures ranging from -1.56 to 4.5°C, in a salt concentration of 31.44 to 34.27‰.

Distribution. This species was found by me in the Barents and Kara seas, in the Bering Strait, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868b; Nordgaard, 1896, 1918, 1923; Norman, 1903b; Kuznetsov, 1941), White Sea (Gostilovskaya, 1957), northern coast of North America and the Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1923, 1932, 1936) and the western coast of Greenland (Busk, 1855; Kluge, 1908b; Levinsen, 1914, 1916; Osburn, 1919, 1936).

This is an Arctic, circumpolar species.

VII. Family **Microporellidae** Hincks, 1880

Celleporidae (part.) Johnston, 1847 : 263; *Membraniporidae* (part.) Busk, 1854a : 55; *Eschariporidae* Smitt, 1868b : 3; *Microporellidae* Hincks, 1880a : 204.

The zoaria are prostrate or free-growing. The zooids have a semicircular or round orifice, or a compensatory sac (ascophore), behind the orifice at the medial line of the frontal surface. Avicularia may or may not be present. The ovicells are hyperstomial.

Genus **Microporella** Hincks, 1877

Microporella Hincks, 1877b : 526; *Porina* Smitt, 1868b : 5; *Lepralia* Busk, 1854d : 63 (part.); *Fenestrulina* Jullien, 1888c : 37; *Haplopoma* Levinsen, 1909 : 280.

The zoaria are prostrate and overgrow the surface. The zooidal orifice is semi-circular with a straight, proximal margin. A semi-circular or round orifice (ascophore) is located behind the orifice at the medial line. Lateral avicularia are either present or absent. The ovicells are hyperstomial. The zooids communicate through pore chambers.

Genus type: *Eschara ciliata* Pallas, 1766.

1 (6). Ascophore crescent-shaped. Proximal margin of the orifice of the zooid straight, without denticles near the corners.

2 (5). Ascophore more or less large and stellate with radially arranged spinules or denticles.

3 (4). Ascophore lies close to the proximal margin of the zooidal orifice. Avicularia present......................1. *M. ciliata* (Pallas).

4 (3). Ascophore lies in the middle of the frontal surface of the zooid. Avicularia absent......................4. *M. malusii* Audouin.

5 (2). Ascophore small, narrow, crescent-shaped, triangular, or round in the same zoarium. Avicularia sparse...2. *M. ciliata* var. *arctica* Norman.

6 (1). Ascophore round. Proximal margin of the zooidal orifice straight with small denticles near the corners. Avicularia absent..........................3. *M. impressa* (Audouin).

1. **Microporella ciliata** (Pallas, 1766) (Figure 361)

Porina ciliata Smitt, 1868b : 6, 58, t. 24, f. 18; *Microporella ciliata* Hincks, 1880a : 206, pl. 28, f. 1-5; Osburn, 1912 : 233, pl. 24, f. 44-44c; *M. impressa* Andersson, 1902 : 540.

The zoaria, prostrate in the form of roundish surfaces, consist of zooids arranged in more or less regular, oblique rows. The zooids are medium in size (length 0.50 to 0.70 mm, average 0.63 mm, width 0.43 to 0.57, average 0.48 mm), hexagonal or oval in shape and, in a young stage, thin-walled, hyaline, moderately raised, and covered with a large number of small pores, which are sometimes arranged radially; as they mature, the walls thicken, the surface becomes more convex, and the pores are less noticeable. The primary orifice, located near the distal end, is semi-circular; it has a straight, proximal margin, and there are usually 4 spines at the distal one which, it should be mentioned, are found more often in just the marginal zooids. Slightly behind the proximal margin of the orifice of the zooid, at the medial line, is located a semi-circular orifice; spines and denticles (ascophores) range radially from it to the margin. The frontal wall is usually strongly thickened behind the ascophore, forming a sort of tubercle which causes the ascophore to tilt toward the orifice, and sometimes become thereby less noticeable from the surface. An avicularium with a triangular, sharp mandible whose free end is directed forward and to one side, is located usually on one side of the ascophore, rarely on both sides, approximately on a level with it. The ovicells are hyperstomial, often have a porous surface, and sometimes have marginal, rebral formations and a more or less strongly developed tubercle at the surface.

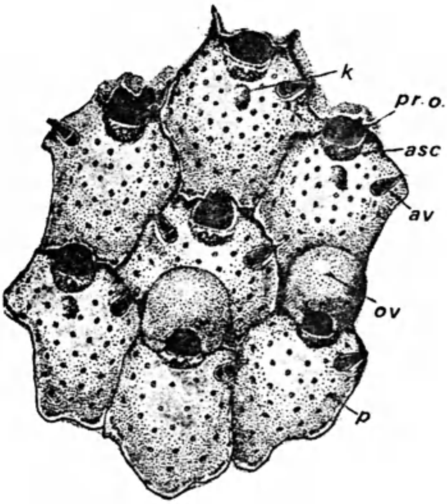


Figure 361. *Microporella ciliata* (Pallas). Part of a zoarium. White Sea.

The species lives on shells and stones, sometimes on algae, at a depth ranging between the littoral and 126 m, on a bed of stone, shells, and silt, under temperatures ranging from 2 to 2.7°C.

Distribution. The species was found by me in the Barents and Chukotsk seas. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879a, 1879b; Nordgaard, 1896; Bidenkap, 1900a; Kuznetsov, 1941), White Sea (Gostilovskaya, 1957), northern coast of North America (Osburn, 1932), Labrador (Packard, 1863; Osburn, 1913), western and eastern Greenland (Levinsen, 1914, 1916), eastern coast of the Atlantic Ocean from northern Norway to the Mediterranean Sea (Smitt, 1868b; Nordgaard, 1896, 1905, 1907b, 1918; Hincks, 1880a; Calvet, 1902), western coast of North America from Cape Cod to the Gulf of Man (Osburn, 1912), and the western coast of North America in the region of the Queen Charlotte Islands and Vancouver Island (Hincks, 1884; O'Donoghue, 1923, 1926).

This is an amphiboreal species but, due to its wide distribution, it has been regarded as a universal species by many authors.

2. **Microporella ciliata** var. **arctica** Norman, 1903 (Figure 362)

Porina ciliata Smitt, 1868b : 6 (part.), t. 24, f. 13-16; *Microporella arctica* Norman, 1903b : 105.

The zoaria are prostrate and consist of zooids arranged in radial rows in a checkered pattern. The zooids are comparatively large (length 0.70 to 0.80 mm, average 0.58 mm), broadly hexagonal or rectangular in shape, and hyaline and translucent in a young stage, becoming opaque with further calcification. The frontal surface is raised and covered with pores. The primary orifice, located at the distal margin of the zooid, is semi-circular; it has a straight proximal margin. Slightly behind the latter lies a small orifice (ascophore) at the medial line; it usually has a very narrow, crescent-shaped cavity, but sometimes this is irregularly triangular or round; regardless of its shape, the orifice never has radially arranged spinules. Zoaria are sometimes found with round ascophores which absolutely resemble those of *Microporella impressa,* and their zooids seem, at first glance, to differ little also. But one way to distinguish this species from the latter is by the presence of even a few crescent-shaped or triangular ascophores, as these are never found in *M. impressa.* Fascicular tubercles are sometimes found behind the ascophore at the frontal surface. Very rarely, lateral avicularia are found at the level of the ascophore, whose triangular and sharp mandibles have their tips pointed forward and toward one side. The ovicells are hyperstomial, round and raised; their width is greater than their height, and they have a granular surface. There are 5 to 6 pore chambers along the basal margin of the lateral wall, and 2 to 3 in the distal septum.

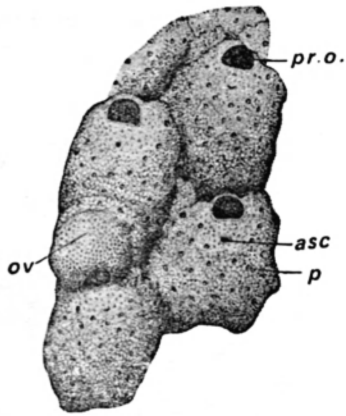


Figure 362. *Microporella ciliata* var. *arctica* Norman. Zooids with different types of ascophores.

The species lives on shells and stones, at a depth of 11 to 136 m, more often from 50 to 75 m, under temperatures ranging from —1.9 to 3.7°C.

Distribution. This species was found by me in the Barents, Kara, and Okhotsk seas, and in the Gulf of St. Lawrence. *Reports in literature:* Barents Sea (Smitt, 1868b; Bidenkap, 1900a; Andersson, 1902; Norman, 1903b; Kluge, 1906; Kluge in Deryugin, 1915; Nordgaard, 1918; Kuznetsov, 1941), White Sea (Gostilovskaya, 1957), Archipelago of the Canadian

Islands (Osburn, 1936), western Greenland (Smitt, 1868c; Norman, 1903b, 1906; Kluge, 1908b), and northern Norway (Nordgaard, 1918).

This is an Arctic species.

3. **Microporella impressa** (Audouin, 1826) (Figure 363)

Microporella impressa Hincks, 1880a : 214, pl. 26, f. 9-11; Nordgaard, 1896 : 21, pl. I, f. 1; non Bidenkap, 1900a : 512; 1900b : 252; non Andersson, 1902 : 540.

The zoarium is prostrate, and consists of zooids arranged in short, regular, oblique rows. The zooids are medium in size (length 0.75 mm, width 0.50 mm) and rhombic-oval in shape; the lateral sides of the distal half are more or less raised and the proximal one is concave. The zooids are thin-walled and translucent. The frontal surface is slightly raised and smooth; it has a weak, transverse, wavy structure and a sharply expressed deep margin. The entire surface is covered with comparatively uniform, small, and slightly raised pores. Among these pores is located a larger, round pore (ascophore) a little behind the orifice of the zooid at the medial line. The primary orifice is semi-circular; its width is slightly greater than its height; it has a straight, proximal margin and 2 small, sharply pointed denticles near the corners. Avicularia are absent. The ovicells are hyperstomial, round, and raised; they have a smooth surface which is covered with pores. The lateral wall has 5 to 7 pore chambers, and the distal septum 2 to 3.

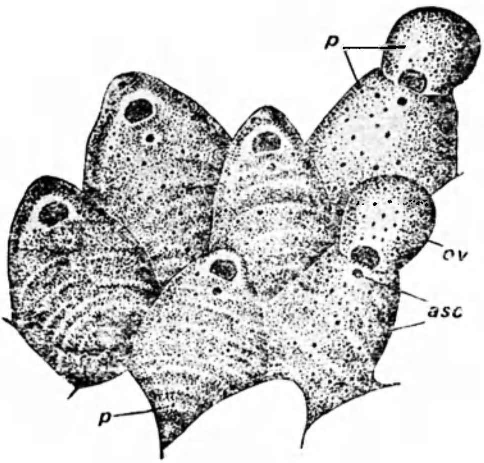


Figure 363. *Microporella impressa* (Audouin). Part of a zoarium.

The species lives on shells and stones, at a depth of 35 to 300 m, on a bed of stone and shells, under a temperature of 3.5°C.

Distribution. This species was found by me in the Barents Sea, in the southwestern, deep-water trough, and in Grinbay at Spitsbergen. *Reports in literature:* Barents Sea (Nordgaard, 1896, 1918), western Norway (Nordgaard, 1918), British and Shetland Islands (Hincks, 1880a), and the northwestern coast of France (Joliet, 1877).

This is a boreal species.

4. **Microporella malusii** (Audouin, 1826) (Figure 364)

Microporella malusii Hincks, 1880a : 211, pl. XXVIII, f. 9-10; *Porina malusii* Smitt, 1868b : 5, 56, t. XXIV, f. 11-12.

The zoaria are prostrate and consist of zooids arranged in radial rows in a checkered pattern. The zooids are medium in size, hexagonal, thin-walled, and translucent. The frontal surface is convex and smooth on the sides and between the orifice of the zooid, and the ascophore is covered with a large number of stellate pores. The orifice of the zooid is semi-circular; it has a straight, proximal margin and 2 to 4 spines at the distal margin. A semi-circular ascophore is located in the middle of the frontal surface, and spinules arise from the margin into its cavity. Avicularia are absent. The ovicells are hyperstomial and round; they have a smooth surface, and are bordered by a row of small pores along the distal margin, which are divided by calcareous rebra.

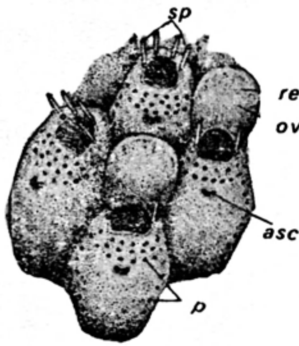


Figure 364. *Microporella malusii* (Audouin). A small part of a zoarium.

The species lives on algae, ascidia, shells, and stones, at a depth from the belt of ebb and flow to a few hundred meters.

Distribution. This species was found by me in the Chukotsk Sea in the region of Ice Cape. *Reports in literature:* Finmark (Smitt, 1868c), western coast of Norway (Nordgaard, 1918), Skagerrack (Smitt, 1868b), Kattegat (Levinsen, 1894; Marcus, 1940), North Sea (Borg, 1930a), Shetland (Norman, 1869), and British Islands (Hincks, 1880a), western coast of France (Fischer, 1870), Bay of Biscay (Jullien and Calvet, 1903), Mediterranean Sea (Calvet, 1902), New Zealand (Hincks, 1880a), and along the western coast of North America (Hincks, 1883; O'Donoghue, 1923, 1926; Robertson, 1908).

This is an amphiboreal species.

VIII. Family **Tessaradomidae** Jullien, 1903

Tessaradomidae Jullien, 1903 : pl. XIV; *Porinidae* (part.) d'Orbigny, 1852 : 431; Hincks, 1880a : 226; *Eschariporidae* (part.) Smitt, 1868b : 3; *Sclerodomidae* Levinsen, 1909 : 301.

The zoaria are free-growing and ramose, or prostrate and overgrowing. The frontal surface of the zooids is smooth, and either entirely covered with pores, or with just a row of marginal pores. Spines are present or absent. The primary orifice, covered with a mildly chitinized operculum, is encircled by a more or less developed tubular peristome, which opens through a roundish secondary orifice. Slightly below the peristome, or near its base, is a much smaller, short, tubular, and round orifice (spiramen) through which water passes into the peristomial tube. Avicularia are present or absent. The lateral wall and the distal septum have pore plates. The ovicells are hyperstomial.

Key for Identification of the Genera of the Family Tessaradomidae

1 (2). Zoaria free-growing and branched. Spiramen located slightly below the peristome. Spines absent. Avicularia present...... ....1. *Tessaradoma* Norman.

2 (1). Zoaria prostrate and overgrowing. Frontal surface covered with pores. Spiramen located near the base of the peristome. Spines present in young zooids. Avicularia absent................ ....2. *Cylindroporella* Hincks.

1. Genus **Tessaradoma** Norman, 1869

Tessaradoma Norman, 1869 : 309; *Pustulipora* M. Sars, 1851 : 146 (26); *Onchopora* Busk, 1860 : 213; *Quadricellaria* M. Sars, 1863a : 152; *Anarthropora* Smitt, 1868b : 7; *Porina* Hincks, 1880a : 227 (part.).

The zoaria are free-growing, cylindrical, and dichotomously branched. Spines are absent. The zooids are arranged in 4 rows in the middle, longitudinal axis. The surface of the zooids is smooth with pores located along the lateral margins. The primary orifice is encircled by a raised peristome. A small, tubular orifice (spiramen) is located near the base of the peristome which leads into the compensatory sac. Adventitious avicularia are present along the lateral margins of the zooid.

Genus type: *Pustulipora gracilis* M. Sars, 1851.

Tessaradoma gracile (M. Sars, 1851) (Figure 365)

Quadricellaria gracilis M. Sars, 1863a : 153; *Anarthropora borealis* Smitt, 1868b : 8, 67, pl. 24, f. 25-29; *Onchopora borealis* Busk, 1860 : 213, pl. 28, f. 6-7; *Tessaradoma boreale* Smitt, 1873 : 32, pl. 6, f. 143-145; *Porina borealis* Hincks, 1880a : 229, pl. 31, f. 4-6; *Tessaradoma gracile* Jullien and Calvet, 1903 : 74, pl. 3, f. 4, pl. 14, f. 2; Marcus, 1940 : 222, f. 113.

The zoarium, free-growing, branched, and rising from a small surface, overgrows the substrate and consists of a few generations of zooids arranged in 1 to 2 rows.

The zoarium attains a height of 3 to 4 cm, but is sometimes stretched horizontally to all sides. The branches are cylindrical and straight. The thickness of the branches is from 0.75 mm at the base to 0.38 mm at the top. Branches consist of zooids arranged around the longitudinal axis in 4 rows on 2 alternate longitudinal planes, which are perpendicular to each other. The zooids are oblong-oval in shape (length from 1 to 1.25 mm, width 0.38 mm), hyaline-translucent, and milky white; their walls have a fibrous structure like asbestos. The frontal surface is mildly raised, continuous, and finely fibrous; it has a very thin, barely noticeable, raised margin along which longitudinal and narrow depressions are located with pores at the bottom. The borders between the zooids are not distinguishable in the more calcified zoaria. The primary orifice, located near the distal margin of the zooid, is semi-circular; it has a weakly concave, proximal margin, and is encircled by an almost round, tubular peristome, which is markedly raised and sometimes slightly tilted, sometimes almost suspended above the surface, and terminates in a more transversely oval than round, secondary orifice. A short, tubular, and round orifice (spiramen), which is 3 to 4 times smaller, is located slightly below this orifice and opens inwardly near the base of the peristome above the primary orifice. When the operculum opens, water enters into the compensatory sac through this short, tubular orifice. One small, round, and slightly raised avicularium is located on both sides, almost at the level of the spiramen, but just below it. The semi-circular mandible points outward with its free margin. Besides these avicularia, 1 to 2 similar avicularia are found at the margin in the places of the marginal depressions. The ovicells are hyperstomial, semi-circular, and barely raised; they have a slightly granulated surface. The neighboring zooids communicate with each other through simple pores.

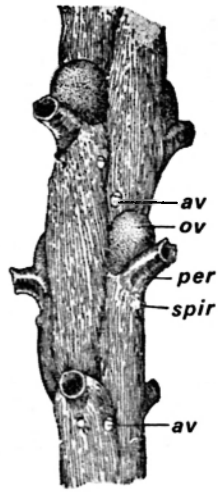


Figure 365. *Tessaradoma gracile* (M. Sars). Part of a branch. Laptev Sea.

The species lives on the stems of hydroids, Bryozoa, and stones, at a depth of 72 to 3,500 m, more often from 300 to 1,000 m, on a bed of stone, sand, and silt, under temperatures ranging from −1.2 to 6.34°C, in a salt concentration of 34.81 to 35.01‰.

Distribution. This species was found by me in the Barents, Kara, and Laptev seas. *Reports in literature:* Barents Sea (M. Sars, 1863a; Smitt, 1868b; Nordgaard, 1900, 1918), Norway (M. Sars, 1851, 1863a; Nordgaard, 1906b, 1907b, 1918, 1927; Norman, 1894), Skagerrack (Smitt, 1868b; Silen, 1936), Shetland Islands (Busk, 1860; Norman, 1869), western Greenland (Levinsen, 1914), Florida (Smitt, 1873), the Azores and Portugal (Smitt, 1873; Jullien and Calvet, 1903), and the Antilles (Busk, 1886).

This is an Arctic-boreal, Atlantic species which dwells in deep water.

2. Genus **Cylindroporella** Hincks, 1877

Cylindroporella Hincks, 1877b : 528; *Anarthropora* Smitt, 1868b : 7; *Porina* d'Orbigny, 1852 : 432; *Porinula* Levinsen, 1916 : 454.

The zoaria are prostrate and consist of small zooids with a well-developed, tubular peristome, in whose proximal part a tubular pore is located. The operculum is chitinized. The frontal surface is raised and porous. The calcified ectooecium has pores and the ovicell is turned backward. Avicularia are absent.

Genus type: *Lepralia tubulosa* (Norman, 1868).

Cylindroporella tubulosa (Norman, 1868) (Figure 366)

Cylindroporella tubulosa Hincks, 1877b : 528; *Porina tubulosa* Hincks, 1880a : 230, pl. 32, f. 6-9; *et auctt.; Anarthropora monodon* forma *minuscula* Smitt, 1868b : 7, 65, pl. 24, f. 20-22.

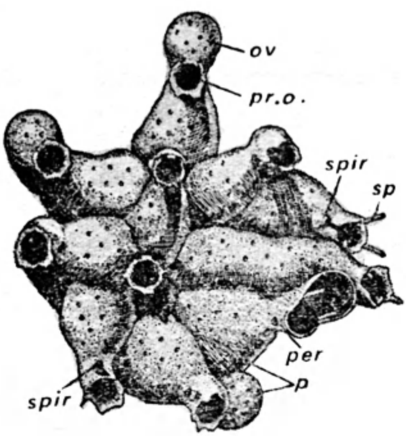


Figure 366. *Cylindroporella tubulosa* (Norman). Proximal part of a zoarium.

The zoaria, small and overgrowing, consist of radially divergent rows of zooids which stretch away from the ancestrula. The zooids are small (length 0.50 to 0.63 mm, width 0.30 mm) and rhombic or oval in shape. The frontal surface is slightly raised, smooth, and covered with pores. The primary orifice, located near the distal end of the zooid, is round, and completely encircled by the peristome; a small, semi-circular sinus is formed at the base of this peristome, the distal ends of which fuse as the peristome develops further, to form a low, tubular orifice. The peristome thus becomes an abruptly rising, round tube with a round secondary orifice. The young zooids located at the margin of the zoarium have 4 thin, long spines at the distal margin of the orifice. The ovicells are round and raised, sometimes bent far behind; their surface is covered with pores. In the zooids carrying ovicells, the lateral sides of the peristome are located on the ovicell and, fusing with each other, form a thin comb behind the proximal margin of the ovicell.

The species lives on algae, ascidia, shells, and stones, at a depth of 5 to 230 m, more often from 30 to 150 m, on a bed of stone, silt, and shells, under temperatures ranging from −1.7 to 3.2°C, in a salt concentration of 32.86 to 33.99‰.

Distribution. This species was found by me in the Barents, Kara, Chukotsk, Bering, and Okhotsk seas, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Urban, 1880; Ridley, 1881; Waters, 1900; Andersson, 1902; Nordgaard, 1905, 1923; Kluge in Deryugin, 1915; Kuznetsov, 1941), White Sea (Smitt, 1879b; Kluge, 1908a; Gostilovskaya, 1957), northern coast of North America and the Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1923, 1932, 1936), western Greenland (Smitt, 1868c; Hincks, 1877b; Norman, 1906; Kluge, 1908b; Levinsen, 1914; Osburn, 1919), Gulf of St. Lawrence (Whiteaves, 1901), eastern Greenland (Levinsen, 1916), Yan-Maien Island (Lorenz, 1886), northern Norway (Nordgaard, 1905, 1918), and the Shetland Islands (Norman, 1869).

This is an Arctic, circumpolar species.

IX. Family **Reteporidae** Smitt, 1868

Reteporidae **Busk, 1886 : 104; Levinsen, 1909 : 290; Canu and Bassler, 1920 : 500.**

The zoaria are free-growing in the form of funnel-shaped or complex, sinuate, lobate walls, which consist either of fused branches with cavities or windows, or ramose branches that do not anastomose with each other. The zoaria are double-layered and consist of one layer of autozooids whose frontal surface faces the inner side of the zoarium; the opposite or basal side of the zoarium is covered with one or many layers of kenozooids. The kenozooids do not resemble the zooids in shape or size, and their inner cavity may be strongly reduced or totally absent. Many of these kenozooids have avicularia which usually correspond to those of the autozooids. Depending upon its age, the zoarium is attached to the substrate by a large or small base which consists of kenozooids that usually have small avicularia on them. The zooids are more or less strongly calcified and communicate with each other and with the kenozooids through uniporous plates. The primary orifice is semi-circular, broad, and either surrounded by spines or devoid of spines. The zooids usually have adventitious avicularia on them of different shapes and sizes. The ovicells are hyperstomial, double-layered, and submerged; they have a smooth surface which is either continuous, or has a longitudinal slit or orifice in the center.

Genus **Retepora** Imperato, 1599

Retepora Busk, 1859 : 73; 1884 : 105; Hincks, 1880a : 388; Waters, 1904 : 77; Canu and Bassler, 1920 : 500.

The zoaria are free-growing in the form of funnel-shaped or complex situate, reticulate structures originating from a small surface of the zooids, which are prostrate over the surface. Short branches uprise from the latter, which are radially divergent, but soon become dichotomously branched; these branches anastomose after the secondary branching, and form cavities or windows. The prostrate base, which fixes the zoarium to the substrate, consists of multiangular, flat kenozooids with small, oval avicularia. The frontal surface of the zooids is located on the inner side of the zoarium, while the dorsal side is covered with flat kenozooids that vary in shape and size, and have one or several avicularia and small orifices. The zooids are small and cylindrically oval in shape; they have a semi-circular primary orifice, and spines may or may not be present. There is a large conical, or small oval, rostral avicularium on the proximal side of the secondary orifice. In addition to this rostral avicularium, other adventitious avicularia are also found on the surface of the zooids.

Genus type: *Retepora reticulata* (Imperato) Lamarck.

1 (4). Zooids have large, raised, conical, rostral avicularia with triangular, sharp mandibles.

2 (3). Cavities or windows of the zoarium are smaller and uniformly oval in shape. Peristome near the orifice usually has a very narrow slit on the side, which slightly broadens on the lower side...... ....1. *R. cellulosa* (L.).

3 (2). Cavities or windows of the zoarium are larger and oblong, and their ends sharper. Peristome continuous, but a rounded bend in its center gives the impression of a small sinus at the proximal margin of the secondary orifice..........2. *R. elongata* Smitt.

4 (1). Zooids have no large rostral avicularia.

5 (6). Pores sparsely located along the raised margin of the frontal surface. Primary orifice surrounded by 1 to 2 spines on each side. A small rostrum with an oval avicularium juts into the

orifice of the zooid....................3. *R. beaniana* King.

6 (5). Pores usually unnoticeable along the margin of the frontal surface. Narrow and oblique sinus located at the straight proximal margin of the secondary orifice; on one or the other side of the latter lies a small rostrum with a semi-circular mandible, slightly away from the proximal margin................................3a. *R. beaniana* var. *watersi* Nordgaard.

1. **Retepora cellulosa** (Linnaeus, 1758) (Figure 367)

Retepora cellulosa forma *cellulosa* Smitt, 1868b : 35, t. 28, f. 222-225; Waters, 1900 : 96, pl. 12, f. 8-9; *et auctt.*

The zoarium, free-growing in the form of a more or less broad, funnel-shaped, or sinuate, lobate wall, consists of fused branches with cavities or windows between them. The cavities are oval in shape, from 1.00 to 1.33 mm in length, and 0.38 to 0.70 mm in width. The branches consist of 1 to 3 rows of zooids of 0.25 to 0.68 mm thickness. The frontal surface of the zooids is located on the inner side of the funnels. The dorsal side of the zooids is covered with flat kenozooids in the form of surfaces of varying size, bordered by raised lines; very often avicularia are located near the distal corner of the window of the kenozooids. The zooids are small (0.55 mm length, and 0.20 mm width), cylindrically oval in shape, and have a smooth surface. The deep-seated, primary orifice, located near the distal margin of the zooid, is semi-circular and without spines. A well-developed peristome covers a large part of the orifice with its own body. It appears to consist of 2 unequal lateral lobes; the larger lobe has an almost straight, distal margin which constitutes the proximal margin of the secondary orifice. Usually on one side of the proximal margin, but rarely, close to its center, the lobes either fuse with each other

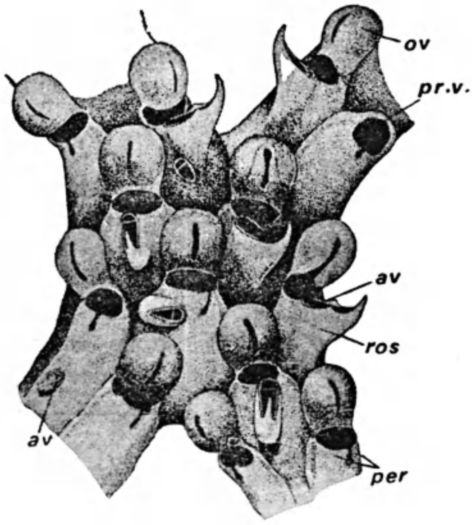


Figure 367. *Retepora cellulosa* (L.). Part of a branch with usual and larger avicularia. Barents Sea.

by their sharp, distal ends to form an oblong loop, as it were, or the distal end of one lobe, usually the larger, lies over the end of the other and forms a closed, oblong orifice. One to 2 small, low, adventitious avicularia are usually located at the surface of the zooid. In addition to these avicularia and their conical rostra, which have a semi-circular base and an upper beak-like end bent at a right angle, there are oblong, triangular, and sharp mandibles found near the proximal margin of the secondary orifice, which are strongly developed and raised above the surface. The ovicells are hyperstomial, semi-circular, and oblong; they have a smooth surface with a longitudinal slit-like orifice in the center, which is often closed but, rarely, may be open at the proximal end.

The species lives on tubes of worms, shells, and stones, at a depth of 1.5 to 450 m, more often from 50 to 200 m, on a bed of stone, silt, and shells with sand, under temperatures ranging from −1.79 to 3.9°C, in a salt concentration of 31.44 to 34.92‰

Distribution. The species was found by me in the Barents, Kara, and Bering seas, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Nordgaard, 1896, 1918; Bidenkap, 1897, 1900a, 1900b; Waters, 1900; Andersson, 1902; Norman, 1903b; Kluge, 1906; Kluge in Deryugin, 1915), White Sea (Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Kluge, 1929), western Greenland (Smitt, 1868c; Levinsen, 1914), eastern Greenland (Andersson, 1902; Levinsen, 1914), Yan-Maien Island (Lorenz, 1886; Nordgaard, 1907b), northern Norway (M. Sars, 1851; Danielssen, 1861; Smitt, 1868b; Nordgaard, 1896, 1905, 1918; Guerin-Ganivet, 1911), the Azores (Jullien and Calvet, 1903), and the Mediterranean Sea (Waters, 1895; Calvet, 1902). A large gap is found in the distribution of this species from Finmark to southwestern France.

This is an Arctic-boreal, Atlantic species.

2. **Retepora elongata** Smitt, 1868 (Figure 368)

Retepora cellulosa forma *notopachys* var. *elongata* Smitt, 1868b : 36, t. 28, f. 226-232; *R. wallichiana* Hincks, 1877a : 107, pl. XI, f. 9-13; Nordgaard, 1905 : 173, pl. III, f. 20; *R. elongata* Levinsen, 1887 : 323, pl. 27, f. 11; Waters, 1900 : 97.

The zoaria, free-growing, white, broad, and funnel-shaped, consist of fused branches with cavities or windows between them. The cavities vary in shape and size, but are distinguished by their oblong, oval, or rhombic form; they are sharp at the ends (1.75 to 4.50 mm length, 0.33 to 1.00 mm width). The branches consist of 2 to 4 rows of zooids formed by the fusion of 6 to 7 rows, and are 0.50 to 1.45 mm thick. The zooids are medium in size (length 0.63 to 0.75 mm, width 0.30 mm) and oblong-hexagonal or cylindrically oval in shape. The frontal surface, mildly raised and granulated, has a raised, thin margin along which very narrow, oblong depressions can be found in the younger zooids. The primary orifice, located near the distal end of the zooid, is semi-circular and encircled by a continuous, short peristome on the lateral and proximal sides, which seems to have a sinus in the middle of its proximal margin; in actuality, this apparent sinus is a rounded bend in the center of the peristome. The semi-circular, conical rostrum, raised at the base of the peristome in the proximal side, has a beak-shaped, bent top, and an oblong, triangular, sharp mandible, which is slightly obliquely directed to one side of the orifice. As a result of the thickening of the walls through greater calcification, on looking toward the base of the zoarium, the avicularia become more and more even with the general surface of the branch until, finally, only the yellow, chitinous mandible remains noticeable at the surface. The zoarium, starting with a small, subtentacular basal surface that is prostrate over the surface, consists of normal zooids with raised, conical avicularia; 5 to 6 short branches arise from their margin, which soon branch dichotomously. The branches arising from the secondary, dichotomous branches, are already anastomosed and initially form thereby, small but oblong cavities or windows. The initial surface of the zooids, having started the zoarium, overgrows the margins with no further formation of autozooids, but kenozooids in the form of small, irregular, polygonal, flat surfaces which are bordered by a raised margin that has flat, small avicularia in its center. The outer, basal side of the zooids, and the branches formed by these, are initially covered by small, irregular, flat surfaces with small, oval avicularia and round pores, but soon, as a result of the overgrowth of the cavities, the surfaces of the kenozooids become larger and larger and more oblong; rostral avicularia appear in them, which are often located either near the proximal ends, or on the sides of the cavities. The ovicells are hyperstomial, round, and

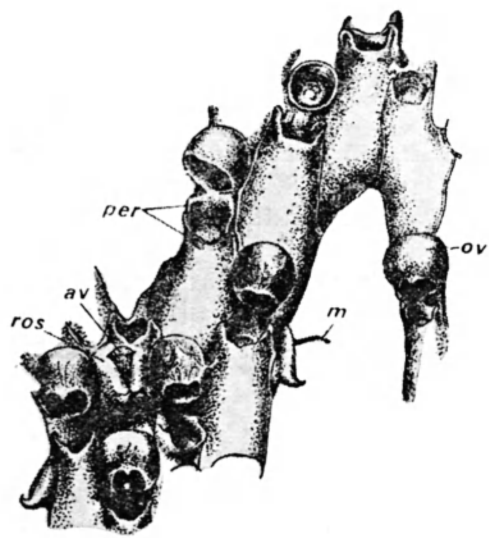


Figure 368. *Retepora elongata* Smitt. Part of a zoarial branch.

convex; they have an incompletely calcified ectooecium, while the concave, proximal margin of the endooecium has a sharp denticle in its center.

The species lives on tubes of worms, calcareous Bryozoa, shells, and stones, at a depth of 1.5 to 450 m, more often from 50 to 150 m, on a bed of stone, silt, and shells, under temperatures ranging from −1.9 to 3.9°C, in a salt concentration of 31.44 to 34.90‰.

Distribution. This species was found by me in the Barents, Kara, Laptev, East Siberian, and Bering seas, and in the waters off Labrador and western Greenland, and in the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Bidenkap, 1897, 1900a; Nordgaard, 1905, 1918; Waters, 1900; Norman, 1903b; Kluge, 1906; Kluge in Deryugin, 1915), Kara Sea (Smitt, 1879a; Levinsen, 1887; Kluge, 1929), Laptev Sea (Kluge, 1929), northern coast of North America and the Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1923, 1936), Gulf of St. Lawrence (Whiteaves, 1901), western Greenland (Smitt, 1868c; Hincks, 1877a; Hennig, 1896; Kluge, 1908b; Levinsen, 1914; Osburn, 1919), eastern Greenland (Andersson, 1902; Nordgaard, 1907a; Levinsen, 1916), and northern Norway (Smitt, 1868b; Nordgaard, 1896, 1905, 1918).

This is an Arctic, circumpolar species.

3. **Retepora beaniana** King, 1846 (Figure 369)

Retepora cellulosa forma *beaniana* var. *borealis* Smitt, 1868b : 34, 200, t. 28, f. 217-221; *R. beaniana* Hincks, 1880a : 391, pl. 53, f. 1-5; Levinsen, 1894 : 72, pl. VI, f. 23-27; *Sertella beaniana* Marcus, 1940 : 219, f. 112.

The zoarium, free-growing, white in color, initially in the form of a simple, and later a complex, sinuate funnel (attaining 5 cm or more in height and 8 cm in width), consists of fused branches with cavities or windows between them. The cavities are oval, from 0.88 to 1.38 mm in length, and 0.25 to 0.63 mm in width. The branches, sometimes narrow and consisting of 2 to 3 rows of zooids, are sometimes broad and consist of 4 to 5 rows. The frontal surface of the zooids is located on the inner side of the zoarium. Flat kenozooids are located on the outer or basal side of the funnel in the form of surfaces of varying shape and size, which are clearly demarcated by lines. The zooids, small (length 0.50 to 0.63 mm, width 0.18 to 0.30 mm) and cylindrically oval in shape, have a smooth frontal surface with 1 to 2 pores at the proximal margin, and scattered pores (from 2 to 5) along the raised, lateral margin. The deep-seated, primary orifice, located near the distal margin of the zooid, is semi-circular; condyles are located along its margins, and there are 1 to 2 spines on each side, which are very often jointed. The small rostrum of the oval avicularium has a semi-circular mandible located in the center of the proximal margin of the secondary orifice (peristome). The sinus is located on one or the other side of the rostrum in the lateral lobe of the peristome. In addition to the rostral avicularium, 1 to 2 low, oval avicularia are often found at the frontal surface of the zooid. Similar avicularia are likewise situated in the granulated basal side of the zoarial branches, and in individual parts of the latter, which are bordered by raised margins, another 1 to 3 avicularia may be seen. The ovicells are hyperstomial, semicircular, and oblong; they have a smooth surface with a longitudinal, slit-like orifice in the center.

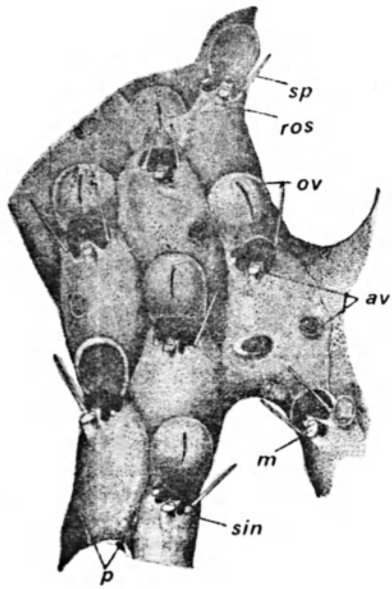


Figure 369. *Retepora beaniana* King. Part of a branch with ordinary and adventitious, oval avicularia on the frontal surface of the zooids. Barents Sea.

The species lives on sponges, shells, and stones, at a depth of 45 to 415 m, more often from 100 to 200 m, on a bed of stone, shells, and silt, under temperatures ranging from 2.93 to 4.95°C, in a salt concentration of 34.65 to 35.69‰.

Distribution. The species was found by me in the Barents Sea and off eastern Greenland. *Reports in literature:* Barents Sea (Danielssen, 1861; Smitt, 1868b, 1879a, 1879b; Nordgaard, 1896, 1907b, 1918; Bidenkap, 1900a, 1900b; Norman, 1903a; Kluge, 1906; Kluge in Deryugin, 1915; Grieg, 1925), eastern Greenland (Levinsen, 1914), western Greenland (Smitt, 1868c; Levinsen, 1914), Iceland (Nordgaard, 1924), western Norway (Smitt, 1868b; M. Sars, 1870; Nordgaard, 1896, 1905, 1918), Skagerrack (Smitt, 1868b; Silen, 1936), Kattegat (Levinsen, 1894), British Isles (Hincks, 1880a), and the Atlantic Ocean between Iceland and Norway (Nordgaard, 1918).

This is an Arctic-boreal, Atlantic species.

3a. **Retepora beaniana** var. **watersi** Nordgaard, 1907 (Figure 370)

Retepora beaniana var. *watersi* Nordgaard, 1907b : 16.

The zoarium is free-growing, broad, funnel-shaped, and ramose;

the branches anastomose with each other and form cavities or windows. The cavities are oval, sometimes broader, sometimes narrower (1.00 to 1.50 mm height, 0.5 to 1.00 mm broad). The branches consist of 2 to 4 rows of zooids formed by the fusion of 6 to 7 rows. The zooids are small (length 0.55 mm, width 0.30 mm) and cylindrically oval in shape; they have a rough, granular surface and raised margin which has no depressions or pores. The primary orifice, located near the distal margin of the zooid, is semi-circular and has no spines. An oblique, narrow sinus is located in the center, or on one side, of the straight, proximal margin of the secondary orifice. The sinus broadens terminally and divides the peristome into 2 parts; the small, oblique rostrum of the avicularium (which has a semi-circular mandible) is located slightly away from the margin in one part. In addition to the rostral avicularium, 1 to 2 small, oval avicularia are also located at the surface of the zooid. Similar avicularia are likewise found on the rough, granulated, basal side of the zoarium, which is covered with kenozooids of varying shapes; 1 to 3 avicularia may be found on a single kenozooid, and the latter is bordered by a raised margin. The ovicells are hyperstomial; they have a smooth surface with a longitudinal, slit-like sinus in its center.

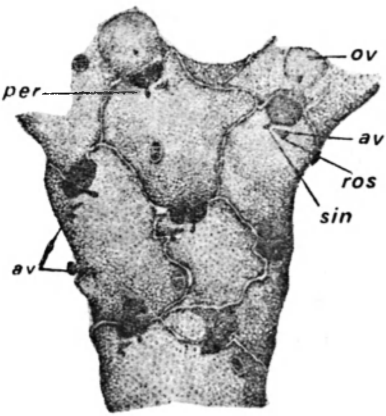


Figure 370. *Retepora beaniana* var. *watersi* Nordgaard. Part of a branch with ordinary and adventitious avicularia on the frontal surface of the zooids. Barents Sea, northward of Franz Josef Land.

The species lives on calcareous Bryozoa, shells, and stones, at a depth of 140 to 800 m, under temperatures ranging from −1.02 to 3.89°C, in a salt concentration of 34.63 to 34.72‰.

Distribution. The species was found by me in the Barents Sea, west of Spitsbergen, north of Spitsbergen, and near Franz Josef Land. *Reports in literature:* Atlantic Ocean on the east of Iceland (Nordgaard, 1907b).

This is an Arctic form.

X. Family **Hippoponellidae** Kluge fam. n.

Escharidae (part.) Smitt, 1868b : 19; Hincks, 1880a : 309; *Reteporidae* Levinsen, 1916 : 466.

The zoaria, prostrate and overgrowing, consist of small zooids. The zooids are thick-walled, hard, hyaline, and translucent; they have a smooth or tubular frontal surface, which is surrounded by a row of scattered, small, marginal pores. The primary orifice is semi-circular; it has a straight or slightly raised, proximal margin and developed condyles along the margins. The operculum is chitinous; one chitinous strip is located on each margin of the inner side for the attachment of the occlusor muscles. The distal margin of the secondary orifice has 2 to 4 spines which are long and thin. Adventitious avicularia are present. The ovicells are hyperstomial. Pore chambers or pore plates are present.

Key for Identification of the Genera of the Family Hippoponellidae

1 (2). Primary orifice semi-circular; its height greater than its width. Avicularian chamber not raised and oval avicularia located on the frontal surface of the zooid..1. *Hippoponella* Canu and Bassler, (see below).

2 (1). Primary orifice semi-circular; its width greater than its height. Avicularian chamber raised at the proximal margin of the secondary orifice, and the sharp mandible of the avicularium has its free end directed upward...2. *Lepraliella* Levinsen, (see p. 648).

1. Genus **Hippoponella** Canu and Bassler, 1920

Hippoponella Canu and Bassler, 1920 : 379; *Lepralia* (part.) Smitt, 1868b : 20; *Eschara* Norman, 1906 : 92; *Lepralia* Levinsen, 1916 : 466.

The primary orifice is semi-circular; its height is greater than its width; the proximal margin is straight or slightly concave. The condyles, rather well-developed at the margin, are sharp, and make the orifice narrower at this place, giving it the appearance of a hoof. The chitinous operculum narrows before the proximal margin in a manner corresponding to the form of the orifice. On one side of the orifice, or near the proximal margin, and at other places of the surface, are located oval avicularia of different sizes. Pore chambers or pore plates are present. The ovicells are round and have no sinus in the frontal wall.

Genus type: *Lepralia hippopus* Smitt, 1868.

1 (2). Frontal wall often gradually thickens toward the middle part, but forms no conical protuberances. A comparatively large, oval avicularium located on one side of the orifice, either on

a level with it or below it.............1. *H. hippopus* (Smitt).

2 (1). A large, conical protuberance usually develops in the middle of the frontal surface; similar but smaller protuberances also develop at the sides of the orifice. A small, round avicularium located between the proximal margin of the orifice and the conical protuberance; similar avicularia likewise located at other places on the surface...2. *H. fastigatoavicularis* (Kluge).

1. **Hippoponella hippopus** (Smitt, 1868) (Figure 371)

Lepralia hippopus Smitt, 1868b : 20, pl. 26, f. 99-105; Hincks, 1880a : 309, pl. 33, f. 8-9; *Lepraliella hippopus* Levinsen, 1916 : 466, pl. 22, f. 10-14; *Hippoponella hippopus* Osburn, 1933 : 44, pl. 10, f. 3, pl. 11, f. 3-4.

The zoarium, prostrate in the form of a thin, translucent crust, which is white in color in a young stage, consists of zooids arranged in irregular rows. The zooids are small (length 0.63 mm, width 0.46 mm) and hexagonal or rhombic in shape. The frontal surface, in a young stage, is moderately convex with a slightly raised margin along which are located small, occasional (6 to 7) depressions with pores at the bottom; with further calcification, the frontal wall thickens and the individuals are separated by slightly depressed margins in which the smaller pores are retained. The primary orifice, located near the distal margin of the zooid, is semi-circular; its height is markedly greater than its width; the distal margin is round and the proximal one almost straight but slightly concave; long, sharp condyles are located a little above the latter at the sides, and the cavity of the orifice is narrower in this place, giving it the appearance of a hoof. The operculum is chitinized, and there are longitudinal, parallel, rebral strips on the sides of its inner side for the attachment of the occlusor muscles. The ovicells are hyperstomial, round, and raised; their outer covering consists of 3 parts—2 lateral, representing the lateral parts of the frontal wall of the neighboring zooids, and the third, distal one belonging to the frontal wall of the overlying zooid. Their

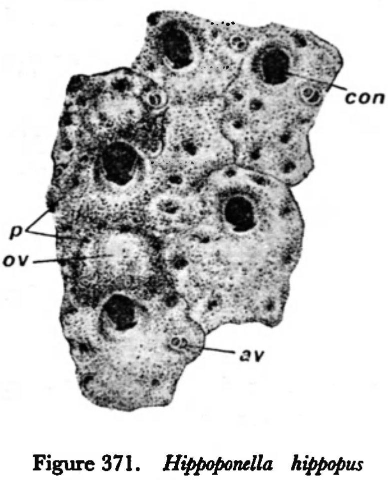


Figure 371. *Hippoponella hippopus* (Smitt). Part of a zoarium. Barents Sea.

surface is continuous and strongly granulated. In some zooids, oval avicularia of varying size are located on one side of the frontal surface proximal to the orifice, or at the level of it on one or the other side. Two pore chambers with a few pores are located along the basal margin of the lateral wall and in the distal septum.

The species lives on stones, shells of mollusks, tubes of *Polychaeta,* and ascidia, at a depth of 14.5 to 235 m, on a bed of stone, sand, and shells, under temperatures ranging from −1.23 to 2.7°C, in a salt concentration of 32.86‰.

Distribution. The species was found by me in the Barents, Kara, Chukotsk, and Bering seas, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Waters, 1900; Andersson, 1902; Kluge in Deryugin, 1915), White Sea (Gostilovskaya, 1957), Archipelago of the Canadian Islands (Nordgaard, 1906a), Labrador (Osburn, 1913), western Greenland (Smitt, 1868c; Norman, 1876, 1906; Kluge, 1908b; Levinsen, 1914), Gulf of St. Lawrence (Whiteaves, 1901), eastern Greenland (Levinsen, 1916), northern Norway (Smitt, 1868b; (Nordgaard, 1918), and the British Isles (Hincks, 1880a).

This is an Arctic, circumpolar species.

2. **Hippoponella fastigatoavicularis** (Kluge, 1955) (Figure 372)

Lepraliella fastigatoavicularis Kluge, 1955a : 93, fig. 37.

The zoarium, prostrate in the form of a small, white, crustaceous overgrowth, consists of zooids arranged in irregular short rows. The zooids are small (length 0.53 mm, width 0.32 mm) and oblong-hexagonal in shape. The frontal wall is hyaline and milky-translucent; it has a moderately raised and smooth surface. A relatively large, conical protuberance is often located proximal to the orifice in the middle of the surface; similar but smaller protuberances are located on the sides of the zooidal orifice. The primary orifice, located near the

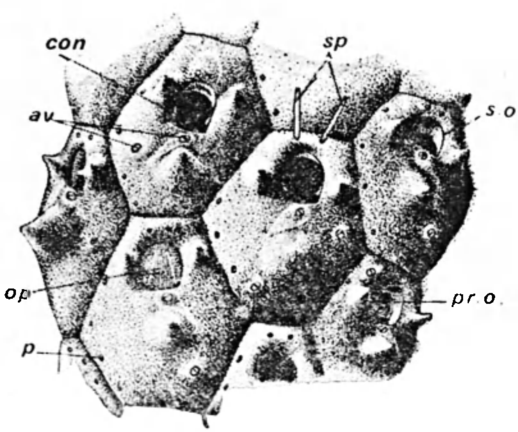


Figure 372. *Hippoponella fastigatoavicularis* (Kluge). Part of a zoarium with ordinary and adventitious avicularia (from Kluge, 1955a).

distal margin of the zooid, is semi-circular; it has straight, lateral margins and a slightly concave, proximal margin; its height is greater than its width. One rather strongly developed, sharp condyle is located slightly above the lateral ends of the proximal margin, on each side of the primary orifice. The quite strongly chitinized operculum is yellow in color; there are 2 lateral, oblique, rebral structures on its inner side, along the 2 sides of the medial line, for the attachment of the occlusor muscles. The primary orifice is covered with a thick frontal wall leading to the formation of a secondary zooidal orifice at the surface. A small, frontal avicularium with a semi-circular mandible is located behind the proximal margin of the orifice prior to the conical protuberance. The free margin of the mandible, raised upward, is obliquely directed toward the longitudinal axis of the zooid by its oval, hollow, and proximally sharpened avicularian chamber. In addition to this avicularium, there are small, adventitious avicularia with semi-circular mandibles, arranged in no definite order on the frontal surface of many zooids, but mainly in the proximal half. The ovicells are small and roundish, and located in the frontal wall of the same zooid above its orifice. There are 4 pore plates with 2 to 3 pores each in the lateral wall of the zooid, and 2 in the distal septum.

This species lives on the shells of lamellibranched mollusks, at a depth of 51 m, on a sandy bed, under a temperature of 2.08°C, in a salt concentration of 32.88‰.

Distribution. This species was found by me in the Bering Sea.

2. Genus **Lepraliella** Levinsen, 1916

Cellepora (part.) Smitt, 1868b : 31; *Rhamphostomella* (part.) Nordgaard, 1905 : 172; *Lepraliella* Levinsen, 1916 : 466.

The primary orifice is semi-circular; its width is greater than its height. The chitinized operculum is semi-circular. The transverse, conical avicularian chamber is located at the proximal margin of the secondary orifice; there is an avicularium with a sharp mandible whose tip is directed upward, located on one of the lateral sides of this chamber. The ovicells are hyperstomial, deep-seated, and oblong semi-circular in shape; they have a rounded, triangular sinus at the frontal surface. Pore chambers are present.

Genus type: *Cellepora ramulosa* forma *contigua* Smitt, 1868.

Lepraliella contigua (Smitt, 1868) (Figure 373)

Cellepora ramulosa forma *contigua* Smitt, 1868b : 31, 189, t. 28, f. 198-201; *Rhamphostomella* *contigua* Nordgaard, 1905 : 172, pl. V, f. 18-20; *Lepraliella contigua* Levinsen, 1916 : 467, pl. 21, f. 2-14; *Lepralia vitrea* Lorenz, 1886 : 89 (7), pl. VII, f. 4-6; Andersson, 1902 : 542, f. 2.

The zoarium, prostrate like a thin, white crust with a glassy surface, consists of zooids arranged in more or less regular, straight and oblique rows. The zooids are small (length 0.50 mm, width 0.50 mm), rhombic-hexagonal in shape, and equal in length and width. The frontal wall is thick with a convex surface, which rises toward the orifice and is covered with wavy tubercles; in a young stage, it is surrounded by an uneven, deep margin near which small pores are scattered (from 3 to 5). The primary orifice, located near the distal margin of the zooid, has a straight or mildly concave, proximal margin and 2 condyles on the sides of the orifice. Three long, thin spines are located at the distal margin of the young zooids, which easily fall off and leave 3 corresponding orifices in their places of attachment. The secondary orifice is semi-circular; there is a raised avicularian chamber, sharpened toward the upper side, located at its proximal margin between the low, lateral lobes of the peristome; an avicularium, whose pointed mandible is usually directed upward by its tip, is located on one of the lateral sides of the avicularian chamber. The ovicells are hyperstomial, deep-seated, and oblong-semi-circular in shape; there is a roundish triangular sinus near the base of the incompletely calcified, frontal wall, which narrows toward the upper side and can be seen in dry preparations. There are 2 pore chambers with a few pores located along the basal margin of the lateral wall and in the distal septum.

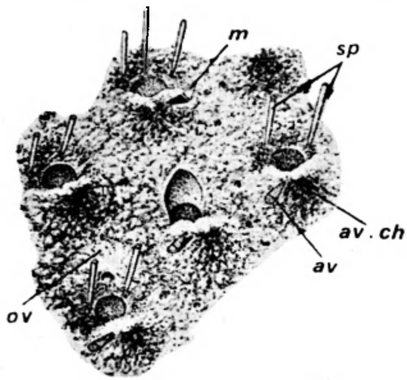


Figure 373. *Lepraliella contigua* (Smitt). Part of a zoarium. Barents Sea.

The species lives on shells and stones, at a depth of 10 to 162 m, more often from 75 to 150 m, on a bed of stone, sand, and shells, under temperatures ranging from −1.23 to 2.56°C, in a salt concentration of 32.86 to 34.79‰.

Distribution. The species was found by me in the Barents, Chukotsk, Bering, and Okhotsk seas, and in the waters off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Bidenkap, 1900a, 1900b; Andersson, 1902; Kluge, 1906; Kluge in Deryugin, 1915; Kuznetsov, 1941), White Sea (Kluge, 1907, 1908a; Kluge in Deryugin, 1928; Gostilovskaya, 1957), Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1923, 1932, 1936), western Greenland (Smitt, 1868c; Norman, 1876, 1906; Kluge, 1908b; Levinsen, 1914), eastern Greenland (Levinsen, 1916), Gulf of St. Lawrence (Whiteaves, 1901), Iceland (Nordgaard, 1924), Yan-Maien Island (Lorenz, 1886), and northern Norway (Smitt, 1868c; Nordgaard, 1918).

This is an Arctic, circumpolar species.

XI. Family **Rhamphostomellidae** Kluge fam. n.

Celleporidae (part.) Smitt, 1868b : 30; *Smittinidae* (part.) Levinsen, 1909 : 343.

The zoaria are prostrate, overgrowing, or free-growing. The frontal surface is either smooth or covered with radially stretched rebra between which marginal pores are found, or the entire surface is covered with pores. The primary orifice is roundish with a narrow lyrule on the proximal margin, or the lyrule may be absent. Condyles are always absent. The operculum is membranous. Spines are not found in most of the species. The peristome may be present or absent. When it is present, it consists of 2 asymmetrical, rarely symmetrical, lobes which are divided by a deep sinus; an avicularium is located in one lobe, on one or the other side. Pore plates are present in both the lateral wall and the distal septum. The ovicells are hyperstomial and consist of 2 calcareous layers; the outer one is either covered with pores or has none.

Key for Identification of the Genera of the Family Rhamphostomellidae

1 (2). Avicularium located near the proximal margin of the orifice of the zooid in the form of a raised conical or semi-circular avicularian chamber; a rostrum is located on its side which is sharp or rounded at the end and has a mandible of corresponding form, or the avicularium is situated in one of the lateral lobes of a more or less developed peristome.................... ....1. *Rhamphostomella* Lorenz.

2 (1). Avicularium located in one, rarely both, lateral lobe of the weakly developed peristome, or situated on the frontal surface on one side of the narrow, straight sinus of the secondary orifice...............................2. *Escharopsis* Verrill.

1. Genus **Rhamphostomella** Lorenz, 1886

Cellepora Smitt, 1868b : 30 (part.); *Rhamphostomella* Lorenz, 1886 : 11 (93); *Discopora* Levinsen, 1909 : 343 (part.).

The zoarium is either prostrate, single-layered, and tightly or loosely overgrows the substrate, or it is free-growing in the form of a double-layered, sinuate, and bent plate. The zooids, thin-walled and translucent, are usually arranged in regular, alternate rows. The smooth frontal surface is moderately raised, and bordered by a more or less raised margin; it may be with or without pores, or covered with rebra which stretch in a radial direction from the margin to the middle of the surface, or toward the base of the rostrum of the avicularium. The primary orifice is large and roundish, and a lyrule may or may not be present on the proximal margin. This operculum is thin and weakly chitinized. The peristome is present or absent. When the peristome is absent, a more or less raised rostrum of the avicularium directly adjoins the proximal margin of the primary orifice in the form of a semi-circular or conical protuberance, on one or the other side of which is located an oblong mandible with a sharp or rounded end. If the peristome is present, it consists of two lateral lobes, one of which is the rostrum of the avicularium, which has a more or less oblong mandible, and lies in the lateral, medial plane against the lateral, medial margin of the lobe of the other side. There are pore plates in the lateral wall and in the distal septum. The basal side of the zooid may or may not be covered with small, white spots or pseudopores.

Genus type: *Eschara scabra* Fabricius, 1780.

1 (8). Semi-circular or conical, and more or less raised rostrum of the avicularium directly adjoins the proximal margin of the orifice of the zooid. In addition to the pre-oral avicularium, adventitious avicularia also found on the surface of the zooids.

2 (5). Mandible of avicularium sharply pointed at the tip. Lyrule present in the middle of the proximal margin of the orifice. Adventitious avicularia large.

3 (4). Lyrule usually well-developed, sometimes in the form of an oblique, asymmetrical tooth. Frontal surface of the zooid covered with radially arranged rebra which often continue on the surface of the rostrum...........2. *Rh. costata* Lorenz.

4 (3). Proximal margin of the orifice has a low asymmetrical, oblique tooth which may be weakly raised. Frontal surface smooth, with traces of radial, rebral structures. Rostrum strongly raised; its bulging avicularian chamber sharply narrows to the upper side and terminates with a beak or pecten which bends at a right angle. Surface of the rostrum coarsely granulated and opaque. There are 2 spines at the distal margin. Adventitious avicularia large.........................

........................2a. *Rh. costata* var. *cristata* Hincks.

5 (2). Mandible of rostrum semi-circular at the free end. Lyrule absent. Ovicells have pores.

6 (7). Proximal margin of the orifice straight or slightly concave. Frontal surface covered with radially arranged rebra reaching up to base of rostrum. Adventitious avicularia large........ ....1. *Rh. scabra* (Fabricius).

7 (6). Proximal margin of orifice has a weakly sharpened, asymmetrical slit. Frontal surface, without rebra, covered with pores. Distal margin of orifice has 2 spinules. Adventitious avicularia small. Ovicells usually have no pores.......... ....3. *Rh. ovata* (Smitt).

8 (1). Zooids have a developed peristome in the form of 2 lateral lobes of which one is the rostrum of the avicularium. Adventitious avicularia absent.

9 (10). Lyrule absent. Secondary orifice triangular. Frontal surface smooth and continuous...........4. *Rh. hincksi* Nordgaard.

10 (9). Lyrule present.

11 (12). Zooids have 4 spines; there are 2 spines in the zooids carrying ovicells. Frontal surface continuous and granulated, has marginal pores.....................5. *Rh. spinigera* Lorenz.

12 (11). Zooids without spines.

13 (14). Zooids small and congested; frontal surface covered with rebra; lateral lobes of peristome have a goffered, distal margin. ....6. *Rh. radiatula* (Hincks).

14 (13). Zooids larger; lateral lobes of peristome do not have a goffered, distal margin.

15 (16). Frontal surface smooth. Rostrum of avicularium significantly stretched and thin, has a long, narrow, and straight mandible. ....7. *Rh. plicata* (Smitt).

16 (15). Frontal surface partly covered with a secondary layer which has turned margins.

17 (18). Both lobes of peristome almost equally developed; their lateral and upper margins outwardly bent; mandible of avicularium small and semi-oval..............8. *Rh. bilaminata* (Hincks).

18 (17). Lobe of peristome with avicularium strongly developed; mandible large, broad, slightly bent, and broader toward the distal end; avicularian chamber broad and bulging, has a flat, sharp pecten at the upper margin.................... ....8a. *Rh. bilaminata* var. *sibirica* Kluge.

1. **Rhamphostomella scabra** (Fabricius, 1780) (Figure 374)

Cellepora scabra Smitt, 1868b : 30, 181 (part.), pl. 28, f. 183-184; *Rhamphostomella scabra* Nordgaard, 1905 : 171, pl. V, f. 8-11.

The zoarium, partly prostrate, consists of zooids arranged in regular rows in a checkered pattern. The zooids are large (length 1.15 mm, width 0.70 mm), broadly hexagonal or oval in shape, and thin-walled. The frontal surface is raised, hyaline, translucent, and bordered by a raised margin that has deep depressions with pores at the bottom; thin, raised rebra arise between the depressions from the margin in a radial direction toward the base of the semi-circular, conical, avicularian chamber. The primary orifice, located at the distal margin of the zooid, is large and semi-circular; its width is greater than its height; raised and barely noticeable condyles are rather closely located on the sides of the proximal margin which is slightly raised. A raised rostrum directly adjoins the proximal margin of the orifice; it has a low, semi-circular, conical, avicularian chamber whose oblong-semi-circular mandible is directed toward one or the other side, while its free margin is pointed upward. Sometimes zoaria are also found in which the zooids have a thin and sharp pecten at the end of the upper margin of the rostrum. In addition to the oral avicularia, similar avicularia are often found at the zooidal surface, but these are larger in size, and their avicularian chamber sometimes covers the entire remaining zooidal surface. The ovicells are large, semi-circular, broad, and raised; they have a smooth frontal surface with pores arranged in a semi-circle in the middle and inside the frontal surface. The basal surface is entirely laden with small, white spots or pseudopores. There are 4 pore plates with 4 to 5 pores each in the lateral wall of the zooid. There are 2 short, calcareous thickenings which transversely arise from the lateral wall of the distal septum and, as it were, divide it into 2 halves; 2 pore plates with 6 to 7 pores each are symmetrically placed in the lower half.

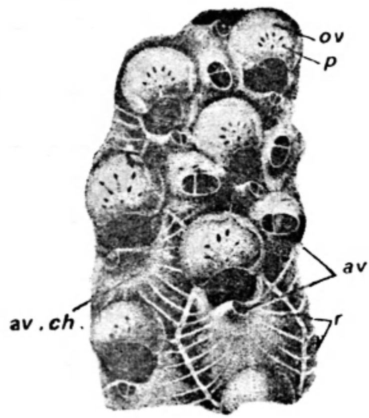


Figure 374. *Rhamphostomella scabra* (Fabricius). Part of a zoarium with ordinary and adventitious, large avicularia. Barents Sea.

The species lives on sponges, ascidia, shells, and stones, at a depth of 1.5 to 460 m, more often from 50 to 250 m, on a bed of stone, silt, and sand, under temperatures ranging from -1.9 to 4.25°C, in a salt concentration of 34.40 to 34.96‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and in the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Bidenkap, 1900a; Andersson, 1902; Nordgaard, 1905; Kuznetsov, 1941), White Sea (Smitt, 1879a; Kluge, 1907; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Levinsen, 1887; Nordgaard, 1912b; Kluge, 1929), Laptev Sea (Kluge, 1929), Archipelago of the Canadian Islands (Nordgaard, 1906a), Gulf of St. Lawrence (Whiteaves, 1901), western Greenland (Fabricius, 1780; Hennig, 1896; Norman, 1906; Kluge, 1908b; Levinsen, 1914; Osburn, 1916), eastern Greenland (Andersson, 1902; Levinsen, 1916),? Yan-Maien Island (Lorenz, 1886), and northern Norway (Nordgaard, 1905).

This is an Arctic, circumpolar species.

2. **Rhamphostomella costata** Lorenz, 1886 (Figure 375)

Cellepora scabra Smitt, 1868b : 30 (part.), pl. 28, f. 183-184; *Rhamphostomella costata* Lorenz, 1886 : 94 (12), t. VII, f. 11; Hincks, 1889 : 426, pl. 21, f. 7-8.

The zoarium, initially prostrate in the form of a single-layered, overgrowing crust, later becomes free-growing in the form of a relatively broad, double-layered lobe, which consists of zooids arranged in regular, straight and oblique rows. The zooids are large (length 0.88 to 1.00 mm, width 0.60 mm), hexagonal or oval in shape, and thin-walled. The frontal surface is convex and bordered by a thin, mildly raised margin that has depressions with pores at the bottom; rebra uprise between the depressions in a radial direction from the margin toward the raised, conical, avicularian chamber. The rebra usually, but not always, convert into the wall of the chamber. The primary orifice of the zooid is semi-circular; its height is slightly greater than its width; a more or less broad lyrule is located in the middle of the proximal margin, which has a straight margin but stretches out into sharp ends directed in opposite directions. Sometimes it seems that only half of the lyrule

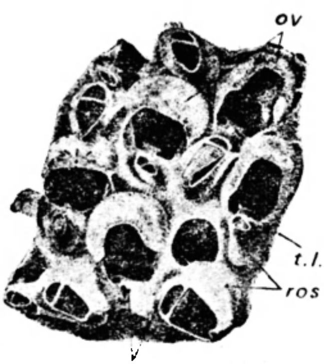


Figure 375. *Rhamphostomella costata* Lorenz. Part of a zoarium with ordinary and adventitious, large avicularia.

develops, and then it has the appearance of an oblique, asymmetrical tooth. Although this species is characterized by the presence of a lyrule, very rarely zoaria are found which have all the other characters typical to this species, but no tooth. The raised rostrum of the avicularium directly adjoins the proximal margin of the orifice; it has a semi-circular, conical, avicularian chamber whose oblong and sharpened mandible is directed toward one or the other side. The sharp tip of the mandible is pointed upward. Very rarely, 2 symmetrically arranged avicularia develop in place of one avicularium and their mandibles are directed toward each other; 1 incompletely developed denticle is located on each proximal margin of the orifice before each avicularium. In addition to the oral avicularium, in many zoaria, similar avicularia are found on the zooidal surface; these are several times larger than the oral and occupy the entire surface of the zooid, and sometimes even a part of the neighboring zooid. The ovicells are hyperstomial and semi-circular; they have a smooth surface with pores arranged in a semicircle in the center and inside the surface. The lateral wall has 4 to 5 pore plates with 4 to 6 pores each. There are 2 short, calcareous thickenings which transversely arise from the lateral wall of the distal septum and, as it were, divide it into 2 halves; there are 2 pore plates with 7 to 8 pores each symmetrically placed in the lower half.

The species lives on hydroids, tubes of worms, shells, and stones, at a depth of 2.8 to 308 m, more often from 50 to 150 m, under temperatures ranging from -1.9 to 3.20°C, in a salt concentration of 29.96 to 34.96‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and in the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879a, 1879b; Nordgaard, 1896, 1900, 1907a, 1912b, 1918; Bidenkap, 1900a, 1900b; Waters, 1900; Andersson, 1902; Norman, 1903a; Kluge, 1906; Kluge in Deryugin, 1915; Kuznetsov, 1941), White Sea (Kluge, 1908a; Kluge in Deryugin, 1928; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Levinsen, 1887), Laptev Sea (Kluge, 1929), East Siberian Sea (Kluge, 1929; Nordgaard, 1929), Chukotsk Sea (Kluge, 1929), Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1932, 1936), waters off Labrador (Osburn, 1913), western Greenland (Smitt, 1868b; Norman, 1906; Kluge, 1908b; Osburn, 1919, 1936), Gulf of St. Lawrence (Hincks, 1889; Whiteaves, 1901), Gulf of Man and Woods Hole (Osburn, 1912, 1933), eastern Greenland (Andersson, 1902), Yan-Maien Island (Lorenz, 1886), and northern Norway (Nordgaard, 1905, 1918).

This is an Arctic, circumpolar species.

2a. **Rhamphostomella costata** var. **cristata** Hincks, 1889 (Figure 376)

Rhamphostomella costata var. *cristata* Hincks, 1889 : 426, pl. 21, f. 6; Osburn, 1913 : 286; 1932 : 14; *Rhamphostomella fortissima* Bidenkap, 1900a : 524, t. IX, f. 8.

The zoarium, prostrate and single-layered, consists of tall zooids arranged in irregular rows. The zooids are large (length 0.90 to 1.25 mm, width 0.50 mm), hexagonal or oval in shape, and thin-walled. The frontal surface is convex, hyaline, transparent, and finely granulated; it has a raised margin that has more or less deep depressions with pores at the bottom. Thin rebra arise between the depressions in a radial direction from the margin of some zooids, toward the base of the avicularian chamber; in other zooids only traces of such rebra can be seen in the form of a thin striation; but in the majority of zooids, the frontal surface is smooth and shows no trace of rebra whatsoever. The primary orifice of the zooids is semicircular; its height is a little greater than its width; either a small, oblique, asymmetrical tooth is located in the middle of the proximal margin, or, in its absence, a small protuberance. Two spines are situated at the distal margin of the zooids located at the margin of the zoarium. A strongly raised avicularium with a semi-circular avicularian chamber, which is raised at the base, is located directly behind the proximal margin of the orifice; the avicularian chamber abruptly narrows toward the upper side, and its tip bends at a right angle to form a beak-like structure. A similar, sharply pointed branchlet often develops on the opposite side of the beak, and then a cock's comb structure forms at the upper end of the avicularium. The oblong mandible, sharply pointed at the free end, is sometimes directed toward one side, sometimes toward the other. While the frontal surface of the zooid is more or less smooth and translucent, the surface of the avicularium is coarsely granulated and opaque, due to which the avicularia are sharply etched against the common background of the zoarial surface. In addition to the oral avicularium, large, oval avicularia are found at the surface of many zooids, which have an oblong, broad mandible whose sharpened free end is

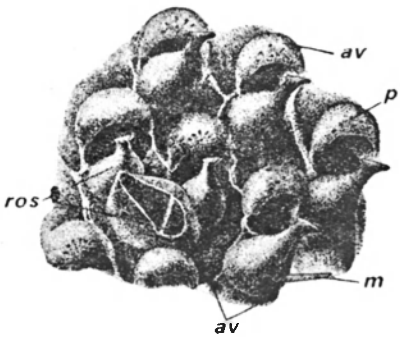


Figure 376. *Rhamphostomella costata* var. *cristata* Hincks. Part of a zoarium showing the smooth surface of the zooids, and usual and adventitious, large avicularia.

raised. The ovicells are hyperstomial, raised, semi-circular, and broad; they have a smooth surface that has pores arranged in a semi-circle in its center. There are 4 pore plates with many pores each in the lateral wall of the zooid, and 2 pore chambers with several pores on the inner side of the distal septum.

The species lives on stones and shells, at a depth of 44 to 105 m, on a bed of stone and silt, under a temperature of 1.72°C.

Distribution. The species was found by me in the Barents Sea, in the Bay of Isfjorden in Spitsbergen, and near Franz Josef Land, as well as in the waters off eastern Greenland. *Reports in literature:* Barents Sea (Bidenkap, 1900a), northern Norway (Nordgaard, 1918), East Siberian Sea (Nordgaard, 1929), Gulf of St. Lawrence (Hincks, 1889; Whiteaves, 1901), Labrador (Osburn, 1913), and Hudson Bay (Osburn, 1932).

This is an Arctic species.

3. **Rhamphostomella ovata** (Smitt, 1868) (Figure 377)

Cellepora ovata Smitt, 1868b : 31, pl. 28, f. 197; *Rhamphostomella ovata* Osburn, 1912 : 245, pl. 26, f. 63; 1933 : 54, pl. 11, f. 5-6.

The zoaria, prostrate and overgrowing, may be free-growing at the margins; they consist of zooids arranged in regular, straight and oblique rows. The zooids are medium in size (length 0.68 mm, width 0.43 mm) and hexagonal or rhombic in shape. The frontal surface is moderately raised, and bordered by a raised margin along which, as at the surface of the less calcified zooids, pores are arranged; in the more calcified zooids, however, the surface is reticulate with pores at the bottom of the alveoli. The primary orifice, located at the distal margin of the zooid, is roundish with a mildly sharpened, asymmetrical slit in the proximal margin. Two spines are located at the distal margin of the young zooids. The bluntly raised rostrum directly adjoins the proximal margin of the orifice, but slightly to one side; it has an oval avicularium at the medial line which obliquely stretches toward one margin of the slightly broadened avicularian chamber. In addition to the oral avicularium, a few

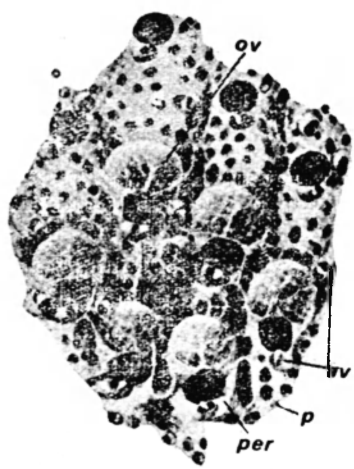


Figure 377. *Rhamphostomella ovata* (Smitt). Part of a zoarium with usual and adventitious avicularia.

slightly larger, oval avicularia are located at the margins of the zooids. The ovicells are hyperstomial and semi-circular; they have a smooth surface, no pores, and are covered by a thin calcareous layer, which consists of 3 parts fused by sutures—2 lateral, smaller ones, and a distal layer which originates from the frontal walls of the neighboring 3 zooids. A small pore is sometimes located in the middle of the surface. There are 4 pore plates with 2 to 4 pores in the lateral wall of the zooid, and about 10 simple pores arranged in groups of 3 to 4 at each lower corner, or in a row of fused pores along the lower margin of the distal septum.

The species lives on algae, hydroids, Bryozoa, and shells, at a depth of 3.5 to 144 m, on a bed of stone, shells, and silt, under temperatures ranging from −1.7 to 3°C, in a salt concentration of 31.80 to 34.83‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and in the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Kluge in Deryugin, 1915; Kluge, 1929), White Sea (Gostilovskaya, 1957), Kara Sea (Nordgaard, 1912b; Kluge, 1929), Laptev, East Siberian, and Chukotsk seas (Kluge, 1929), northern coast of North America and the Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1932, 1936), Labrador (Hincks, 1877a), Gulf of St. Lawrence (Whiteaves, 1901), Gulf of Man and Woods Hole (Osburn, 1912, 1933), western Greenland (Smitt, 1868c; Hincks, 1877a; Kluge, 1908b; Levinsen, 1914; Osburn, 1919), eastern Greenland (Levinsen, 1916), and northern Norway (Nordgaard, 1918).

This is an Arctic, circumpolar species.

4. **Rhamphostomella hincksi** Nordgaard, 1906 (Figure 378)

Cellepora plicata Hincks, 1877a : 106, pl. XI, f. 3-4; *Rhamphostomella plicata* Lorenz, 1886 : 94 (12); *et auctt.; Rh. hincksi* Nordgaard, 1906a : 31, pl. IV, f. 51.

The zoarium, prostrate and overgrowing the substrate lightly, consists of zooids arranged in regular, straight and oblique rows. The zooids are large (length 0.90 mm, width 0.50 mm), hexagonal in shape, and thin-walled; they are broader in the distal half and narrower in the proximal. The frontal surface is moderately raised, smooth, translucent, and bordered by a raised margin from which short rebra uprise in a radial direction. The primary orifice, located near the distal end of the zooid, is semi-circular. The operculum is slightly chitinized. Due to the development of the peristome, a triangular secondary orifice is formed which consists of a raised, distal margin, and 2 lateral lobes that narrow at a more or less acute angle in the center of the proximal margin. The lyrule is absent. A large oblong-oval avicularium is located at one of the lateral lobes on one or the other side; its semi-circular mandible is directed obliquely upward. In many zooids, the basal wall forms protuberances. The ovicells are hyperstomial, semi-circular, and convex; they have a smooth, glassy surface covered with pores. There are 4 pore plates with 2 to 4 pores each located in the lateral wall, and 2 with 4 to 5 pores each in the distal septum; the margins of the plates in the latter are not clearly defined at the corners of the basal side.

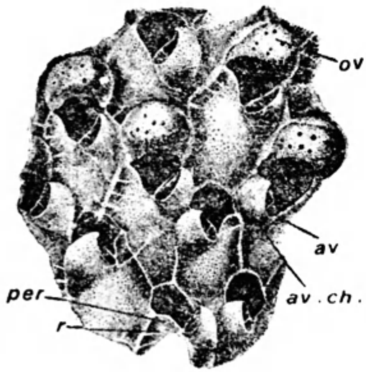


Figure 378. *Rhamphostomella hincksi* Nordgaard. Part of a zoarium.

The species lives on Bryozoa and shells, at a depth of 10 to 270 m, more often from 30 to 150 m, on a bed of stone, silt, and shells, under temperatures ranging from −1.62 to 1.50°C, in a salt concentration of 32.18 to 34.83‰.

Distribution. This species was found by me in the Barents, Kara, Laptev, Chukotsk, and Okhotsk seas, and the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Nordgaard, 1896; Bidenkap, 1900a; Waters, 1900; Andersson, 1902; Norman, 1903a), Archipelago of the Canadian Islands (Nordgaard, 1906a), western Greenland (Smitt, 1868c; Norman, 1876; Hincks, 1877d; Kluge, 1908b; Levinsen, 1914; Osburn, 1919, 1936), Gulf of St. Lawrence (Whiteaves, 1901), eastern Greenland (Levinsen, 1916), and Yan-Maien Island (Lorenz, 1886).

This is an Arctic, circumpolar species.

5. **Rhamphostomella spinigera** Lorenz, 1886 (Figure 379)

Cellepora plicata Smitt, 1868b : 30 (part.), t. 28, f. 192; *Rhamphostomella spinigera* Lorenz, 1886 : 94 (12); Nordgaard, 1906a : 32, pl. IV, f. 52-55; *Rh. plicata* Waters, 1900 : 92, pl. 11, f. 28-29; Nordgaard, 1905 : 171, pl. V, f. 14-15.

The zoaria, prostrate, single-layered, and loosely overgrowing the substrate, consist of zooids arranged in radially divergent rows; they are red in color in a live state. The zooids are medium in size (length 0.78 mm, width 0.53 mm) and an elongated oval in shape. The frontal surface is moderately raised, continuous, finely granulated, and bordered by a thin, raised margin that has depressions with pores at the bottom; short rebra are located between the depressions, starting from the margin in a transverse direction. The primary orifice, located at the distal margin of the zooid, is roundish; its width is greater than its height; a lyrule is usually located in the center of the proximal margin, which is usually bifurcated at the end, with one small, sharp denticle arising from each of its sides. Two well-developed spines are located at the sides of the distal margin in the sterile zooids, but there is only 1 spine on each side of the proximal margin of the ovicell in the zooids carrying ovicells. The peristome is in the form of 2 asymmetrical lateral lobes—the less raised lobe is the rostrum which has a relatively short, broader, slightly bent avicularium that starts a little on the side from the middle of the proximal margin; this avicularium has a short mandible which is slightly bent and rounded at the tip, while its free end is directed obliquely upward; the other lobe, in the form of a triangular plate, is more raised and shifted from the plane of the frontal surface; it originates from the middle of the proximal margin of the orifice. The ovicells are hyperstomial, semi-circular, and raised; they have a smooth surface which is covered with pores. There are 4 pore plates with 3 to 6 pores each in the lateral wall, and 10 to 12 simple pores arranged along the basal margin, with a larger grouping of pores at the sides, in the distal septum. The basal side has no white pseudopores, but there is a tendency for it to form protuberances for the attachment of the zoarium to the substrate.

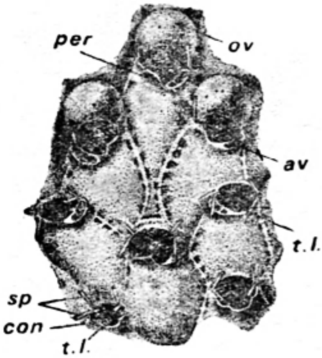


Figure 379. *Rhamphostomella spinigera* Lorenz. Part of a zoarium.

The species lives on Bryozoa, shells of barnacles and mollusks, at a depth of 10 to 234 m, more often from 50 to 150 m, under temperatures ranging from −1.9 to 3.7°C, in a salt concentration of 31.87 to 34.54‰.

Distribution. This species was found by me in the Barents and Kara seas, and in the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879a, 1879b; Bidenkap, 1900a; Nordgaard, 1905; Waters, 1900; Kluge, 1906; Kuznetsov, 1941), White Sea (Kluge, 1907; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Nordgaard, 1912b), northern coast of North America and the Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1932), western Greenland (Hennig, 1896; Kluge, 1908b; Osburn, 1936), eastern Greenland (Levinsen, 1916), and Yan-Maien Island (Lorenz, 1886).

6. **Rhamphostomella radiatula** (Hincks, 1877) (Figure 380)

Cellepora plicata Smitt, 1868b : 30 (part.), t. 28, f. 193; *Lepralia radiatula* Hincks, 1877a :

104, pl. X, f. 9-14; *Rhamphostomella radiatula* Lorenz, 1886 : 95 (13), pl. VII, f. 9; Nordgaard, 1905 : 172, pl. V, f. 16-17; *et auctt.*

The zoaria, small, prostrate and loosely overgrowing the substrate, consist of zooids arranged in irregular, divergent rows. The zooids are small (length 0.50 mm, width 0.33 mm) and rhombic-hexagonal or oval in shape. The frontal surface is convex, white in color, finely granulated, and bordered by a significantly raised margin that has closely fitted, deep depressions with pores at the bottom; more or less long rebra stretch between the depressions in a radial direction from the margin to the center of the surface. The primary orifice, located near the distal margin of the zooid, is roundish; there is a small, thin, and straight lyrule located in the center of the proximal margin, and small, sharp denticles at the sides of the lyrule. Spines are absent. The primary orifice is encircled by a strongly developed peristome in the form of 2 uniformly developed, raised, lateral lobes which terminate in a goffered distal margin. A small, oval avicularium with a semi-circular mandible is located near the base of one of the lobes, in the center of the proximal margin of the secondary orifice. The ovicells are hyperstomial, semi-circular, and convex; they have a smooth surface which is sparsely covered with pores. The peristome is developed more strongly in the zooids carrying ovicells, and both lobes are located on the sides of the ovicell surface. There are 4 pore plates with a few pores in the lateral wall of the zooid, and 6 to 8 simple pores arranged in one row along the basal margin and the lateral walls in the distal septum.

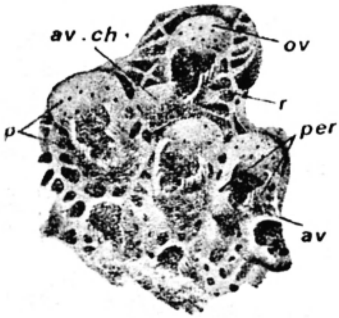


Figure 380. *Rhamphostomella radiatula* (Hincks). Part of a zoarium. Barents Sea.

The species lives on algae, mostly on red algae, soft Bryozoa, ascidia, and shells, at a depth from 9 to 280 m, more often from 50 to 150 m, on a bed of stone, shells, and sand, under temperatures ranging from −1.56 to 3.2°C, in a salt concentration of 34.07 to 34.27‰.

Distribution. This species was found by me in the Barents, Kara, and Bering seas, and in the Davis Strait and the Gulf of St. Lawrence. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Nordgaard, 1896, 1918; Bidenkap, 1900a, 1900b; Kluge, 1906; Kluge in Deryugin, 1915), White Sea (Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Nordgaard, 1912b), northern coast of North America and the Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1932), Labrador (Hincks, 1877a), western Greenland (Hincks, 1877a; Levinsen, 1914), eastern

Greenland (Levinsen, 1914, 1916), Yan-Maien Island (Lorenz, 1886; Nordgaard, 1907a), Iceland (Nordgaard, 1924), and northern Norway (Smitt, 1868b; Nordgaard, 1905, 1918).

This is an Arctic, circumpolar species.

7. **Rhamphostomella plicata** (Smitt, 1868) (Figure 381)

Cellepora plicata Smitt, 1868b : 30 (part.), t. 28, f. 189-190; *Rhamphostomella plicata* Nordgaard, 1906a : 30, pl. IV, f. 49-50; *Rh. lorenzi* Kluge, 1907 : 188; 1915 : 386.

The zoarium, prostrate, single-layered, and loosely overgrowing the substrate, consists of zooids arranged in regular, straight and oblique rows. The zooids are large (length 0.88 mm, width 0.50 mm), oblong-hexagonal in shape, thin-walled, and their broader, distal half is shorter than their narrower, proximal one. The frontal wall, convex and lowered toward the proximal margin, has fine granulations and a few pores along the margins, which have short rebra between them; but sometimes the frontal surface has no rebra, while preserving the marginal pores, and then the thin margin cf the zooid is clearly raised. The primary orifice, located near the distal margin of the zooid, is roundish and slightly narrows toward the proximal margin; a small lyrule whose free end is slightly broadened, is located in the center of the latter. One small, sharp denticle is often located at the sides of this lyrule, but sometimes these denticles are absent, in which case a mild protuberance replaces each. Due to the development of the peristome, a triangular secondary orifice forms. The peristome consists of 2 raised, lateral lobes—the more raised one forms the rostrum with a long, narrow, and straight avicularium which originates from the middle of the proximal margin, and has an oblong, straight mandible that is bent at its end, while its free tip is directed obliquely upward, and the less raised lobe which originates a little on the side of the middle point, and is shaped like a long triangle with a pointed top. Both lobes bend away from the plane of the frontal surface. The basal side of the zooids is densely covered with white pseudopores and has a tendency to form protuberances. The ovicells are hyperstomial, semi-circular, and convex; they have a straight, proximal margin and a smooth shiny surface which is covered with pores. There are 4 pore plates with 5 to 8 pores each in the lateral

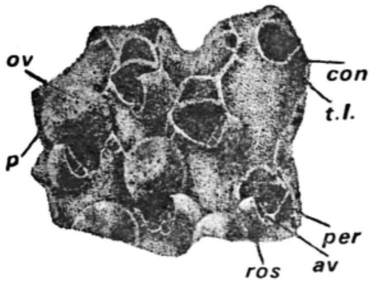


Figure 381. *Rhamphostomella plicata* (Smitt). Part of a zoarium. Barents Sea.

wall, and many pores arranged in a few rows in the lower basal half of the distal septum.

The species lives on Bryozoa, ascidia, and shells, at a depth of 12 to 132 m, more often from 50 to 100 m, on a bed of stone, shells, and sand, under temperatures ranging from −1.61 to 1.82°C, in a salt concentration of 33.77 to 34.27‰.

Distribution. This species was found by me in the Barents, Kara, Chukotsk, and Bering seas, and in the Davis Strait. ***Reports in literature:*** Barents Sea (Smitt, 1868b, 1879b; Bidenkap, 1900a; Nordgaard, 1905; Kuznetsov, 1941), White Sea (Smitt, 1879b; Kluge, 1907; Gostilovskaya, 1957), Kara Sea (Nordgaard, 1912b), Archipelago of the Canadian Islands (Nordgaard, 1906a), western Greenland (Norman, 1906; Levinsen, 1914; Osburn, 1919, 1936), Gulf of St. Lawrence (Whiteaves, 1901), eastern Greenland (Levinsen, 1916), Iceland (Nordgaard, 1924), and northern Norway (Nordgaard, 1905, 1918).

8. **Rhamphostomella bilaminata** (Hincks, 1877) (Figure 382)

Cellepora bilaminata **Hincks, 1877a : 111, pl. XI, f. 6-7;** ***Rhamphostomella bilaminata*** **Lorenz, 1886 : 95 (13), t. VII, f. 10; Osburn, 1912 : 244, pl. 26, f.. 61;** ***Cellepora plicata*** **Smitt, 1868b : 30 (part.), t. 28, f. 191.**

The zoaria, prostrate, small, and incompletely overgrowing the substrate, being somewhat free-growing at the margins, consist of zooids arranged in short, divergent, and straight rows. The zooids are small, thin-walled (length 0.62 mm, width 0.35 mm), and rectangular; sometimes they have a uniform width, and sometimes they narrow toward the proximal end. The frontal surface is moderately convex, continuous, and smooth; it is bordered by a strongly raised margin which often turns over the surface to form a partial secondary layer. The primary orifice, located near the distal margin of the zooid, is roundish; it has a small, straight lyrule, which may be bifurcated at the end, located in the middle of the proximal margin; there is a sharp denticle located on each side of this lyrule. The primary orifice, encircled by a peristome, consists of 2 almost uniformly developed, raised,

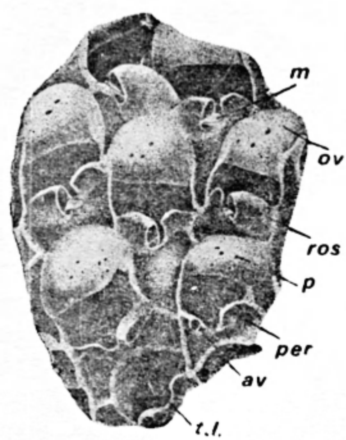


Figure 382. ***Rhamphostomella bilaminata*** **(Hincks). Part of a zoarium.**

lateral lobes which strongly tilt away from the frontal surface; either lobe may form the rostrum which has an avicularium with a semi-oval mandible. Sometimes there is no avicularium on the rostrum, but frequently avicularia are located on both lobes and directed toward each other. Usually the outer margin, but often the upper also, of both peristomial lobes, is turned outward slightly; sometimes these margins attract the outer lateral margin of the frontal surface behind them, which is turned over the latter and forms, as it were, a duplicate surface, except for the middle portion, which remains free. The ovicells are hyperstomial, large, and semi-circular; they have a straight proximal margin that usually covers the distal half of the orifice, and a smooth surface covered with pores that are usually arranged in a semi-circle. There are 4 pore plates with a few pores in the lateral wall, and 2 in the distal septum.

The species lives on hydroids, alcyonids, ascidia, and shells, at a depth of 5.5 to 226 m, more often from 50 to 150 m, on a bed of shells, silt, and sand, under temperatures ranging from −1.9 to 4.5°C.

Distribution. This species was found by me in the Barents, Kara, Laptev, Chukotsk, and Bering seas, and in the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879a, 1879b; Bidenkap, 1900a; Andersson, 1902; Kluge in Deryugin, 1915; Nordgaard, 1918, 1923; Kuznetsov, 1941), White Sea (Kluge, 1908a; Kluge in Deryugin, 1928; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Nordgaard, 1923), Chukotsk Sea (Osburn, 1923), Hudson Bay (Osburn, 1932), western coast of Greenland (Levinsen, 1914; Osburn, 1936), Labrador (Hincks, 1877a), Gulf of St. Lawrence (Whiteaves, 1901), south of Cape Cod (Osburn, 1912), Yan-Maien Island (Lorenz, 1886; Nordgaard, 1907b), and Finmark (Smitt, 1868b).

This is an Arctic, circumpolar species.

8a. **Rhamphostomella bilaminata** var. **sibirica** Kluge, 1929 (Figure 383)

Rhamphostomella bilaminata var. *sibirica* Kluge, 1929 : 21; 1955b : 108, t. XXIII, fig. 6; *Rh. bilaminata* Levinsen, 1916 : 461; Nordgaard, 1929 : 7; Osburn, 1933 : 55, pl. 10, f. 8.

The zoarium, prostrate, single-layered, and loosely overgrowing the surface, consists of zooids arranged in straight and oblique rows. The zooids are medium in size (length 0.87 mm, width 0.55 mm), irregularly hexagonal in shape, tall, and thin-walled. The frontal surface is raised, smooth, translucent, and bordered by a strongly raised margin from which radially arranged, oblique rebra arise; large depressions occur between the rebra along the margin. The primary orifice, located at the distal margin of the zooid, is roundish; it has a small lyrule that is straight or bifurcated, in the middle of the proximal margin; there are 2 less noticeable denticles at the sides of the lyrule. The peristome is strongly developed in the form of 2 lateral lobes, one of which is more strongly developed and more raised above the frontal surface. This is the rostrum of the avicularium, which has a large, oblong, and slightly bent mandible. Initially, the lateral margin, and sometimes even the upper, of both peristomial lobes, is turned upward, but as further growth of the zoarium takes place, the turning of the margin does not occur, and the upper parts of the lobes become straight and flat. The avicularian chamber is strongly developed, broadened, bulging, and fitted with a sharp, flat pecten which is raised at its upper margin. The ovicells are hyperstomial, small, semi-circular, and broad; they have a smooth surface that has a few scattered pores. There are 4 pore plates with many pores in the lateral wall, and 2 in the distal septum.

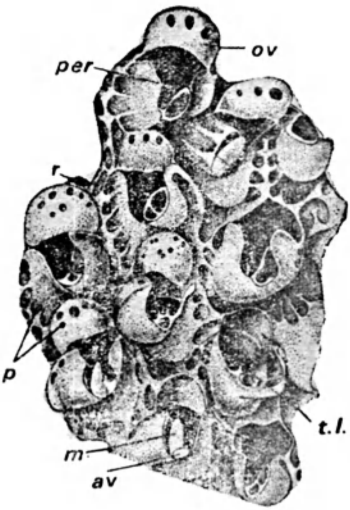


Figure 383. *Rhamphostomella bilaminata* var. *sibirica* Kluge. Part of a zoarium (from Kluge, 1955b).

The species lives on hydroids, Bryozoa, ascidia, stones, and shells, at a depth of 3 to 170 m, more often from 50 to 150 m, on a bed of stone, silt, and sand, under temperatures ranging from —1.61 to 4.78°C, in a salt concentration of 29.96 to 34.83‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and off western Greenland, and in the Gulf of St. Lawrence. *Reports in literature:* Barents Sea (Smitt, 1868b), White Sea (Gostilovskaya, 1957), Kara and Laptev seas (Kluge, 1929), East Siberian Sea (Kluge, 1929; Nordgaard, 1929), Chukotsk Sea (Kluge, 1929), Gulf of Man (Osburn, 1933), and eastern Greenland (Levinsen, 1916).

This is an Arctic species.

2. Genus **Escharopsis** Verrill, 1880

Eschara (part.) Busk, 1856b : 33; *Escharoides* Smitt, 1868b : 24; *Discopora* (part.) Smitt, 1879a : 24; *Escharopsis* Verrill, 1880 : 196.

Initially the zoaria are prostrate and overgrowing, and later rise from the prostrate part and become free-growing and double-layered. The frontal surface is weakly raised and bordered by a row of small, marginal pores. The primary orifice is roundish with a semi-circular sinus, or has a mildly concave, proximal margin. With further calcification of the wall, a secondary orifice is formed that has a semi-circular or straight, narrow, and long sinus at the proximal margin. Oval avicularia develop on one or both sides at the semi-circular sinus between the primary and secondary orifices; a round avicularium develops on one side of the sinus at the outer surface. In addition to the latter avicularium, similar, small, round avicularia are often found at other places of the surface. The ovicells are hyperstomial, semi-circular, and mildly raised with or without orifice at the surface. There are multi- or uni-porous plates located in the lateral wall and the distal septum.

Genus type: *Eschara lobata* Lamarck, 1836.

1 (2). Zooids medium in size. Secondary orifice round with a semi-circular sinus at the proximal margin, in which avicularia located on one or both sides, suspended to the plane of the orifice...... ....1. *E. sarsi* (Smitt).

2 (1). Zooids small. Secondary orifice semi-circular with a straight, narrow sinus on the proximal margin. A round avicularium located on one side of the sinus at the frontal surface on one or the other side. In addition to this avicularium, similar but smaller avicularia also found at different places on the frontal surface..............................2. *E. rosacea* (Busk).

1. **Escharopsis sarsi** (Smitt, 1868) (Figure 384)

Escharoides sarsi Smitt, 1868b : 24, 158, t. 26, f. 147-154; Hincks, 1888 : 218, pl. 14, f. 1; Waters, 1900: 85, pl. II, f. 21-23; *Posterula sarsi* Jullien and Calvet, 1903 : 89, pl. XI, f. 4.

The free-growing part of the zoarium has the appearance of double-layered lobes, which are sometimes continuous, sometimes branched, and attain up to 5 to 6 cm in height and width. The zooids are arranged in regular, straight and oblique rows; they are medium in size (height 0.83 mm, width 0.48 mm), oval in shape, and flesh colored in a live state. Their frontal surface, convex, continuous, granulated, and covered with the epitheca, has a raised margin with a row of marginal depressions which have pores at the bottom; short, transverse rebra occur between the depressions from the margin to the center. The primary orifice, situated near the distal margin of the zooid, is roundish; it has a semi-circular sinus at its proximal margin. The operculum is weakly chitinized.

Usually on one side of the sinus, rarely on both, is located a small, oval avicularium that has a stretched mandible with a rounded tip. The avicularium faces into the cavity of the sinus, i.e., it is suspended toward the frontal surface. The avicularian chamber varies in size and sometimes is markedly raised above the surface, reaching up to the margin of the zooid. Sometimes small, adventitious avicularia are also found in the oval region. Because of the deposition of calcium on the epitheca in this order of zoaria, the frontal wall become thicker, the secondary roundish orifice strongly narrows toward the middle of the proximal margin, the avicularium overgrows, and the marginal depressions also overgrow, and a row of marginal pores forms at their place. The zoaria are very similar in this species to the strongly calcified zoaria of *Porella compressa,* making it difficult to decide to which species a given zoarium belongs. The color of the zoarium may serve as a criterion for a temporary solution to this difficulty, as *E. sarsi* is gray-yellow, and *P. compressa,* white.

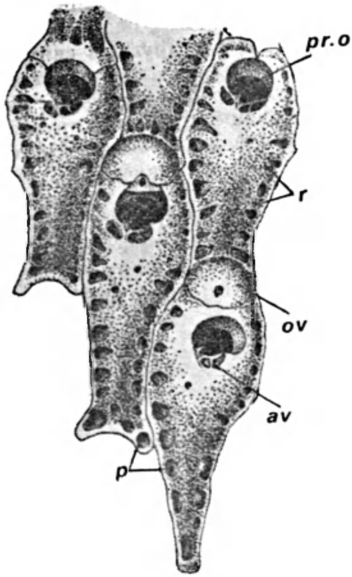


Figure 384. *Escharopsis sarsi* (Smitt). Part of a zoarium.

The ovicells are hyperstomial, semicircular, and slightly raised; they have a granulated surface with a round orifice in its center. There are 6 pore plates with 4 to 6 pores each in the lateral wall, and 2 large pore plates with many pores in the lower half of the distal septum.

The species lives on shells and stones, at a depth of 4 to 300 m, more often from 50 to 200 m, on a bed of stone, silt, and shells, under temperatures ranging from —1.9 to 3°C, in a salt concentration of 31.80 to 34.54‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, and in the coastal waters of Labrador and western Greenland. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879a; Ridley, 1881; Bidenkap, 1897, 1900a, 1900b; Nordgaard, 1900, 1907b, 1912b, 1918; Waters, 1900; Andersson, 1902; Kluge, 1906; Kluge in Deryugin, 1915; Grieg, 1925; Kuznetsov, 1941), White Sea (Smitt, 1879b; Kluge, 1907, 1908a; Kluge in Deryugin, 1928; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Levinsen, 1887; Nordgaard, 1912b; Kluge, 1929), Laptev, East Siberian and Chukotsk seas (Kluge, 1929), Archipelago of the Canadian Islands (Busk, 1880;

Nordgaard, 1906a; Osburn, 1936), Labrador (Packard, 1863; Osburn, 1913), western Greenland (Smitt, 1868b; Norman, 1876, 1906; Hennig, 1896; Kluge, 1908b; Levinsen, 1914), Gulf of St. Lawrence (Hincks, 1888; Whiteaves, 1901), Gulf of Man (Osburn, 1933), Newfoundland (Jullien and Calvet, 1903), eastern Greenland (Kirchenpauer, 1874; Andersson, 1902; Levinsen, 1916), Yan-Maien Island (Lorenz, 1886), Iceland (Nordgaard, 1924), northern Norway (Nordgaard, 1896, 1905, 1918; Guerin-Ganivet, 1911), and the Pacific Ocean along the southern coast of Alaska (Robertson, 1900, 1908).

This is an Arctic, circumpolar species.

2. **Escharopsis rosacea** (Busk, 1856) (Figure 385)

Eschara rosacea Busk, 1856b : 33, pl. I, f. 4; *Escharoides rosacea* Smitt, 1868b : 25, 161, t. 26, f. 155-159; Hincks, 1880a : 336, pl. 47, f. 5-9; Waters, 1900 : 86, pl. 11, f. 24-25.

The prostrate part of the zoarium has the appearance of a small, round, closely overgrowing, single-layered surface, which mainly consists of kenozooids; it has no orifice, but does have avicularia. The free-growing part has the appearance of a more or less flat, double-layered stem which broadens into a lobe from whose margin narrower and shorter lobes arise. The zooids are located in regular, straight and oblique rows; they are small (length 0.56 mm, width 0.40 mm), broadly rhombic in shape, thick-walled, and separated by deep, wavy margins. The frontal surface is weakly raised and granulated, with pores scattered around its margin. The primary orifice, located near the distal margin of the zooid, is semi-circular; its height is slightly greater than its width; the proximal margin is slightly concave with weakly developed condyles at the margins. As the frontal wall thickens, the secondary orifice develops with a straight proximal margin; a long, narrow sinus is located in the middle of the latter. A round avicularium is usually located on one side of the sinus, which has a semi-circular mandible. Initially the avicularium is located in

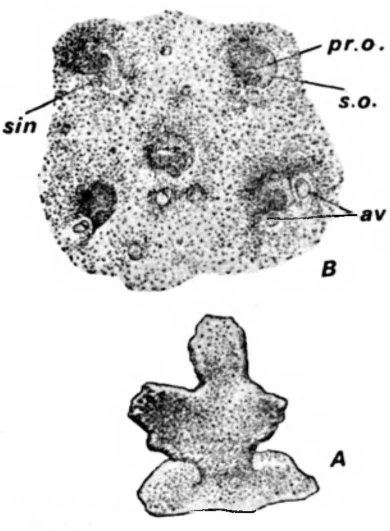


Figure 385. *Escharopsis rosacea* (Busk). *A*—general view of a zoarium; B—part of a zoarium with usual and adventitious avicularia. White Sea.

the plane of the frontal surface, but after the further calcification of the latter, the avicularium tilts more and more toward the plane of the sinus, becoming finally almost suspended to the frontal surface. In addition to the oral avicularium, 1 or 2 avicularia of various sizes are located at different places on the zooidal surface; the larger ones are slightly raised above the surface, and the smaller ones, in the plane of the surface, are less noticeable at first glance. The ovicells are hyperstomial, semi-circular, convex, and smooth surfaced. The zooids communicate with each other through simple pores.

The species lives on stones and shells, at a depth of 12 to 315 m, mostly from 50 to 150 m, on a bed of stone, shells, and silt, under temperatures ranging from −1.9 to 3.5°C, in the White Sea from −0.9 to 12.5°C, in a salt concentration of 33.73 to 34.72‰, in the White Sea from 26.6 to 29.13‰.

Distribution. The species was found by me in the Barents, Kara, East Siberian, and Okhotsk seas, and in the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Nordgaard, 1896, 1912a; Bidenkap, 1897, 1900a; Norman, 1903b; Kluge in Deryugin, 1915; Kuznetsov, 1941), White Sea (Kluge, 1908a; Kluge in Deryugin, 1928; Gostilovskaya, 1957), Kara Sea (Nordgaard, 1912b), western Greenland (Smitt, 1868c; Norman, 1876, 1903b), Gulf of St. Lawrence (Whiteaves, 1901; Norman, 1903b), Gulf of Man and New Scotland (Verrill, 1879a; Osburn, 1933), Yan-Maien Island (Lorenz, 1886), Iceland (Nordgaard, 1924), British Isles (Hincks, 1880a), Faeroes Islands (Nordgaard, 1907b), and northern Norway (M. Sars, 1863a; Smitt, 1868b; Nordgaard, 1918).

This is an Arctic-boreal species.

XII. Family **Celleporidae** Busk, 1854

Celleporidae Busk, 1854a : 85; Hincks, 1880a : 397; Canu and Bassler, 1920 : 592.

The zoaria, prostrate or free-growing, consist of semi-erect or erect zooids at the plane of the zoarium; the zooids are usually congested. This form of zoarium is the result of 2 methods of budding—terminal and superficial. Because terminal budding takes place at the distal end of the zooid, the zooids grow in a definite direction and are usually parallel to each other; after superficial budding, daughter zooids form at the frontal surface of the zooid, and the zooids grow in all directions. As a result of this superficial budding, one generation of zooids is deposited in a layer over the other, and since this budding takes place at different stages of zooidal growth, along with fully adult zooids, one finds a few incompletely developed zooids at the surface of the zoarium in the form of more or less large cavities; the latter should not be confused with the cavities of the large, vicariating avicularia. The orifices of the zooids are usually round with a sinus at the proximal margin. Spines are absent. The peristome is often present. Adventitious avicularia are always present, and larger, vicariating avicularia occur frequently. The ovicells are hyperstomial.

Genus **Cellepora** Linnaeus, 1767

Cellepora Linnaeus, 1767 : 1285; Busk, 1854a : 85 (part.); Hincks, 1880a : 398 (part.); Smitt, 1868b : 31 (part.); Levinsen, 1909 : 346 (part.); *Celleporaria* Lamouroux, 1821 : 43; Smitt, 1868b : 33 (part.); *Schismopora* MacGillivray, 1888 : 241n; Osburn, 1933 : 59.

The zoarium, consisting of many layers of zooids, is either prostrate and overgrowing the substrate in the form of ganglia, or free-growing and branched. The zooids are either thick- or thin-walled, semi-erect or erect, oval or cylindrical, irregularly arranged, congested, or located at different levels. The orifice of the zooid is located at the proximal end of the zooid. The raised rostra of the avicularia are located either on the sides or at the proximal side of the orifice. Besides these rostral avicularia, adventitious and vicariating avicularia are also present in many species. The ovicells have a partially or completely calcified outer layer; they are smooth and pores may or may not be present.

Genus type: *Cellepora pumicosa* (Pallas) Linnaeus, 1767.

1 (8). Zooids usually have a pair of lateral rostra on the avicularia near the orifice, or just one rostrum.

2 (5). Zoaria, large and overgrowing the substrate in the form of ganglia, or branched, consisting of short cylindrical branches with rounded ends. Zooids thick-walled.

3 (4). Zooids medium in size and semi-erect. Primary orifice round with a sharp sinus at the proximal margin. One avicularium located at each side of the raised peristome. In addition to oral avicularia, vicariating avicularia of 2 types also present: one type has a semi-circular mandible, and the other an oblong mandible shaped like a palette knife...3. *C. surcularis* (Packard).

4 (3). Zooids large, thick-walled and semi-erect. Frontal surface covered with small depressions. Primary orifice, oblong-oval, slightly narrows above the proximal margin which has a sharp sinus in its center. Vicariating avicularia are of one type—a round mandible with a straight incision at the proximal margin............................4. *C. ventricosa* Lorenz.

5 (2). Zoaria small and overgrow the substrate in the form of small

ganglia or masses. Zooids thin-walled. Ovicells semi-circular with pores at the frontal surface.

6 (7). Zooids erect and cylindrical. Round primary orifice with a sharp sinus, surrounded by a row of depressions. Rostra at the sides of the orifice tall, straight, and joined on the proximal side by a calcareous plate..........1. *C. nordenskjoldi* Kluge.

7 (6). Zooids semi-erect and urceolate. Round orifice with rounded sinus, not surrounded by depressions. Rostra thin and short. ....2. *C. costazii* Audouin.

8 (1). Zooids have one raised rostrum on the avicularium on the proximal side of the orifice.

9 (10). Zoaria free-growing, consist of dichotomously divided or slightly flattened branches................10. *C. ramulosa* L.

10 (9). Zoaria prostrate in the form of continuous or irregularly branched ganglia.

11 (16). Primary orifice round with a broad, arcuate sinus.

12 (13). No lateral lobes of the peristome on the rostrum of the oral avicularium. Zooids broadly oval in shape and thick-walled. A short, conical, semi-circular, sharp rostrum, with a broad avicularian chamber, located on the proximal side of the orifice. Vicariating avicularia of one type—the mandible is shaped like a palette knife..........5. *C. smitti* Kluge.

13 (12). Lateral lobes of the peristome on the rostrum of the oral avicularium.

14 (15). Zooids large. Primary orifice round with a broad, arcuate sinus. Thin, cylindrical, bent rostrum has a semi-circular mandible and the asymmetrical, lateral lobes of the peristome. ....6. *C. nodulosa* Lorenz.

15 (14). Zooids small. Primary orifice almost round with a barely noticeable, broad, concave sinus. Thick, straight rostrum has a triangular mandible near its base, and stretches upward into a sharp spine. Lateral lobes mildly developed........ ....7. *C. pumicosa* L.

16 (11). Primary orifice round with a sharply pointed sinus.

17 (18). Zooids medium in size. Primary orifice round with a rounded, sharp sinus. Raised or slightly concave rostrum has the symmetrical lobes of the peristome at its sides, and strongly varies from short up to the length of the zooid itself. Vicariating avicularia of one type, with an oval mandible......... ....8. *C. canaliculata* Busk.

18 (17). Zooids small. Primary orifice round with a triangular sinus. Relatively short and oval rostrum has an oval avicularium and is obliquely located near the proximal margin of the orifice

on one side of the medial line. In addition to rostral avicularia, oval, adventitious, large, and vicariating avicularia also present, whose free ends are shaped like a palette knife........ ....9. *C. avicularis* Hincks.

1. **Cellepora nordenskjoldi** Kluge, 1929 (Figure 386)

Cellepora nordenskjoldi Kluge, 1929 : 22; 1946 : 203, t. IX, fig. 3.

The zoaria, in the form of small, round, or oval structures, grow in a few layers arranged one over the other. The zooids are cylindrical, medium in size (height 0.75 mm, diameter at the base 0.50 mm, near the top 0.43 mm), and erect. At the top, i.e., in the middle of the convex frontal surface, is located a round, primary orifice with a sharp sinus at its proximal margin. The orifice is surrounded by one row of radially arranged depressions which occupy the entire frontal surface. Tall and oval rostra rise from both sides of the orifice, terminating on the upper side in oval avicularia with longitudinal, semi-oval mandibles whose free ends are directed upward and backward. The rostra are connected on their proximal side to a bent calcareous plate, whose upper margin is slightly raised in the middle, slightly bends to the inner side, and sometimes has an obliquely placed avicularium. A round ovicell is located near the distal margin of the orifice, which has an endooecium whose semi-circular surface is covered only with a membrane; pores are located along its margin from which short striations arise like cracks to join toward the middle of the surface. In addition to rostral avicularia, sometimes larger, vicariating avicularia are also found.

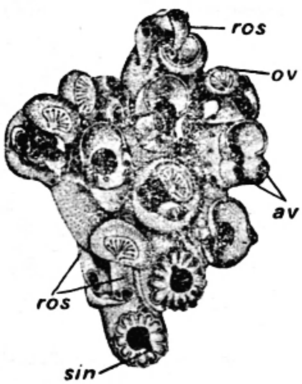


Figure 386. *Cellepora nordenskjoldi* Kluge. Part of a zoarium (from Kluge, 1946).

The species lives mostly on hydroids and algae, at a depth of 16 to 146 m, more often from 40 to 60 m.

Distribution. The species was found by me in the Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas.

This is an Arctic-boreal, Pacific species.

2. **Cellepora costazii** Audouin, 1826 (Figure 387)

Cellepora costazii Hincks, 1880a : 411, pl. LX, f. 11-14; ? Bidenkap, 1900a : 526; non

Robertson, 1908 : 313, pl. 24, f. 89; *Siniopelta costazii* Marcus, 1940 : 293, f. 152; *Cellepora Hassali* Busk, 1854a : 86, pl. CIX, f. 4-6.

The zoaria overgrow in the form of small ganglia. The zooids are semi-erect in a young stage and erect in older parts of the zoarium, irregularly arranged, and oval; they have a smooth surface and sometimes carry navel-shaped (umbilical) protuberances on the frontal side under the orifice. The primary orifice, located near the distal end, is round with a rounded sinus, and surrounded by a raised margin; a tubular rostrum with an oval avicularium, which has a rounded, triangular mandible at its tip, is located on the raised margin. Sometimes larger, vicariating avicularia shaped like a palette knife, are found among the zooids. The ovicells have a porous surface, are hyperstomial, turned back, and broader; they have a semi-circular rebrum at the surface.

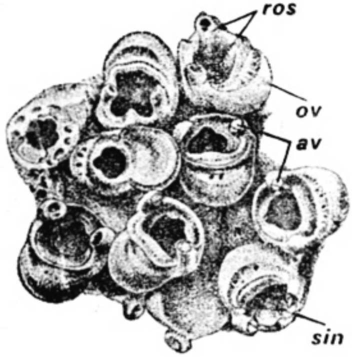


Figure 387. *Cellepora costazii* Audouin. Part of a zoarium. Waters off the southwestern coast of Sweden.

The species lives on algae, hydroids, Bryozoa, shells, and stones, at a depth of 0 to 550 m.

Distribution. Reports in literature: Although this species was reported by Bidenkap (1900a) as occurring in the Barents Sea, in the region of Spitsbergen, I strongly doubt the accuracy of his identification. I did not find this species in the Bryozoan collection analyzed by Bidenkap and preserved in the Zoological Museum of Berlin University. Neither Smitt not I found this species among the numerous collections from Spitsbergen, which have been preserved in Stockholm. This species is found along the southwestern coast of Norway (Nordgaard, 1912a), Sweden (Smitt, 1868b), the Faeroes and British Islands (Hincks, 1880a), the western coast of France (Fischer, 1870), and the Mediterranean Sea (Calvet, 1902).

This is a boreal species.

3. **Cellepora surcularis** (Packard, 1863) (Figure 388)

Celleporaria incrassata Smitt, 1868b : 33, 198 (part.), t. 28, f. 212, 216; *Cellepora incrassata* Nordgaard, 1905 : 172, pl. III, f. 25; Waters, 1900 : 93, pl. 12, f. 11-14; *C. cervicornis* Busk, 1880 : 238, pl. XIII, f. 6-8; Lorenz, 1886 : 95 (13), pl. VII, f. 12.

The zoaria, free-growing and ramose, consist of cylindrical branches which gradually narrow toward a rounded top. The zoaria attain up to 70 mm in height and 100 mm in width; the branches have a diameter of 6 to 8 mm near the base, and up to 2.5 to 3 mm near the top. The zooids are irregularly arranged, congested, semi-erect, oval in shape, and medium in size (length 0.63 to 0.75 mm, width 0.45 to 0.63 mm). The young zooids at the tips of the branches are cylindrical and low, and their orifice is in the middle of the round, upper surface; there are depressions with pores arranged radially at the bottom on this upper surface. At some distance from the top of the branches, the upper surfaces of the zooids gradually stretch out on one side and acquire the form of an oval, frontal surface; the orifice of the zooid then occupies the position near the distal margin of the latter. The depressions also stretch out in a radial direction toward the orifice along the margin of the convex, frontal surface, and a somewhat radial, rebral surface develops. But with further calcification, the depressions are gradually covered and the frontal surface becomes smooth and granulated with traces of the depressions along the margin. The primary orifice of the zooid is round with a sharp sinus in the middle of the proximal margin. The peristome develops around the primary orifice to form secondary oval orifice; along its margins are located small, round avicularia with semi-circular mandibles; the latter tilt toward each other and their free ends point toward one side. In addition to the oral avicularia, large vicariating avicularia are also found among the zooids. These avicularia are of 2 types—those with semi-circular mandibles (length 0.15 mm, width 0.25 mm), and those with mandibles shaped like a palette knife, in which the distal end is slightly broader (length 0.35 to 0.43 mm, width 0.20 to 0.23 mm). Between the zooids and the vicariating avicularia, one finds large, empty cavities covered over with a membrane; these are the undeveloped zooids. The ovicells are hyperstomial, semi-circular, convex, and smooth surfaced.

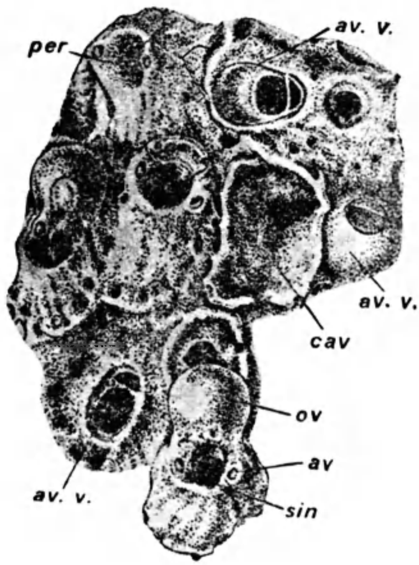


Figure 388. *Cellepora surcularis* (Packard). Part of a branch with the cavity (*cav.*) of the undeveloped zooid, and ordinary and vicariating avicularia of 2 types.

The species lives on shells and stones, at a depth of 7 to 450 m, more often from 50 to 150 m, on a bed of stone, shells, and silt, under temperatures of −1.9 to 4.78°C, in the White Sea from −1.2 to 8.10°C, in a salt concentration of 31.80 to 34.54‰, in the White Sea from 27.48 to 29.38‰.

Distribution. The species was found by me in the Barents, Kara, East Siberian, Chukotsk, Bering, and Okhotsk seas, and in the Davis Strait. *Reports in literature:* Barents sea (Smitt, 1868b, 1879b; Bidenkap, 1897, 1900a, 1900b; Nordgaard, 1896, 1900, 1918; Waters, 1900; Andersson, 1902; Kluge, 1906; Kluge in Deryugin, 1915), White Sea (Smitt, 1879b; Kluge in Deryugin, 1928; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Livensen, 1887; Nordgaard, 1912b), East Siberian Sea (Nordgaard, 1929), Chukotsk Sea (Osburn, 1923), northern coast of North America and the Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1923, 1932, 1936), Labrador (Packard, 1863; Osburn, 1913), western Greenland (Smitt, 1868c; Norman, 1876, 1906; Hincks, 1877a; Hennig, 1896; Vanhöffen, 1897; Kluge, 1908b; Levinsen, 1914; Osburn, 1919), Gulf of St. Lawrence (Whiteaves, 1874, 1901), Iceland (Smitt, 1868b; Nordgaard, 1924), and northern Norway (Nordgaard, 1918).

This is an Arctic, circumpolar species.

4. **Cellepora ventricosa** Lorenz, 1886 (Figure 389)

Cellepora ventricosa Lorenz, 1886 : 14 (96), t. VII, f. 13; Waters, 1900 : 96, pl. 12, f. 10; Nordgaard, 1905 : 172, pl. III, f. 26-29; *et auctt.*

The zoaria, free-growing and ramose, consist of more or less short, cylindrical branches of almost uniform thickness throughout their length, which have round, blunted ends. Because of their larger size, the zooids are more prominently raised on the surface of the branches and give them a verrucose appearance. The zoaria attain up to 30

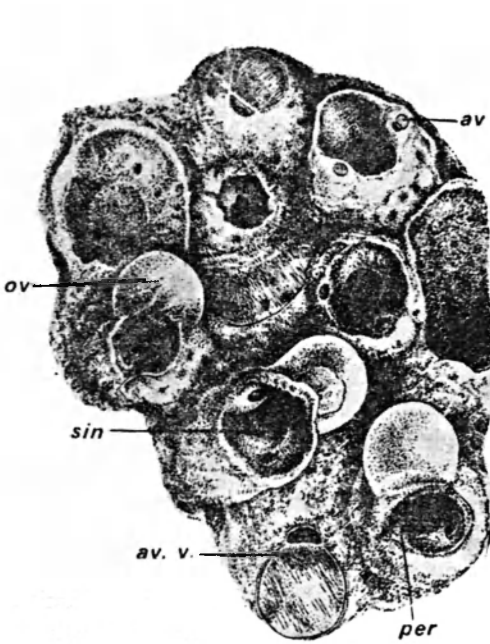


Figure 389. *Cellepora ventricosa* Lorenz. Part of a branch with ordinary and vicariating avicularia. Barents Sea.

to 40 mm in height and 50 mm in width; the branches reach up to 6 to 7 mm in thickness. The zooids are irregularly arranged, congested, semi-erect, thick-walled, oval-conical in shape, and large in size (length 1.00 mm, width 0.87 mm). The young zooids at the top of the branches are tall and cylindrical; their orifice has depressions radially arranged around it, and is located almost in the middle of the upper, roundish surface; a second row of depressions follows all around on the lateral wall behind the orifice. But soon the upper surfaces of the zooids stretch out on one side, forming the frontal surface of the zooids on which the margins of the depressions stretch toward the orifice with a light, rebral formation on the surface. As the walls thicken, this rebral structure becomes covered, and in its place, only small, roundish depressions remain. The primary orifice, located near the distal margin of the zooid, is oblong-oval with a very light constriction above the proximal margin, followed by a slight broadening of the latter with the formation of sharp denticles at its ends. A sharp sinus is located proximal to the margin. The peristome develops along the primary orifice to form an oval secondary orifice at the sides of which are located round avicularia with semi-circular mandibles; the latter tilt toward each other with their free ends directed toward one side. In addition to the oral avicularia, sometimes frequently, sometimes rarely, larger vicariating avicularia spread between the zooids, which have almost round mandibles and a straight incision at the proximal margin (length 0.42 mm, width 0.37 mm). Large, hollow cavities are found between the zooids which are covered with a membrane; these are the undeveloped zooids. The ovicells are semi-circular and convex; they have an incompletely calcified outer layer in the form of a triangular surface on the frontal surface, and a slightly turned proximal margin.

The species lives on hydroids, shells, and stones, at a depth of 12 to 460 m, more often from 75 to 200 m, on a bed of stone, shells and silt, under temperatures ranging from −1.9 to 4.78°C, in the White Sea from −1.2 to 12.5°C, in a salt concentration of 31.80 to 34.79‰, in the White Sea up to 28.93‰.

Distribution. This species was found by me in the Barents, Kara, Chukotsk, and Bering seas, and in the Davis Strait, the Gulf of St. Lawrence, and western and eastern Greenland. *Reports in literature:* Barents Sea (M. Sars, 1851; Smitt, 1868b, 1879a; Bidenkap, 1900a; Waters, 1900; Andersson, 1902; Kluge, 1906; Kluge in Deryugin, 1915; Kuznetsov, 1941), White Sea (Kluge, 1908a, Kluge in Deryugin, 1928; Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Nordgaard, 1912b; Kluge, 1929), northern coast of North America and the Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1936), western Greenland (Kluge, 1908b; Osburn, 1936), Yan-Maien Island (Lorenz, 1886), Iceland (Nordgaard, 1924), and northern Norway (Nordgaard, 1905, 1918).

This is an Arctic, circumpolar species.

5. **Cellepora smitti** Kluge nom. n. (Figure 390)

Cellepora ramulosa forma *tuberosa* Smitt, 1868b : 31; *C. tuberosa* Nordgaard, 1906b : 96, pl. II, f. 28-34; *et auctt.*; non *Celleporaria tuberosa* d'Orbigny.

The zoaria are either in the form of ganglia or free-growing, cylindrical, branched structures. The preparations studied by me had the following dimensions: a ganglion-shaped, overgrowing *Hornera lichenoides* was $5 \times 10 \times 5$ mm; an irregularly branched zoarium in a small conglomerate was 16 mm high, 30 mm long, and 8 mm thick at the base, but 4 mm at the end of the branches; and lastly, a piece of one branch had a length of 18 mm and a thickness of $2\frac{1}{2}$ mm. Because the conical rostra of the avicularia are raised, the zoarial surface has the appearance of a sharply pointed denticle. The zooids in the zoarium form no particular pattern. They are medium in size (length 0.88 mm, width 0.63 mm), broadly oval in shape, and thick-walled. The frontal surface is concave with a fine granulation, sometimes bordered by a row of small, sparse pores. The primary orifice, located near the distal margin of the zooid, is round with a broad, concave sinus; sharp condyles are situated at the margins of the sinus. The operculum is round with a raised structure at the proximal margin, yellow in color, and chitinized. The raised, sharp, upwardly conical and semi-circular rostrum of the avicularium, has a pointed, triangular mandible whose tip is directed obliquely upward; the rostrum directly adjoins the proximal margin of the secondary, round orifice on one or the other side, or sometimes on both, of the medial line. The avicularian chamber is broad, reaches up to the margin of the zooid of the corresponding side, and sometimes occupies a large portion of the frontal surface. In addition to the oral avicularium, vicariating avicularia are also found among the zooids, whose mandible is shaped like a palette knife which broadens at the end (length 0.38 mm, width

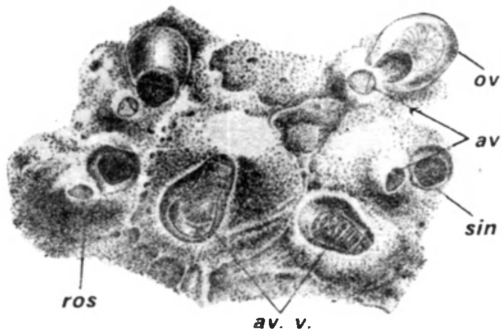


Figure 390. *Cellepora smitti* Kluge nom. n. Part of a zoarium with ordinary and vicariating avicularia. Barents Sea

0.18 mm near the proximal margin, 0.25 mm at the distal end). Large empty cavities which are covered with a membrane, lie between the zooids; these are the undeveloped zooids. The ovicells are hyperstomial, semi-circular, convex, and smooth surfaced.

The species lives on hydroids, Bryozoa, shells, and stones, at a depth of 40 to 385 m, on a ground of stones and sand, under temperatures ranging from 3 to 6°C.

Distribution. This species was found by me in the Barents Sea. *Reports in literature:* Barents Sea (Kluge, 1906; Nordgaard, 1905, 1918), northern Norway (M. Sars, 1851; Smitt, 1868b; Nordgaard, 1905, 1906b, 1918), region of the Faeroes Islands (Nordgaard, 1907b, 1918), and ? western Greenland (Levinsen, 1914).

This is a boreal, Atlantic species.

6. **Cellepora nodulosa** Lorenz, 1886 (Figure 391)

Cellepora nodulosa Lorenz, 1886 : 96 (14), t. VII, f. 14-15; Nordgaard, 1905 : 172, pl. III, f. 21-24; Kluge, 1906 : 48, f. 5.

The zoaria, overgrowing in the form of small, multilayered, oval ganglia, consist of irregularly arranged and overlapping zooids. The zooids are medium in size (length 0.75 mm, width 0.50 mm) and oval in shape. The re-formed zooids are surrounded by a row of orifices, the submerged and overgrown ones have avicularia which join them. The frontal surface of the zooid is convex, smooth, and finely granulated. The primary orifice, located near the distal margin, is round with a broad, arcuate sinus at the proximal margin. The raised, cylindrical rostrum of the avicularium directly adjoins the latter; at the top of the avicularium is a semi-circular mandible whose free end is directed obliquely upward. The peristome is raised on both sides of the orifice in the form of thin plates, which stretch along the lateral walls of the rostrum toward its top forming, as it were, grooves; these lobes are asymmetrical because of the bent structure of the rostrum. I did not find vicariating avicularia in the present species, and no other

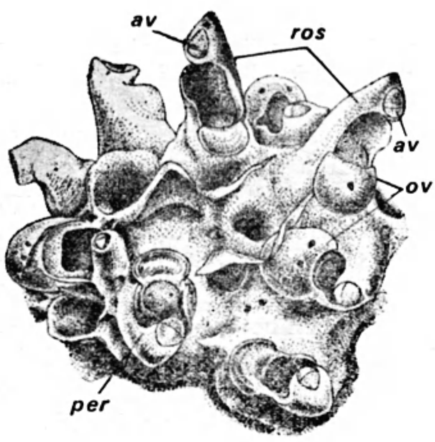


Figure 391. *Cellepora nodulosa* Lorenz. Part of a zoarium. Kara Sea.

author has mentioned them to date. The ovicells are hyperstomial, semi-circular, and convex; they have a smooth surface which is covered with pores.

The species lives on hydroids, Bryozoa, tubes of annelids, and shells, at a depth of 1.5 to 698 m, more often from 50 to 200 m, under temperatures ranging from −1.7 to 6.3°C, in the White Sea up to 12.5°C, in a salt concentration of 27.22 to 34.96‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, and East Siberian seas, in the Davis Strait, and off eastern Greenland. *Reports in literature:* Barents Sea (Smitt, 1868b, 1879b; Marenzeller, 1877; Urban, 1880; Nordgaard, 1896, 1905, 1912a, 1918; Bidenkap, 1897, 1900a, 1900b; ? Waters, 1900; Andersson, 1900; Kluge, 1906; Kluge in Deryugin, 1915), White Sea (Gostilovskaya, 1957), Kara Sea (Smitt, 1879a; Levinsen, 1887; Nordgaard, 1912b; Kluge, 1929), Laptev Sea (Kluge, 1929), eastern Greenland (Andersson, 1902; Nordgaard, 1907a; Levinsen, 1914), Yan-Maien Island (Lorenz, 1886), and northern Norway (Nordgaard, 1905, 1918).

This is an Arctic, Atlantic species.

7. **Cellepora pumicosa** L., 1767 (Figure 392)

Cellepora pumicosa Busk, 1854a : 86, pl. 110, f. 4-6; Hincks, 1880a : 398, pl. 54, f. 1-3; non Bidenkap, 1900a : 256, non Waters, 1900 : 95.

The zoarium is either prostrate or in the form of a tubular ganglion or hollow tube, which surrounds the stem of an alya of a hydroid. Because its sharp rostrum rises above the surface, the zoarium has a needle-like appearance. The zooids are small (height 0.60 mm, width 0.37 mm), oval or urceolate, semi-erect in the younger parts of the zoarium, and erect in the older, and smooth surfaced. The primary orifice, located near the distal margin of the zooid, is round with a concave, broad sinus encircled by a thin peristome. A strongly developed, thick, straight rostrum rises at the middle of the proximal margin of the orifice, and stretches out toward the end into a sharply pointed spine. The avicularium has an irregular mandible situated near the base of

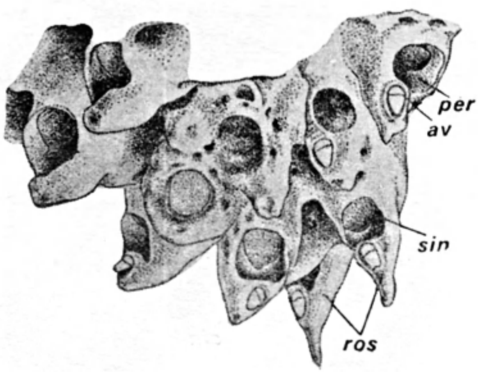


Figure 392. *Cellepora pumicosa* L. Part of a zoarium. Barents Sea.

the rostrum, which is obliquely directed toward the orifice. Except for the rostral avicularium, other types are not found. The ovicells are hyperstomial; they have a smooth surface which is either covered with a few large pores, or has no pores whatsoever.

The species lives on algae, hydroids, and shells, at a depth of 9 to 400 m.

Distribution. Reports in literature: This species was located in the waters of northern and eastern Finmark, which form part of the Barents Sea (Nordgaard, 1896; Norman, 1903b). In addition, it has been found along the eastern coast of the Atlantic Ocean, near the western coast of Norway (Nordgaard, 1906b, 1918), the British Isles (Hincks, 1880a), and the northern coast of France (Joliet, 1877).

The reports about the existence of this species in the waters of Franz Josef Land (Waters, 1900), Labrador (Packard, 1863), and the Gulf of St. Lawrence (Whiteaves, 1901) are questionable and need to be verified.

This is a boreal species.

8. **Cellepora canaliculata** Busk, 1886 (Figure 393)

Cellepora canaliculata Busk, 1886 : 204, pl. XXX, f. 5; *Cellepora nordgaardi* Kluge, 1906 : 47, f. 4; *C. nodulosa* var. *nordgaardi* Nordgaard, 1918 : 87.

The zoaria overgrow in the form of small (up to 10 mm long), multi-layered, oval ganglia, which consist of congested, medium sized, erect zooids, whose raised rostra provide a needle-like appearance to the surface of the zoarium. The frontal surface is convex and smooth. The primary orifice, located at the distal end of the zooid, is round with a narrow, round, pointed sinus in the middle of its proximal margin. The raised, straight, or slightly concave, rostrum of the avicularium is located at the proximal side of the distal surface of the zooid, and is surrounded by the more or less developed, symmetrical, lateral lobes of the peristome. The terminal part of the rostrum is cylindrical, and an oval avicularium is located at its distal end; this avicularium has a semi-circular mandible. The development of the

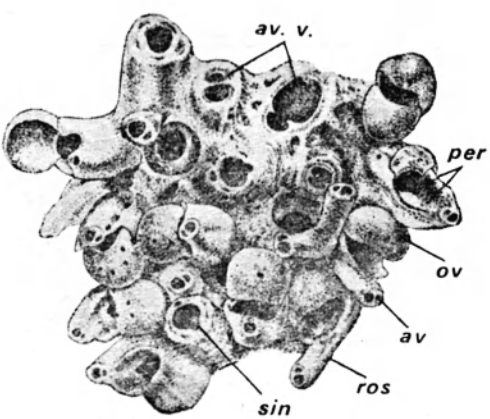


Figure 393. *Cellepora canaliculata* Busk. Part of a zoarium with ordinary and vicariating avicularia.

rostrum varies greatly; sometimes it is short and slightly concave, sometimes it is long and almost straight, and its length is sometimes equal to the height of the zooid (0.50 mm). In addition to the oral avicularium, a zoarium may also (though rarely) have comparatively small (0.13 to 0.25 mm long), oval, vicariating avicularia, which have semi-circular or semi-elliptical mandibles. The ovicells are hyperstomial, round, and convex; they have a smooth surface which is covered with pores.

The species lives on hydroids, Bryozoa, tubes of worms, and shells, at a depth of 18 to 272 m, more often from 100 to 200 m, under temperatures ranging from −1.9 to 4.95°C, in a salt concentration of 30.79 to 34.72‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, and East Siberian seas, in the Davis Strait, and off eastern and western Greenland. *Reports in literature:* Barents Sea (Kluge, 1906; Kluge in Deryugin, 1915; Nordgaard, 1912a), White Sea (Gostilovskaya, 1957), Laptev Sea (Kluge, 1929), Gulf of St. Lawrence (Hincks, 1892; Whiteaves, 1901), Iceland (Nordgaard, 1924), and northern Norway (Nordgaard, 1912a).

This is an Arctic, Atlantic species.

9. **Cellepora avicularis** Hincks, 1880 (Figure 394)

Cellepora ramulosa forma *avicularis* Smitt, 1868b : 32, 194, t. 28, f. 202-205; *C. avicularis* Hincks, 1880a : 406, pl. 54, f. 4-6; Nordgaard, 1906b : 98, pl. II, f. 37, 39.

The zoaria either overgrow, or are in the form of more or less thick ganglia, or hollow, cylindrical structures; in all cases, they consist of many layers of zooids. The zooids are small (length 0.62 mm, width 0.37 mm), oval, and in the younger part of the zoarium semi-erect; they have a smooth surface with sparse pores along the barely raised, thin margin; in the older part of the zoarium, the zooids are erect, closely congested, and irregularly arranged; their distal surfaces have orifices directed to different sides and lying on different planes. The primary orifice of the zooid is round, and has a triangular sinus at its proximal margin which is encircled by a thin peristome. The raised, thick, oval (in cross section) rostrum of the avicularium has a semi-oval mandible, is obliquely located at the proximal margin of the orifice, on one side of the medial line; the free end of the mandible points upward. Sometimes small, oval avicularia, with semi-circular mandibles, are found on one or both sides of the zooid on small, erect outgrowths. In addition to these adventitious avicularia, large (length 0.37 mm), broad, vicariating avicularia with free ends shaped like a palette knife, are also found among the zooids. The ovicells are raised and almost round; they have a smooth surface which is covered with large pores.

The species lives on algae, hydroids, tubes of annelids, and shells, at a depth of 10 to 300 m, on a bed of stone, shells, and silt.

Distribution. Reports in literature: This species is found in the waters of northern Finmark, near Nordkapp and Inge Island in the Barents Sea (Nordgaard, 1896, 1918). Reports have also been verified of its

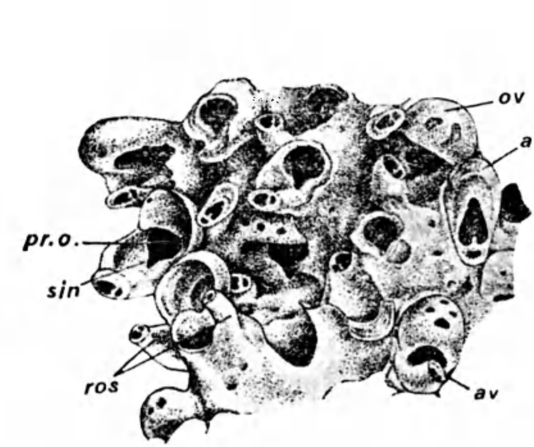


Figure 394. *Cellepora avicularis* Hincks. Part of a zoarium with ordinary and vicariating avicularia. Barents Sea (off Finmark).

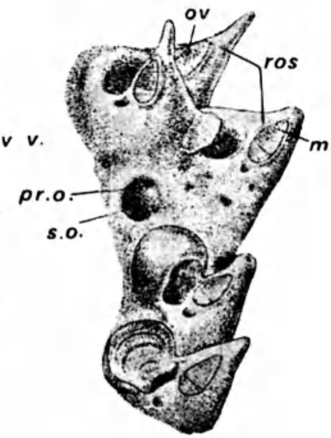


Figure 395. *Cellepora ramulosa* L. Part of a branch. Coastal waters of Skagerrack.

existence along the eastern coast of the Atlantic Ocean, near the western coast of Norway (Smitt, 1868b; Nordgaard, 1896, 1918), Skagerrack (Smitt, 1868b), the British Isles (Hincks, 1880a), and the Mediterranean Sea (Calvet, 1902).

This is a boreal, Atlantic species.

*10. **Cellepora ramulosa** Linnaeus, 1726 (Figure 395)

Cellepora ramulosa forma *ramulosa* Smitt, 1868b : 31, 192, t. XXVIII, f. 207; Hincks, 1880a : 401, pl. LII, f. 7-9; non Levinsen, 1887 : 324.

The free-growing zoarium attains up to 7 cm in height and is often irregularly branched. The branches are cylindrical and thin, and sometimes fuse with each other. Due to the presence of rostra, the surface of the branches is rough. The zooids are medium in size, semi-erect, and smooth surfaced. The primary orifice is roundish and encircled by a thin peristome. The secondary orifice is semi-circular. The raised, semi-circular, sharply pointed, conical rostrum of the avicularium is located near the straight proximal margin of the secondary orifice. It has a triangular mandible at the lateral side, which points toward one or the other side. There is an oval incision or orifice present between the base of the avicularium and the lateral lobe of the peristome. In addition to the rostral avicularium, sometimes large, vicariating avicularia, shaped like a palette knife, are also found among the zooids. The ovicells are hyperstomial, raised, and semi-circular; they have a smooth surface which has no pores.

The species lives on hydroids, tubes of annelids, shells, and stones, at a depth of 14.5 to 400 m, on a bed of stone and shells.

Distribution. Reports in literature: Although this species was reported by Levinsen (1887) as present in the Kara Sea, my examination of the collections analyzed by him and preserved in the Zoological Institute in Copenhagen, revealed them to be *Cellepora nodulosa* Lorenz, and *C. canaliculata* Busk. This species is found in the coastal waters of southwestern Norway (Nordgaard, 1918), Skagerrack (Smitt, 1868b; Marcus, 1940), the North Sea (Nordgaard, 1918), the Shetland and British Islands (Hincks, 1880a) and northwestern France (Joliet, 1877).

This is a boreal species.

XIII. Family **Hippopodinidae** Levinsen, 1909

Hippopodinidae Levinsen, 1909 : 353, *Discoporidae* (part.) Smitt, 1868b : 28; *Escharidae* (part.) Hincks, 1888 : 225.

The zoaria are prostrate and often free-growing. The zooids are thin-walled and have no spines. The frontal surface, except for the peristome, is entirely covered with small pores. The primary orifice has a weakly concave proximal margin. The mildly chitinized operculum is surrounded by a more chitinized margin. The condyles and peristome may be present or absent. The lateral wall and the transverse septum have multiporous or uniporous plates. Avicularia may be present on one or both sides of the orifice, or entirely absent. The ovicells are endozooecial; their outer layer is membranous, while the inner one is calcareous, and covered with pores at the surface.

Genus **Cheilopora** Levinsen, 1909

Chelipora Levinsen, 1909 : 353; *Discopora* (part.) Smitt, 1868b : 28; *Lepralia* (part.) Hincks, 1877a : 102; *Mucronella* (part.) Hincks, 1880b : 280.

The zoaria consist of zooids arranged in regular, straight and oblique rows. The zooids are large, thin-walled, and hyaline. The primary orifice is large and roundish, or tall and semi-circular; it has a mildly concave proximal margin. A short peristome, consisting of 2 halves—distal and porximal—forms a secondary orifice that is transversely oval in shape, and has a sharply pointed or broad lyrule in the middle of its proximal margin, or the orifice is semi-circular with a mildly raised proximal margin. There are multiporous plates in the lateral wall and in the distal septum.

Genus type: *Discopora sincera* Smitt, 1868.

1 (4). Zooids more or less raised. Secondary orifice round with a lyrule at the proximal margin. Avicularia present or absent. Ovicells round.

2 (3). Zooids raised. Secondary orifice round with a sharply pointed tooth at the proximal margin. Avicularia are usually present on one or both sides of the orifice, but in many zooids of the zoarium they are absent................1. *Ch. sincera* (Smitt).

3 (2). Zooids less raised. Secondary orifice round with a more or less broad tooth in the middle of its proximal margin. Avicularia rarely present, but often appear in a vestigial state...................................1a. *Ch. sincera* var. *praelucida* (Hincks).

4 (1). Zooids flat. Secondary orifice semi-circular with a mildly raised proximal margin. Avicularia usually absent. Ovicells less raised and slightly narrower toward the end...2. *Ch. inermis* (Busk).

1. **Cheilopora sincera** (Smitt, 1868) (Figure 396)

Discopora sincera Smitt, 1868b : 28, 177 (part.), pl. 27, f. 178-180; *Mucronella sincera* Nordgaard, 1896 : 29, pl. 1, f. 6; *Eschara sincera* Nordgaard, 1905 : 168, pl. III, f. 12-14; *Cheilopora sincera* Nordgaard, 1912b : 21; *Mucronella simplex* Hincks, 1880b : 280, pl. XV, f. 7.

The zoaria are single-, or, double-layered. The zooids, arranged in more or less regular, straight and oblique rows, vary in shape, being either rhombic, oval, or rectangular; they are a little more than medium in size (length 1.00 mm, width 0.50 mm) and their height is more than 2 times greater than their width. The frontal surface is moderately raised, and bordered by a thin, raised margin which separates the zooids; its entire surface, except for the peristome, is uniformly covered with pores. The primary orifice, located near the distal margin, is round; it has no lyrule, condyles, or spines; it is encircled by a peristome which consists of 2 halves—a distal which belongs to the overlying daughter zooid, and a proximal which belongs to the given zooid. The distal half is semicircular, and the proximal encloses the ends of the distal half at the point of their fusion and, narrowing toward the proximal margin, forms a round, secondary orifice with a raised, sharp tooth at the center. Often on the sides, at the point of fusion of the distal half with the proximal, oval avicularia are present on one or both sides; their mandibles are shaped like a palette knife which broadens toward the end, and is directed toward one side and forward. The ovicells are round and raised; they have a coarsely granulated surface that is covered with fine pores, and narrows as it approaches the upper half of the peristome. The lateral margins of the peristome are located on the frontal surface of the ovicells and, facing each other up to the stage of fusion, give rise to a thin pecten behind the proximal margin of the ovicell.

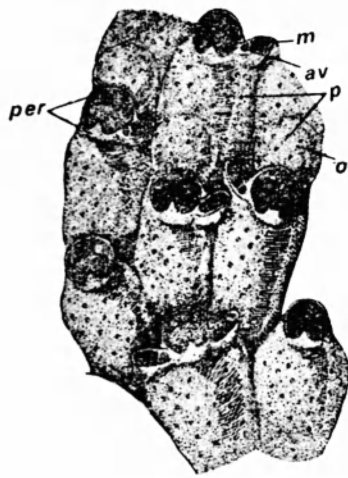


Figure 396. *Cheilopora sincera* (Smitt). Part of a zoarium.

There are 2 pore plates with many pores each, in the lateral wall and the distal septum of the zooid.

The species lives on hydroids, Bryozoa, tubes of *Polychaeta,* shells, and stones, at a depth of 1.5 to 408 m, more often from 50 to 150 m, on a bed of silt, stone, and shell, under temperatures ranging from —1.9 to 3°C, in a salt concentration of 31.44 to 34.83‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, East Siberian, Chukotsk, Bering, and Okhotsk seas, in the waters off western Greenland, and in the Davis Strait. *Reports in literature:* Barents Sea (Smitt, 1868b; Urban, 1880; Vigelius, 1881; Nordgaard, 1896, 1900, 1912a, 1918; Bidenkap, 1897, 1900a, 1900b; Waters, 1900; Andersson, 1902; Kuznetsov, 1941), Kara Sea (Smitt, 1879a; Nordgaard, 1912b; Kluge, 1929), Laptev Sea (Kluge, 1929), East Siberian Sea (Nordgaard, 1929), Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1936), western Greenland (Smitt, 1868c; Norman, 1876, 1903b, 1906; Hennig, 1896; Kluge, 1908b; Levinsen, 1914), eastern Greenland (Andersson, 1902), Yan-Maien Island (Lorenz, 1886), Iceland (Nordgaard, 1924), and the fiords of northern Norway down to the Lofoten Islands in the south (Smitt, 1868b; Nordgaard, 1896, 1905, 1918).

This is an Arctic, circumpolar species.

***1a. Cheilopora sincera** var. **praelucida** (Hincks, 1888) (Figure 397)

Mucronella praelucida Hincks, 1884 : 52 (26), pl. 4, f. 1; 1888 : 225, pl. XV, f. 3; Osburn, 1913 : 283, pl. 34, f. 3, 3a, 3c.

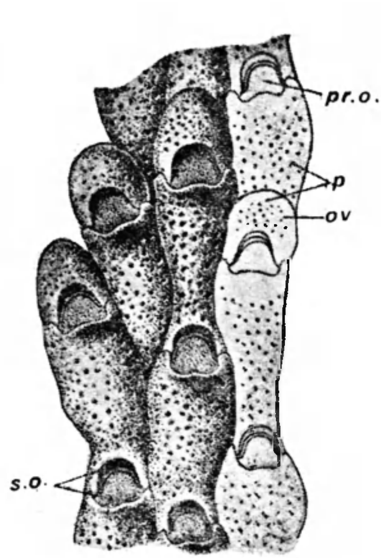


Figure 397. *Cheilopora sincera* var. *praelucida* (Hincks). Part of a zoarium without avicularia. Barents Sea.

The zoaria are prostrate. The zooids are less raised. The primary orifice is round. The proximal margin of the secondary orifice has a more or less broad tooth. Avicularia are found very rarely and demonstrate a tendency toward vestigiality, often appearing in the form of a rudimentary rostrum without a developed mandible.

The species lives on Bryozoa and shells.

Distribution. Reports in literature: Coastal waters off Queen Charlotte Islands (Hincks, 1884), northern coast of North America and the Archipelago of the Canadian Islands (Osburn, 1923, 1932), western Greenland (Osburn, 1919), Labrador (Osburn, 1913), and the Gulf of St. Lawrence (Hincks, 1888; Whiteaves, 1901; Norman, 1903b).

This is an Arctic species.

2. **Cheilopora inermis** (Busk, 1880) (Figure 398)

Discopora sincera Smitt, 1868b : 28, 177 (part.); *Lepralia sincera* Hincks, 1877a : 102, pl. XI, f. 2; *Hemeschara sincera* var. *inermis* Busk, 1880 : 237; *H. contorta* Kirchenpauer, 1874 : 422.

The zoaria often have a convex or concave surface. The zooids are arranged in longitudinal rows in a checkered pattern, but the regularity and arrangement are quite often disturbed, particularly in those regions with developed ovicells. The zooids are a little more than medium in size (length 1.00 mm, width 0.40 mm) and oblong-rectangular in shape; they are broader in the distal half and slightly narrower in the proximal. The frontal surface is flat and bordered by a raised margin which separates the zooids. The primary orifice, located near the distal end of the zooid, is round and shaped like a palette knife; it has a bent (concave), proximal margin with no lyrules or condyles, and a semi-circular distal margin with no spines. The orifice is encircled by a peristome which consists of 2 halves—the distal one belongs to the daughter zooid, and the proximal half to the given zooid. The distal half is semi-circular, and the proximal half, at the place of fusion with the distal, encloses the proximal ends of the latter and, broadening toward the proximal margin with its corners rounded on each side, it transforms into the broadened, proximal margin of the peristome, which has a graded protuberance in the center. An oblong, more or less narrow slit with pores at the bottom (Figure 398, *sl*) is located on each side of the proximal margin of the overlying daughter zooid, and on the distal margin of the given zooid, in the place where the lateral margins of the zooid convert into the distal and proximal halves of the peristome. Avicularia are usually absent, but sometimes, though extremely rarely, they may be present on the sides at the place of the fusion of the distal half of the peristome with the proximal one, in the form of incompletely developed structures or apparent vestiges. The ovicells are oblong spheres and less raised; they have a coarsely granulated surface, which is covered with pores in the distal half. The lateral lobes of the upper half of the peristome are located over the ovicell in zooids carrying ovicells, and fuse to form a pecten, as it were, along the proximal margin of the ovicell. There are 2 pore plates with many pores each in both the lateral wall and the distal septum.

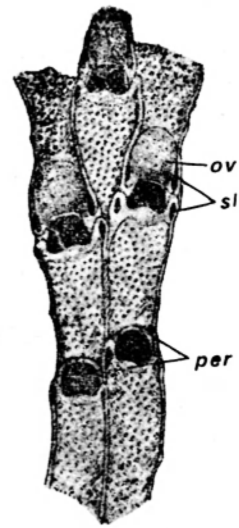


Figure 398. *Cheilopora inermis* (Busk). Part of a zoarium. Barents Sea.

The species lives on hydroids, tubes of worms, shells, and calcareous Bryozoa, at a depth of 11 to 323 m, on a bed of silt, stone, and shells, under temperatures ranging from -1.9 to 3°C, in a salt concentration of 32.86 to 34.54‰.

Distribution. The species was found by me in the Barents, Kara, Chukotsk, Bering, and Okhotsk seas, and near Disko Island in Baffin Bay. *Reports in literature:* Barents Sea (Smitt, 1868b; Andersson, 1902; Nordgaard, 1918), western Greenland (Hincks, 1877a; Busk, 1880), and eastern Greenland (Kirchenpauer, 1874).

This is an Arctic, circumpolar species.

XIV. Family **Peristomellidae** Kluge fam. n.

Discoporidae (part.) Smitt, 1868b : 26; *Escharellidae* (part.) Levinsen, 1909 : 314, Borg, 1930a : 86; Marcus, 1940 : 234.

The zoaria are prostrate. The primary orifice is large and roundish, and has no lyrule. The distal margin has from 2 to 6 spines; a strongly developed vestibular arch is depressed from inside it. It is encircled on the lateral and frontal surfaces by a more or less developed peristome, which is separated from the primary orifice by a specific border. The frontal surface of the secondary orifice forms either a pointed or a saccate outgrowth. The operculum is usually membranous. Avicularia are usually present in the form of paired structures on the sides of the orifice. In most species, multiporous chambers are also present. The ovicells are hyperstomial.

Genus **Escharoides** Milne-Edwards, 1836

Escharoides Milne-Edwards, 1836 : 218; Levinsen, 1909 : 317; *Mucronella* (part.) Hincks, 1880a : 371; *Peristomella* Levinsen, 1902 : 26.

The zoarium is prostrate and overgrowing. The primary orifice is roundish or transversely oval; in most species, it has no lyrule and is not separated from the encircling peristome by any specific border. The orifice has a more or less developed vestibular arch. The distal margin of the orifice has 2 to 6 spines. Each lateral margin of the secondary orifice forms a groove-like (canaliculate), lamellate spine which is directed toward the center of the orifice. The frontal margin of the secondary orifice has either a lamellate tooth in its center, or it forms a saccate protuberance. In most species, the operculum is membranous, and rarely, strongly chitinized. Avicularia are present in most species, located on each side of the orifice; sometimes they are absent from one or both sides. The ovicells are hyperstomial; the outer layer is membranous and calcareous, and the inner one may have scattered small pores.

Genus type: *Cellepora coccinea* Abildgaard, 1806.

1 (8). Zooids large. Primary orifice roundish or transversely oval in shape, not separated from its encircling peristome by any specific border, and without lyrule or condyles. There are 4 to 6 spines on the distal margin.

2 (3). There are 6 spines on the distal margin of the orifice. Frontal margin of the peristome has a simple, lamellate tooth in its center which is bifurcated at the end...... 1. *E. coccinea* (Abildgaard).

3 (2). Distal margin of the orifice has 4 to 5 spines. Frontal margin of the peristome forms a saccate protuberance in its center.

4 (5). There are 4 spines on the distal margin of the orifice. A short, rounded denticle is usually found in the middle of the saccate protuberance of the peristome, on the outer side; a short, hollow, rounded outgrowth uprises inside the orifice of the zooid, from under the protuberance................2. *E. bidenkapi* (Kluge).

5 (4). There are 4 to 5 spines on the distal margin of the orifice. Saccate protuberance of the frontal margin of the peristome has neither denticle nor digitate protuberance in the orifice.

6 (7). There are 4 spines on the distal margin of the orifice. Frontal margin of the peristome forms a rectangular projection in the center, the inner corners of which are sharpened and close...... ....3. *E. jacksoni* (Waters).

7 (6). There are 4, sometimes 5, spines at the distal margin of the orifice. Saccate protuberance in the center of the peristome stretches out strongly and narrows toward the end; it resembles the spout of a pitcher..................3a. *E. jacksoni* var. *rostrata* (Kluge).

8 (1). Zooids small. Primary orifice semi-circular; it has a weakly raised proximal margin and blunt condyles at the sides of the orifice. There are 2 small spines at the distal margin of the orifice. A voluminous, rectangular, hollow protuberance is located in the middle of the proximal margin of the secondary orifice, which has an orifice directed toward the orifice of the zooid. Lateral lobes of the peristome strongly developed in the zooids carrying ovicells. There are multiporous plates in the lateral and distal walls................4. *E. monstruosa* (Kluge).

*1. **Escharoides coccinea** (Abildgaard, 1806) (Figure 399)

Cellepora coccinea Abildgaard in Müller, 1806 : 30, pl. 146, f. 1-2; *Lepralia coccinea* Busk, 1854a : 70, pl. 88; *Mucronella coccinea* Hincks, 1880a : 371, pl. 34, f. 1-6.

The zoarium consists of zooids of medium size arranged in irregular and divergent rows. The frontal surface is raised, rising from the proximal margin to the orifice of the zooid. The zooids are separated by deep margins along which saccate depressions with pores at the bottom are located. The surface is granular. The primary orifice has a transversely oval form and no lyrule. There are 6 thin spines at the distal margin of the orifice and, in the zooids carrying ovicells, there are 4 spines located before the ovicells. A vestibular arch arises inwardly from the distal margin in the form of a slightly tilted, calcareous plate with a thick, straight, finely denticulate margin. The primary orifice is enclosed on two sides in the proximal part by the peristome, thus forming the secondary orifice. One lamellate denticle is located on each side, at the margin of the peristome, at the place where the lateral lobes of the peristome convert into the frontal side; a similar denticle is also formed in the center of the frontal side of the peristome, which is sometimes inwardly bent and developed at the tip. A large, beak-shaped avicularium with a sharp mandible whose free end is directed forward and toward one side, is usually located on each side of the orifice. The ovicells are round and slightly flattened; they have a granular surface.

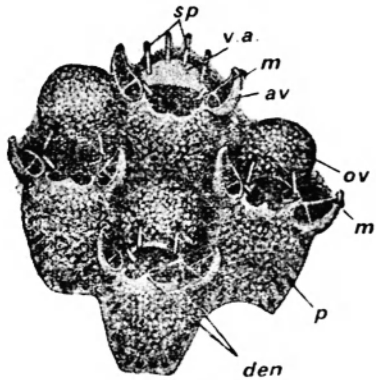


Figure 399. *Escharoides coccinea* (Abildgaard). Zooids with vestibular arch (*v. a.*), denticles of the peristome (*den.*), spines, avicularia, and ovicells. Coastal waters of western Norway.

The species lives on algae, ascidia, shells, and stones, at a depth ranging from the belt of ebb and flow to the median depths of the sublittoral.

Distribution. Reports in literature: Along the western coast of Norway (M. Sars, 1853; Nordgaard, 1896, 1912a), Denmark (Marcus, 1940), British Isles (Hincks, 1880a), France (Joliet, 1877; Fischer, 1870), and the Mediterranean Sea (Calvet, 1902).

This is a boreal, Atlantic species.

2. **Escharoides bidenkapi** (Kluge, 1946) (Figure 400)

Peristomella bidenkapi Kluge, 1946 : 200, t. II, fig. 6.

The zoaria, prostrate and overgrowing the substrate in the form of thick crusts, consist of large zooids arranged in irregularly divergent rows; the zooids in adjoining rows are sometimes alternate, sometimes parallel. The frontal surface is raised and the zooids separated by deep margins that have flat, saccate depressions with pores at the bottom. The surface is granular. A transversely oval, primary orifice is located at the distal end; it has no lyrule. There are 4 spines on the distal margin of the orifice; the vestibular arch arises inside it in the form of a slightly tilted, small, calcareous plate with a straight, thick, and finely denticulate margin. The primary orifice is encircled by a raised peristome on each side of the frontal part; the lateral margins of the peristome rest against the proximal pair of spines, giving rise to the secondary orifice. At the place where the lateral lobes of the peristome are transformed into its frontal side, the margin of the peristome is projected on each side toward the middle of the orifice forming, as it were, 2 lateral, grooved denticles which are rounded at the ends. These denticles isolate the middle, frontal part of the peristome in the form of a broad, saccate protuberance. The peristome usually has a raised, short, and rounded denticle in the center of this protuberance, on the outer side, under which a short, hollow, and rounded outgrowth arises inwardly, itself making a digitate projection into the peristomial wall. In specimens collected from the Siberian Sea, the middle outer denticle was often absent, the inner weakly developed, and the middle part of the peristome formed a broad, shallow, saccate protuberance resembling the one in *E. jacksoni* Waters. Avicularia are located along the sides of the peristome, which are usually slightly directed to the side by their sharp rostrum which has a depressed tip; their mandible is oblong and lanceolate. The ovicells are round and raised, and their surface is granular. There are 2 pore chambers with 6 to 12 pores along the basal margin of the lateral wall, and 3 with 3 to 9 pores along the distal wall; but these chambers are incomplete and seem to represent the transition of pore plates into pore chambers. Thirteen spines encircle the round aperture which occupies a large part of the frontal surface of the ancestrula, 6 spines are located near its middle daughter zooid, and 7 in each of the 2 lateral zooids; the granddaughter and succeeding zooids have 4 spines each.

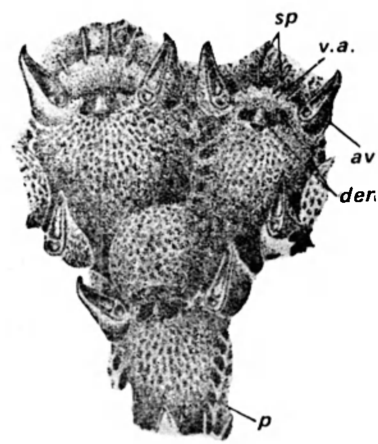


Figure 400. *Escharoides bidenkapi* (Kluge). Zooids with vestibular arch (*v. a.*), denticles of the peristome (*den.*), spines, avicularia, and ovicell (from Kluge, 1946).

The species lives on stones, shells of brachiopods, and calcareous Bryozoa, particularly on *Hornera lichenoides*, at a depth of 11 to 1,000 m, more often from 50 to 300 m, on a bed of silt and stone, under temperatures ranging from —1.68 to 3.95°C, in a salt concentration of 34.27 to 35.01‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, and East Siberian seas. *Reports in literature:* Barents Sea (Smitt, 1868b; Bidenkap, 1900a; Nordgaard, 1900, 1918), Yan-Maien Island (Andersson, 1902), the Norwegian Sea up to 62°30′ n. l. (Nordgaard, 1907b), and the northern fiords of Norway (Nordgaard, 1905, 1918).

This is an Arctic, Atlantic species.

3. **Escharoides jacksoni** (Waters, 1900) (Figure 401)

Smittia jacksoni Waters, 1900: 87, pl. 12, f. 18; *Mucronella coccinea* Bidenkap, 1897: 624, pl. 25, f. 5-6.

The zoaria, overgrowing the substrate in the form of thick crusts, consist of more or less regular, oblique rows of zooids arranged in neighboring rows, sometimes in a checkered pattern, sometimes almost parallel. The zooids are large (height 1.10 to 1.25 mm, width 0.75 to 0.88 mm), hexagonal, rhombic, or oval, sometimes broad, sometimes narrow, and strongly raised, gradually rising from the proximal margin toward the distal one; the frontal surface is coarsely granulated and surrounded by 1 to 2 rows of marginal pores in the distal parts, and 2 to 3 rows in the proximal. The pores are located in the saccate depressions formed by the short rebra which originate from the margin of the zooidal wall in a radial direction; these rebra continue toward the center of the base of the peristome in the form of thin, radial striations. The roundish, primary orifice, located at the distal margin, has no lyrule or condyles. The distal margin of the orifice has 4 erect spines; the vestibular arch arises inwardly in the form of a plate from the distal margin, and is bent downward at a right angle, like a segment, at the line of the two proximal spines. The primary orifice is encircled by a raised peristome on the proximal and lateral sides; the peristome reaches up with its margins to the proximal pair of spines and, fusing with them almost along their entire length, gives rise to the secondary orifice. The peristome forms a rectangular, saccate projection in the middle of the proximal margin of the latter, and its inner corners are slightly pointed and narrow. The ovicells are convex and round; their height is slightly greater than their width; they have a coarsely granulated surface; in the distal end they are covered with very small pores and, at the margins of the ovicells, surrounded by saccate depressions with pores at the bottom. Large avicularia are often located at the sides of the peristome, sometimes on one, sometimes on both; they have straight,

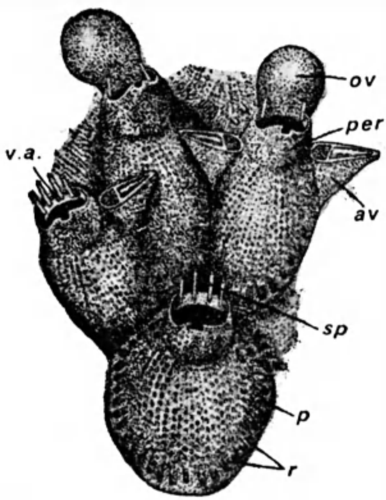


Figure 401. *Escharoides jacksoni* (Waters). Zooids with vestibular arch (*v.a.*), peristome, spines, avicularia, and ovicells. Barents Sea.

broad, short or longer, triangular mandibles whose tips are pointed outward in opposite directions. There are 2 pore chambers along the basal margin of the lateral wall, and 3 with many pores along the distal margin of the zooid.

This species lives on stones, shells of mollusks, and calcareous Bryozoa, at a depth of 3 to 385 m, more often from 50 to 150 m, on a bed of silt and stone, under temperatures ranging from —1.9 to 3°C, in a salt concentration of 31.14 to 34.83‰.

Distribution. The species was found by me in the Barents, Kara, Laptev, and East Siberian seas, and off western Greenland. *Reports in literature:* Barents Sea (Smitt, 1879a; Bidenkap, 1897, 1900a; Waters, 1900; Andersson, 1902), Kara Sea (Smitt, 1879a; Levinsen, 1887), northern coast of North America and the Archipelago of the Canadian Islands (Nordgaard, 1906a; Osburn, 1923, 1932), western Greenland (Smitt, 1868c; Vanhöffen, 1897; Levinsen, 1914; Osburn, 1936), and eastern Greenland (Andersson, 1902; Nordgaard, 1907a; Levinsen, 1916).

This is a high Arctic species.

3a. **Escharoides jacksoni** var. **rostrata** (Kluge, 1946) (Figure 402)

Peristomella jacksoni var. *rostrata* Kluge, 1946 : 201, fig. 5.

This form differs from the main *E. jacksoni* Waters in that the rectangular, saccate projection of the proximal margin of the peristome, is strongly raised forward and narrows toward the end to resemble the spout of a pitcher. A row of saccate depressions with a pore at the bottom, is located at the margin of the frontal surface. Short rebra divide these depressions and a strongly expressed thin, radial pattern arises on the surface in the direction of the base of the neck of the peristome. The lateral avicularia are slightly smaller and located a little lower than in the main form.

The species lives on laminaria and hydroids, at a depth of 20 to 45 m, on a bed of silt, sand, and stones.

Distribution. This species was found by me in the East Siberian Sea, north of the Novo Sibirsk Islands.

Thus far, the species is endemic to the East Siberian Sea.

4. **Escharoides monstruosa** (Kluge, 1946) (Figure 403)

Peristomella monstruosa Kluge, 1946 : 200, fig. 4.

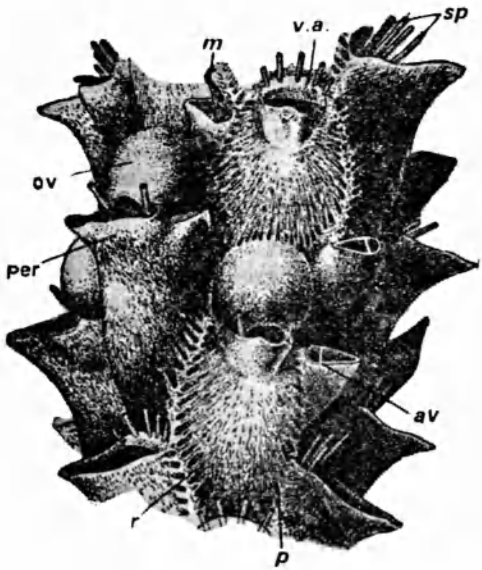


Figure 402. *Escharoides jacksoni* var. *rostrata* (Kluge). Part of a zoarium (from Kluge, 1946).

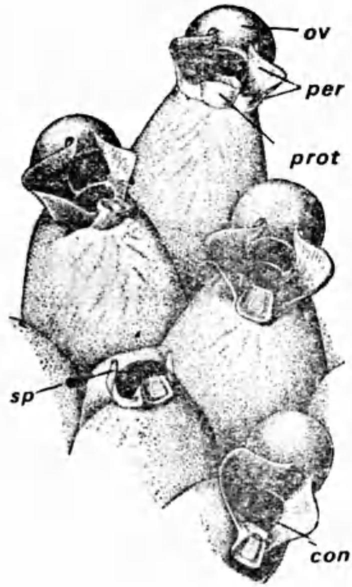


Figure 403. *Escharoides monstruosa* (Kluge). Zooids with a typical protuberance in the center of the proximal margin of the secondary orifice (from Kluge, 1946).

The zoarium, in the form of a small, prostrate crust, consists of flabellately divergent rows of zooids arranged in a checkered pattern. The zooids are small and rhombic; they have a smooth, convex, and translucent frontal surface on which a weak radial pattern is noticeable in the direction of the zooidal orifice. The primary orifice of the zooid is semicircular; it has a weakly raised, proximal margin and narrow, blunted condyles at its sides. A small spine is located on each side of the distal margin of the orifice. A voluminous, rectangular, and internally hollow protuberance is located in the center of the proximal margin of the secondary orifice; this protuberance is covered on top by a slightly depressed wall, and opens on the outer side through a fairly large, roundish orifice at the boundary between the upper wall and the wall directed toward the orifice of the zooid. The lateral walls of the peristome strongly overgrow in the zooids carrying ovicells, in the form of broad lobes which first diverge toward the sides, and then come close together and fuse with the lateral margins of the orifice of the ovicell; the spines remain on the outer side of the fused structure. The ovicells are round and convex; they have a smooth outer surface which has a few pores arranged in a semi-circle on its distal part. There are probably 4 pore plates with several pores in the lateral wall, and 2 in the distal septum.

The species lives on calcareous tubes of *Polychaeta*, at a depth of 89 to 162 m.

Distribution. This species was found by me in the East Siberian Sea, north of the Novo Sibirsk Islands and near the edge of the continental shelf.

Thus far, the species is endemic to the East Siberian Sea.

ADDENDUM TO THE SUBORDER ASCOPHORA[8]

Family **Adeonidae** Jullien, 1903

Genus **Adeonellopsis** MacGillivray, 1886

Adeonellopsis tuberculata (Busk, 1854) (Figure 404)

Eschara lichenoides Busk, 1854a : 90, pl. CVI, f. 1-3; *Adeonella tuberculata* Ortmann, 1890 : 53, pl. IV, f. 9.

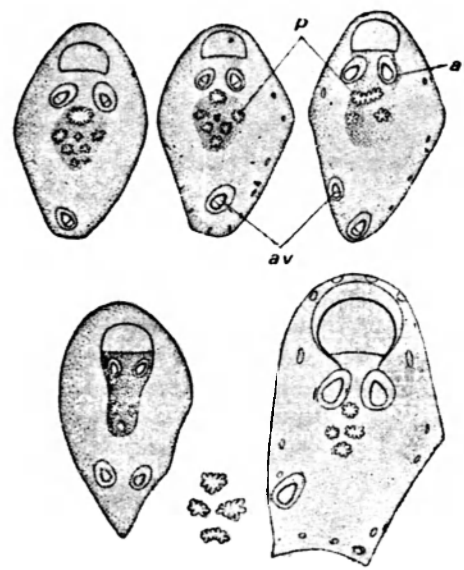


Figure 404. *Adeonellopsis tuberculata* (Busk). Zooids wih a varying number of stellate pores on the frontal surface. Chukotsk Sea.

[8] This material was discovered after the death of G. A. Kluge. According to the works of Ortmann (1890), this family should have been included after the family *Myriozoidae*.

This species, found by Busk (1854a) in the waters off southeastern Africa (Algoa Bay) and Australia (Bass Strait and Cape Capricorn), and by Ortmann (1890) in the waters of Japan (Sagami Bay) is quite rare. Although Ortmann pointed out certain differences between the forms described by him and the specimens described by Busk, at the time of my work at the British Museum I had an opportunity to do a detailed study of the samples described by Busk, and came to the conclusion that the differences pointed out by Ortmann were occasioned by the extremely brief or incomplete description provided by Busk. Busk reported only 3 to 4 stellate pores when in actuality there were from 3 to 7; furthermore, he made no mention of the avicularia existing in the proximal part of the frontal surface and at the lateral margins of the branches. Thus the specimens described by Busk and Ortmann are identical in all the important characters, and the specimen recovered by me from the Chukotsk Sea did not differ from that first found and described by Busk.

This species is found in the region slightly off the eastern side of Kolyuchinskaya Inlet in the Chukotsk Sea, at a depth of 3.6 to 27 m, on a bed of silt and stone, under a temperature of $-1.6°C$.

INDEX[1]

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[1]Synonyms have been given in italics; bold numbers indicate the page on which the identification of the given form can be found, italicized numbers refer to the list of geographical distribution, and numbers with asterisks indicate the page on which an illustration for the given form appears.