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body to contain 18·60% of sulphur, whilst  $(C_6H_3NH_2)_2H_2S_2O_1$  requires 18·40% S.

“The Use of the Opercula in the Determination of the Cheilostomatous Bryozoa,” by ARTHUR WM. WATERS, F.G.S.

In the determination of the Bryozoa various authors have attached very different importance to the characters used, but the form of the aperture has been recognised by all to be of use. D’Orbigny rightly used this very largely, and Hassall pointed out that it was much less varying than many points. Busk of course mentions the form in most cases, but Professor F. A. Smitt, the first authority on the Bryozoa, has used it much more largely, and has based his classification of the *Lepralia* and allied genera principally upon the form of the aperture. Dr. Hincks also has recently proposed a new classification in many points similar to Smitt’s, in which the form of the aperture is largely made the basis.

It seemed to me that as the shape of the oral-aperture can only indicate the form of the operculum, which closes it, the opercula themselves might furnish more reliable information, and I therefore prepared a series from the material I had available, and I find it may be even more useful than I at all expected. Besides indicating the form of the aperture, there are also many other characters shown, so that in the first 35 examined and figured all have an easily distinguishable operculum.

The operculum is closed by means of two muscles, which in some cases, as *Myriozoom truncatum*, fig. 15; *Lepralia pertusa* var., fig. 4; *Lepralia arrogata*, fig. 6, &c., &c., are attached at the side, in some quite from the edge, in others, as *Cellepora*, fig. 8, from a muscular boss on the rim; but in most of the *Celleporidæ*, and some *Lepralia*, &c., the muscular attachment is on the interior surface as in *Lepralia Cecillii*, fig. 1; *Cellepora*, fig. 5, &c.

In many it would seem that the opercula move upon a sort of hinge, as in *Myriozoum truncatum*, fig. 15; *Lepralia arrogata*, fig. 6, and a large number figured. In others it seems that a membrane attached at the proximal end retains it in its place. The opercula of some are curved into a saddle-shaped form, as *Retepora Couchii*, fig. 22, *Eschara foliacea* in stadium *Eschara* and *Hemeschara*, fig. 24, 25, and these have a concave proximal edge.

In some the operculum consists of two separable layers, and this apparently causes the peculiar light portion of a part in *Lepralia cucullata*. In *Tubucellaria cereoides* a light oval patch is seen in the centre, and in section fig. 36 this is shown to be caused by the chitinous operculum being double elsewhere; in fact it is like a meniscus with a concave stop in front. I have every reason to think there is no membrane enclosing this oval space, but cannot speak with certainty, as I have confined my attention to those points I deemed useful in determination, though a complete study of the structure of the opercula, generally, would no doubt repay the trouble. *Tubucellaria hirsuta* is not double in the same way, and has the long muscular bosses further from the edge.

In a large number of the Bryozoa the old and young zoecia are known to vary so much as not to be recognisable as the same species if discovered separately, but the opercula of both are the same; also the operculated aperture is in many surrounded by an elevated peristome, in other words, is deep down in the throat, so that the shape cannot be seen on account of the projecting lips. In such a case the examination of the operculum will reveal the true form.

The determination of the Celleporidæ has seemed to be an almost hopeless task, as the form of the colony varies greatly, and the avicularia and other characters are difficult to use, but I believe the opercula may assist very much to bring this family out of its present confusion. In *Cellepora*

the outside cells are decumbent, while the central ones are erect, so that often no similarity is apparent, but so far as my examination goes the opercula of both stages are the same.

The size seems to vary but little, and in a slide of 6 or 7 in many cases all would exactly correspond with the drawing of the one figured, and in few cases was the variation over a tenth of the size. I was also much surprised to find how closely the measurements of these Naples specimens corresponded with the sizes of the aperture as given by Smitt in his description of the Northern forms.

Although only groups allied to *Lepralia* have now been brought under examination, it is by no means in these families only that the shape of the oral aperture is of importance, as in nearly all genera it is specifically characteristic as may be seen in *Membranipora*, *Diachoris*, *Bugula*, *Flustra*, &c., and a little more attention to this would have made the British Museum Catalogue of much more value, and prevented uniting under one name as *Lepralia spinifera* species with different shaped apertures, which it has since been necessary to separate. There are also other points which may be of use, as for instance I find in one *Eschara* from Australia that the operculum has 7 teeth in front, the central one the largest, and in *Cellepora sardonica*, fig. 27, it is strange to find lines on the edge corresponding with the minute teeth in the aperture.

I should propose to divide the opercula into (*a*) those with a straight proximal edge 27, 28, 29, 30, 31, 34; (*b*) those with a straight edge and a small projection 1, 2, 3, 4; (*c*) those with a subtriangular proximal end 5, 6, 7, 8, 15; (*d*) those with a rounded proximal end 9, 10, 11, 12, 16; (*e*) saddle shaped, mostly with a concave end 22, 23, 24, 25, 26; (*f*) suboblong 17, 18, 19, 20.

That the opercula may be of the greatest use in specific determination there is now no doubt, and thus intimate



Fig. 1.



Fig. 2.



Fig. 3.



Fig. 4.



Fig. 5.



Fig. 6.



Fig. 7.



Fig. 8.



Fig. 9.



Fig. 10.



Fig. 11.



Fig. 12.



Fig. 13.



Fig. 14.

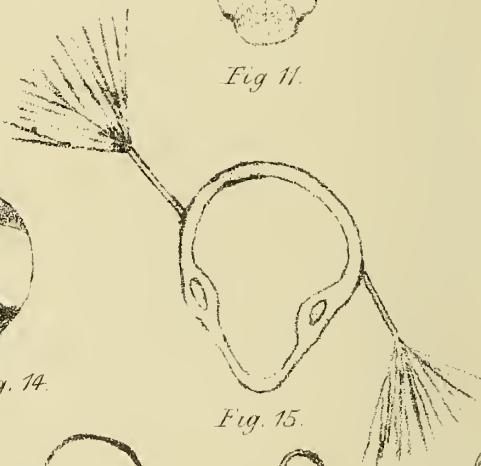


Fig. 15.



Fig. 16.



Fig. 17.



Fig. 18.

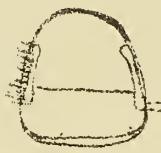


Fig. 19.



Fig. 20.



Fig. 21.



Fig. 22.



Fig. 23.



Fig. 24.

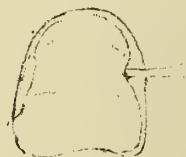


Fig. 25.



Fig. 26.



Fig. 27.



Fig. 28.



Fig. 29.



Fig. 30.



Fig. 31.



Fig. 32.



Fig. 33.



Fig. 34.



Fig. 35.



Fig. 36.



Fig. 37.

relationship will be indicated, but how far general classification may be assisted must remain open until larger series have been examined.

## EXPLANATION OF PLATE.

### OPERCULA OF

- 1 *Lepralia Cecillii*, Aud.
- 2 ——— *vulgaris*, Moll.
- 3 ——— *pertusa*, var.
- 4 ——— ———, var.
- 5 *Cellepora*.
- 6 *Lepralia arrogata*, Waters.
- 7 ——— *linearis*, Hass. var *typica* Smitt.
- 8 *Cellepora*.
- 9 *Lepralia errata*.
- 10 *Cellepora Hassallii*, John.
- 11 ——— *verruculata*, Smitt.
- 12 *Cellepora*.
- 13 *Lepralia auriculata*, Hass.
- 14 ——— *cucullata*, Busk.
- 15 *Myriozoum truncatum*, Pall.
- 16 *Lepralia*.
- 17 *Lepralia Pallasiana*, Moll. var *projecta*, W.
- 18 ——— *coccinea*, Abild.
- 19 ——— *Pallasiana*, Moll.
- 20 ——— *lata*, Busk. This is larger than most opercula of *lata*.
- 21 *Eschara contorta*, Busk.
- 22 *Retepora Couchii*, Hincks.
- 23 ——— *cellulosa*, Jam.
- 24 *Lepralia foliacea*, stadium *Hemeschara*.
- 25 *Eschara foliacea*, Ell & Sol.
- 26 *Lepralia reticulata*, Macg. var *ophidiana*, W.
- 27 *Cellepora sardonica*, Waters.
- 28 *Eschara verrucosa*, Peach.
- 29 *Lepralia ciliata*, Pall.
- 30 ——— *Malusii*, Aud.
- 31 ——— *bimucronata*, Moll.
- 32 ——— *Brongniartii*, Aud.
- 33 ——— *reticulata*, Macg. var *inequalis*, Waters.
- 34 ——— *Gattyae*, Lands.
- 35 *Tubucellaria hirsuta*, Busk.
- 36 ——— *cereoides*, Ell & Sol. (in section).
- 37 Ditto do.

All magnified 85 times.