In the case of these pegmatites it is probable that the contraction of the parent rock on consolidation would diminish the pressure upon the still fluid veins. These would, therefore, at last consolidate under conditions of temperature, pressure, and also concentration, very different from those under which the main mass crystallised, and a marked difference in texture might then be expected.

On the whole, I am inclined to think that we have in these Blekinge pegmatites merely a local modification of Brögger's theory. The contorted pegmatites may indeed be the 'aufpressungen' of a differentiated magma; not, it is true, in this case, invading cracks and fissures of a consolidated rock, but streaming into the still fluid portions of a neighbouring molten mass. But while differentiation has thus played an important part in the process, it must not be overlooked that, if this view should prove correct, the final result was, to a still larger degree, due to the imperfect integration of a streaky magma.

VI.—The Jurassic forms of the 'genera' *Stomatopora* and *Proboscina*.

By W. D. Lang, B.A., F.Z.S., of the British Museum (Natural History).

After many months' work at the Polyzoa in the British Museum, the author has been driven to the conclusion that the relationships of the Jurassic forms of the 'genera' *Stomatopora* and *Proboscina* have been misunderstood, and that consequently their present arrangement, as put forward in the British Museum Catalogue, is unsatisfactory.

A detailed examination of all the material available has resulted in the following conclusions :—

1. The division of the forms into the genera *Stomatopora* and *Proboscina* is unnatural.

2. The development of a colony (the *zoarium* of Polyzoa) is comparable with and follows the same laws as the development of the individual (the *zoœcium* of Polyzoa).

3. Therefore the diagnosis of a form, whether 'species' or 'circulus,'[1] is incomplete, and for practical purposes useless, unless the part of the zoarium with respect to its age is specified.

4. In the 'genera' *Stomatopora* and *Proboscina* the method of branching is of paramount importance.

It is intended to take each of the above conclusions and explain by what observations it has been reached, and to what rearrangement of the specimens it tends. To upset the existing order may seem revolutionary, but if by this means a natural grouping is arrived at, if evolutionary series are found, such as have been demonstrated among Brachiopods and Ammonites, if when a new form occurs it is found to fit into one of these series, then the orderly result will justify the radical alterations.

[1] J. W. Gregory: Brit. Mus. Cat. Jur. Bryozoa, 1896, p. 22; and Mem. Geol. Surv. Ind., 1900, ser. IX, vol. ii, pt. 2, pp. 17–22.

The first point, namely, the artificiality of the genera *Stomatopora* and *Proboscina*, has already been discussed by Gregory,[1] who, while admitting that the line which divides them is arbitrarily drawn, since it is obvious that the forms constitute a natural series, maintains that, if this be done, the genera *Berenicea, Reptomultisparsa, Idmonea, Diastopora, Entalophora*, and *Spiropora* must for similar reasons be merged. And since the retention of these genera is convenient for working purposes, he leaves them as they are. But he does not suggest, what the author believes to be the case, that these 'genera' are polyphyletic in origin, and that in some cases a given species of *Proboscina* may be at the head of a series of forms, the simplest of which are undoubted *Stomatopora*.

In such a case the series would form a natural genus parallel with, and having a common origin with, other series. These would constitute new genera, starting from the point at which they branched from the first series.

Given sufficient material, such series can be found, and in one or two cases have been found, by tracing the development of the different characters of a colony from the first zoœcium, and by this means finding genetic relationships.

And this question of zoarial development leads to the second proposition, namely, that the development of the colony is comparable with and follows the same laws as the development of the individual.

It was the observation of this fact that led the author to doubt the validity of the 'genera' under consideration, and the matter was fully treated of in a paper. This paper, however, was not published, because it was considered a poor thing to put forward an idea having such a destructive tendency without providing an alternative scheme whereby a natural classification could be constructed. And the latter would involve much further detailed work, some of which has since been done.

Cumings,[2] however, in January of this year, in a paper on the development of *Fenestella* and other Palæozoic forms, has in a masterly manner shown that the zoarium has a developmental history, exactly comparable with that of the individual. He says:[3] "The now generally accepted classification of the stages of growth and decline, proposed by Alpheus Hyatt, has never been consistently applied to a colonial organism, such as are the Bryozoa, nor to one whose ontogeny presents the retrograde metamorphosis which characterizes the latter class." He further proposes a nomenclature for the stages in the development of the colony analogous to the nepionic, neanic, ephebic, and gerontic, or the infantile, youthful, mature, and old-age stages, proposed by Buckman & Bather[4] as modifications of Hyatt's original terms for the individual. These

[1] J. W. Gregory: Brit. Mus. Cat. Jur. Bryozoa, 1896, pp. 14–22.
[2] E. R. Cumings: Amer. Journ. Sci., vol. xvii, pp. 49–78.
[3] Cumings: op. cit., p. 50.
[4] S. S. Buckman & F. A. Bather, "The terms of Auxology": Zooglischer Anzeiger, 1892, p. 421.

colonial stages he terms nepiastic, neanastic, ephebastic, and gerontastic, formed from the stem of the first terms suffixed with the termination *-astic*, from τὸ ἄστυ, 'the city.'

Cumings also terms the first-formed zoarium, which has hitherto been known as the 'primitive disc' in Cyclostomata and the 'ancestrula' in Cheilostomata, the 'protœcium,' analogous to the 'protegulum' and 'protoconch' in Brachiopods and Ammonites respectively.

Among the Jurassic forms of *Stomatopora* and *Proboscina*, it has been found that when any given character, such, for instance, as the ratio of the length of the zoœcium to its breadth, is followed from the first zoœcium until the last, that it has a progressive development, or anagenesis, reaches a maximum or acme, and often may be seen to have a retrogressive development, or katagenesis, in the ultimate branches of the zoarium.

To illustrate this point, some examples of the character mentioned, namely, the ratio of the length of the zoœcium to its breadth, are given below, the points of dichotomy of the zoarium being taken as fixed points, and referred to by the numbers 1, 2, 3, etc., No. 1 being the point in the zoarium marked by the first dichotomy, and so on. The numbers with the names are the British Museum register numbers of the specimens.

Specimen.	Ratio of length of zoœcium compared with its breadth at the 1st, 2nd, 3rd . . . n^{th} dichotomies.						
	1	**2**	**3**	**4**	**5**	**6**	**7**
1. *Stomatopora Waltoni*, No. 97,083 ... ... Cornbrash, Wilts.	$3\frac{1}{2}$	$4\frac{1}{2}$	3	$2\frac{3}{4}$	$2\frac{1}{4}$	$2\frac{1}{4}$	2
2. *Stomatopora dichotoma*, No. 60,535... ... Cornbrash, Wilts.	$2\frac{1}{2}$	$2\frac{3}{4}$	$3\frac{1}{2}$	3	$2\frac{1}{4}$	2	2
3. *Stomatopora dichotoma*, No. 46,218... ... Bathonian, Ranville.	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{3}{4}$	$1\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{1}{4}$	
4. *Stomatopora dichotoma*, No. B. 4,832 ... Cornbrash, Wilts.	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{3}{4}$	$2\frac{1}{2}$	2	2	2
5. *Stomatopora*, sp. ... ... Cornbrash, Wilts.	$2\frac{3}{4}$	3	$2\frac{1}{4}$	2	2	2	
6. *Stomatopora Waltoni*, No. B. 2,287 ... Inf. Oolite, Gloucestershire.	$2\frac{3}{4}$	$2\frac{3}{4}$	$2\frac{1}{4}$	$2\frac{1}{4}$	$2\frac{1}{4}$	2	2

The numbers in the above table, representing the length of the zoœcium (the breadth being taken as 1), are, of course, averages; for at each dichotomy are three zoœcia; and if n is the number of the dichotomy, the theoretical number of the zoœcia of which the average is taken will be $3\ (2^{n-1})$. Practically, however, the number is smaller, owing to the loss of certain branches.

The specimens whose zoœcial lengths are given in the table are chosen because they illustrate so well the regular changes of this character. Other specimens are more irregular, but all show to some extent a definite plan of development. In the first four cases given it will be seen that this character is anagenetic at first, and reaches its acme at the third dichotomy, after which it is katagenetic. The fifth example reaches its acme at 2, while the sixth is at its acme at the first dichotomy, and declines after the second.

As far as actual length is concerned, numbers 2, 4, 5, and 6 are practically the same, while No. 1 has much longer and No. 3 much shorter zooecia than the rest.

This particular character was chosen only as an example. Other characters show a similar regularity in development, according to the part of the zoarium in which they are situated. Those which have been observed and treated in the same way as the length of the zooecium are four, two zoarial and two zooecial. The zoarial are the method of branching, which will be treated later, and the frequency of branching, which is measured by the number of peristomes between two dichotomies. The zooecial are the shape of the zooecium, and its ornamentation by transverse ribs.

Two characters which have been used by former workers have been found by the author so unpractical that they have been given up as useless; these are the height of the peristome and the punctation of the zooecium.

The first of these, though doubtless an excellent character where the state of preservation of the fossil is such that its presence may be counted on, becomes useless in the fossils here dealt with, because in the majority of cases the whole peristome has been broken off, leaving it impossible to say whether this structure was high or low when the organism was alive.

Again, the appearance of the punctation of the zooecium seems to depend to such a large extent upon the state of preservation of the zooecial wall, that its presence is of little use for systematic work. Nor does it appear to show any variation during the growth of the zoarium.

The results obtained from the study of the development of the characters previously mentioned, namely, the frequency of branching, the shape of the zooecium, and the transverse ribbing of the zooecium, show that the rule in the majority of cases is as follows:—

1. *Frequency of branching.*—The number of peristomes between the first two or three dichotomies is small (nearly always 1 or 2), then suddenly increases largely, and finally becomes small again.

2. *Shape of zooecium.*—Generally the zooecia are either cylindrical or pyriform. In many of those forms which have cylindrical zooecia throughout the greater part of the zoarium, the zooecia between the first and third dichotomies tend to be slightly pyriform; while in those forms with pyriform zooecia, the zooecia between the first and third dichotomies are generally more pyriform than the rest.

3. *Transverse ribbing of the zooecium.*—Ribbing, when present, is usually faint at its first appearance, becoming stronger later on, and in some cases becoming fainter again finally. The point at which the acme is reached varies a great deal.

The systematic value of any one of these characters and the amount that the consideration of them affects the question of species the author hopes to consider in a future paper; all that is wished at present is to demonstrate the importance of following each character through its own development in the zoarium, and by this means determining its value as an index to the relationship of one zoarium to another. The fact that each character has a developmental history makes it clear that the diagnosis of a form is incomplete, and for practical purposes useless, unless the part of the zoarium with respect to its age is specified.

The last point to be considered is the method of branching in the Jurassic forms of the two 'genera' *Stomatopora* and *Proboscina*.

In a single series of zoœcia, such as is typical in the genus *Stomatopora*, two ways of branching may be noticed, namely, lateral branching and dichotomy.

In lateral branching a new zoœcium arises from any point in a chain of old zoœcia, and generally diverges at a wide angle (see Diagram II, Fig. 1, p. 321). It is common in Silurian and Cretaceous forms, but has not been observed (except in one doubtful case) in any Jurassic form.

In dichotomy, which always occurs in Jurassic forms, two new zoœcia arise from the end of an older zoœcium, the angle at which they diverge varying from 180° to 20° or 30°, and varying in a definite manner. (See Diagram II, Figs. 2–9, p. 321.)

Dichotomy in the forms under consideration occurs in three types, one of which is intermediate between the other two. In that termed Type I the two new zoœcia are separate from one another throughout their whole length (Diagram II, Figs. 2, 3, 9, p. 321), only touching at their bases. In Type II they are contiguous throughout their length (Figs. 4, 5, 8); and they are contiguous for part of their length in the Intermediate Type (Figs. 5, 6, 7).

To a large extent correlated with the type of branching is the angle of divergence of the two new branches. This angle tends to diminish distally. But that it is not wholly dependent upon the type of branching may be seen in cases where the new branches diverge at an angle of as much as 60° after branching according to Type II (Fig. 5), while in other cases (Fig. 8) the two new branches may remain contiguous until they branch again. In the majority of cases, however, the angle of divergence and the type of branching are so closely correlated that for practical purposes they may be considered together.

Starting from the first zoœcium, which arises directly from the primitive disc, one or two zoœcia generally follow before the first dichotomy takes place. This in all *Stomatopora* and in a few *Proboscina* (e.g. *P. Cunningtoni*, Gregory, B.M. No. 23,852, zoarium marked 1) is after Type I with a wide angle nearly always 180° (Fig. 9). The second dichotomy in the great majority of cases is on Type I, with an angle of divergence of 120°. The angle of the next dichotomy is commonly 90°, of the next 60°, of the next 45°, Type I being still the mode of dichotomy.

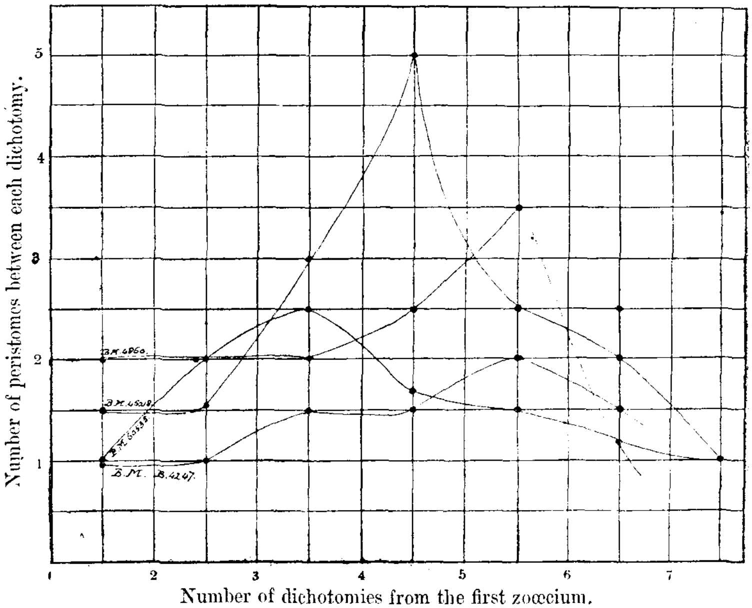
In primitive forms (e.g. *S. Waltoni*, Haime, B.M. No. B. 2,287) the branching never gets beyond Type I with a small angle. In the majority of forms, however, sooner or later the Intermediate Type of branching comes in, and in a great many forms this type is the final one. In a few cases of *Stomatopora*, and in all *Proboscina*, Type II is at some time or other reached, and remains the ultimate form of branching of the zoarium.

This sequence, namely, Type I—Intermediate Type—Type II, is invariably followed. For, although an individual dichotomy may occasionally occur of slightly more primitive order than its predecessor, it is only an irregularity, and the general scheme of development is in no wise obscured.

In more primitive forms this evolution in branching does not progress beyond Type I with a small angle.

In the commoner forms of *Stomatopora* the ultimate branches are formed on the Intermediate Type and on Type II.

Diagram I.—Curves showing the Frequency of Branching in Stomatopora.

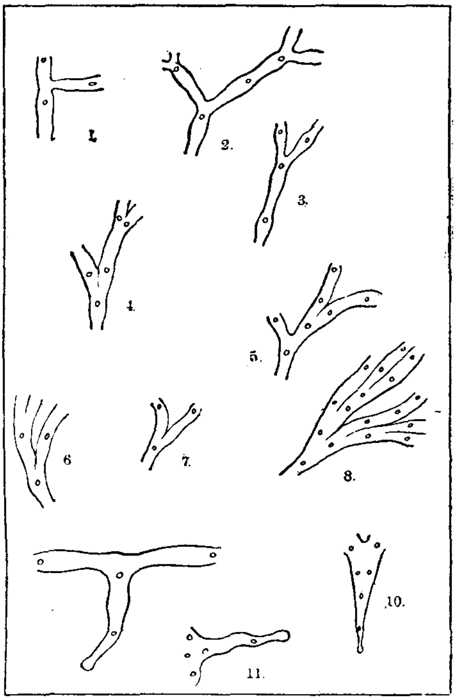


In a few forms of *Stomatopora* (e.g. B.M. No. B. 4,822) Type II occurs after a few dichotomies, while it comes in very soon in some primitive *Proboscina* (e.g. *Proboscina Cunningtoni*, Gregory, B.M. No. 97,617).

In typical forms of *Proboscina* the early stages have been so condensed, according to the law of acceleration (Tachygenesis),[1] that the first dichotomy is formed on Type II (Fig. 10). Sometimes

[1] A. Hyatt, "Bioplastology and the related branches of Biologic research": Proc. Boston Soc. Nat. Hist., vol. xxvi (1893), p. 77.

DIAGRAM II, to show the method of branching in Jurassic forms of the two 'genera' *Stomatopora* and *Proboscina*.



These figures are diagrammatic reproductions of pieces of specimens in the British Museum. The Museum register number is given with each.

FIG. 1. Lateral branching; B. 4,238. *Stomatopora granulata* (Milne Edwards): Chalk, England; loc.? × about 5.

,, 2. Type I with large angle; B. 2,287. *Stomatopora Waltoni*, Haime: Inferior Oolite, Crickley Hill. Dichotomy 2. × about 4.

,, 3. Type I with small angle; B. 2,287, same specimen as the last. Dichotomy 8. × about 4.

,, 4. Type II with small angle; B. 4,247. *Stomatopora dichotomoides* (D'Orb.): Cornbrash, Wiltshire. × about 6.

,, 5. Type II with large angle, preceded by Intermediate Type with large angle; B. 4,832. Zoarium marked 2. *Stomatopora dichotoma* (Lamouroux): Cornbrash, Wiltshire. × about 6.

,, 6. Intermediate Type with small angle; B. 4,382, same specimen as the last, but the zoarium marked 1. × about 7.

,, 7. Intermediate Type with large angle; 60,536. *Stomatopora*, sp.: Cornbrash, Wiltshire. × about 6.

,, 8. Type II with an angle of 0°; 97,617. *Proboscina Cunningtoni*, Gregory: Cornbrash, Chippenham. × about 5.

,, 9. Type I with angle of 180°; D. 2,064. Zoarium marked 5. *Stomatopora dichotomoides* (D'Orb.): Cornbrash, Midland Railway Pit, Bedford. × about 13.

,, 10. The first dichotomy is after Type II with an angle of 0°; D. 7,185. *Proboscina*, sp.: Inferior Oolite, Crickley Hill. × about 7.

,, 11. The arrangement of the peristomes is irregular from the first; D. 1,843. *Proboscina Eudesi*, Haime: Inferior Oolite, Gloucestershire. × about 7.

a second dichotomy on Type II follows, but often the arrangement of peristomes is quite irregular after the first dichotomy.

In the most advanced types of *Proboscina*, e.g. *P. Eudesi*, Haime, B.M. No. D. 1,843, the arrangement of peristomes is irregular from the first (Fig. 11)—the arrangement typical for *Berenicea*, the next 'genus' in the series of which *Stomatopora* and *Proboscina* are the first two terms.

The absolute regularity of the sequence of these different types of branching and the condensation of the more primitive types in the more advanced forms show of how much importance this character is in determining the relationships of different forms. Moreover, it is worthy of notice that, while in the Jurassic forms of *Stomatopora* Type II is not very common, it becomes extremely common in the Cretaceous forms, though the sequence in these is considerably obscured by the superimposition of lateral branching upon the dichotomy.

In the case of the Cretaceous *Stomatopora* the lateral branching seems to be the reappearance of a character which was formerly present and has been lost, for it occurs in Silurian forms of *Stomatopora*, and is apparently absent in Jurassic forms.

Taking the type of branching as a character of primary importance, and following this and the other characters in their development from the beginning of the colony, series can be traced and natural relationships established. The true genera will probably be found to correspond to some extent with the present 'species.' But before this can be done at all satisfactorily it will be necessary to work through a great deal more material, carefully collected according to horizon and locality.

It is easy to represent graphically the evolution of the characters of two forms for comparison by means of curves. Diagram I, on p. 320, gives an example.

The writer of this paper, intending only to introduce his idea and method of dealing with this difficult group, as a means of establishing a natural classification, has purposely avoided entering into much detail, and confined himself rather to general statements. But illustrations are taken from actual specimens, and these may be seen in the British Museum. What is needed is more material which shall test the above propositions. What has been attempted is not arbitrarily to select a character and invest it with specific or generic importance, but by tracing the development of the character to assign it to its appropriate rank. The terms genus and species can then be applied with some meaning, and new forms, as they occur, will fall into their proper places in a natural scheme.