Videnskabelige Meddelelser

fra

den naturhistoriske Forening i Kjøbenhavn

for

Aaret 1902.

Udgivne af Selskabets Bestyrelse.

Med 15 Tavler, 1 Kort og 24 Figurer i Texten.

Sjette Aartis fjerde Aargang.

Kjøbenhavn.

Bianco Lunos Bogtrykkeri.

1902.

Studies on Bryozoa.

By

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In a paper: „On the Structure and Classification of the Cheilostomatous Polyzoa“ [1]) Dr. S. Harmer has exposed the chief results of his later investigations into the *Bryozoa*, partly dealing with the compensation-sac, first discovered by Jullien, partly with the morphology of the front wall, a structure of such great importance in classification. Julliens discovery of the compensation-sac having been either ignored or discredited by later observers, Dr. Harmer has so to say, discovered it anew and by new investigations into its structure and development supplied Julliens short communications. It is a thin-walled membranous sac lying beneath the calcareous front wall and generally opening to the exterior immediately behind the proximal border of the operculum which is continuous with the hinder wall of the sac. „Numerous muscles pass from the vertical calcareous walls of the zooecium to the floor of the sac. It may safely be concluded that the contraction of these muscles will dilate the sac, thereby introducing water into it from the outside and excercising a pressure on the fluid of the body cavity resulting in the protrusion of the polypide.“ While I quite coincide with Dr. Harmers observations on the structure of this sac I do not agree with this author in his

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[1]) Proceedings of the Cambridge Philos. Soc. Vol. XI, Pt. I. pag. 11—17.

view of the calcified front wall of those *Cheilostomata* provided with a compensation-sac. Before entering into this question I propose to divide the Order *Cheilostomata* in the following four groups:

Malacostega. The front wall in a greater or lesser part of its surface only consists of a membrane, by two rows of parietal muscles connected with the calcareous side-walls; the operculum as a rule is a membranous valve; no compensation-sac. To this division belong the families: *Aeteidae, Flustridae, Farciminariidae, Bicellariidae, Cellulariidae, Membraniporidae, Steganoporellidae, Thalamoporellidae.*

Acanthostega. A greater or lesser part of the front wall is membranous and protected by a roof, formed by the overarching and fusion of numerous circumareal spines; the parietal muscles as in *Malacostega*; no compensation-sac. Family *Cribrilinidae.*

Coilostega. The calcified front wall is more or less concave and surrounded by raised margins; a chitinous operculum; no compensation-sac. To this divison belong the families *Microporidae, Chlidoniidae* and *Cellariidae.*

Camarostega. The calcified front wall is more or less convex and not surrounded by raised margins; the operculum is chitinous or membranous; a compensation-sac [1]).

This group which is identical with the Lepraliod or Escharine forms of Harmer contains the chief bulk of the Cheilostomatous *Bryozoa* and is that whose division in families and genera presents the greatest difficulties. It complects the following families: *Onchoporidae, Calymmophoridae, Adeonidae, Reteporidae, Catenicellidae, Porinidae, Mucronellidae, Smittiidae* etc.

Before entering into the question of the front wall I think it useful to propose some names for the different types of individuals which can be met with in the colonies of the *Bryozoa*. Besides the

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[1]) The three first groups are not sharply separated and nearer related to each other than to the fourth group.

Gonozooecia in the *Adeonidae* whose structure is still very imperfectly known, we can distinguish the three following types:

Autozooecia which contain a polypide and are provided with an orifice.

Heterozooecia which lack a polypide or possess only a feeble rudiment of it. On the contrary they are provided with a powerfull muscular apparatus for the movement of the operculum which is modified in various ways. To this type belong the *avicularium* and the *vibraculum*.

Kenozooecia which lack both a polypide and an orifice. To this type belong the partitions composing the connecting tubes, the radical fibres, the stolons and stalks (*Stirparia, Chlidonia*), the singular lateral chambers (loculi) of the *Catenicellidae*, the modified marginal zoocia in several species of *Flustra*, the small chambers forming the basal expansion in the colonies of *Retepora* and the supporting tubes of many Cyclostomatous *Bryozoa*.

The front wall. According to Harmer the calcified front wall in the *Camarostega* corresponds with the united overarching spines of the *Acanthostega*, the membranous opercular wall of which is represented by the floor of the compensation-sac, but at the same time this author admits that „the calcareous matter of *Cheilostomata* is probably always covered by an „epitheca“ limited by a cuticle of chitine or other organic substance“. If Harmer were right in his interpretation we should expect to find the overarching spines of a *Cribrilina* provided with a similar epitheca, but I have never been able to detect the slightest vestige of a membrane covering the spines, neither in *Cribrilina* nor in *Membranipora*, although such a membrane is very distinct in the calcified part of the front wall surrounding the area. According to my investigations the membrane named „epitheca“ is the original membranous surface of the zooecium, and the calcified front wall originates under this membrane in direct connection partly with the side-walls partly with the proximal wall. While the front wall in most species of *Flustra* is represented only by a membrane extended within a calcified

frame we find in a smaller number of species (for instance in *Fl. carbasea*, *Fl. denticulata*, *Fl. biseriata* etc.) a little under the membrane a narrow, calcified band in connection with the side walls and with the proximal wall. In Waters' paper on *Flustridae*[1]) we see this band, which the author signifies as „chitino-calcareous band", in a cross section of *Fl. biseriata*. This calcified band in the named *Flustra*-species is the first faint beginning of the calcified front wall, and in *Membraniporidae* we find it developed in very different degrees. While in a number of species it is either absent or only developed in the same degree as in the above named *Flustra*-species, in others it extends over most part of the front surface. While in some cases as for instance in *Chaperia annulus*[2]) it is concave in its whole extension, in other species it is convex in most part of its surface and only concave within the margin of the membranous area[3]). That the membrane covering this calcified layer is really the original membranous surface of the zooecium is evident from the fact that it is continuous with the opercular membrane. Also in *Coilostega* and *Camarostega* the calcified front wall takes its origin under the original membranous covering of the zooecium and in connection with the calcified frame which can be easily seen in the growing edge of the colonies. Like Harmer I have seen in several forms that the compensation-sac takes its rise beneath the proximal edge of the operculum, and although I have not yet examined its development by means of longitudinal sections I cannot doubt that it is formed by an invagination of the covering membrane. The view here proposed of the morphology of the front wall perfectly agrees with the researches of L. Calvet[4]), this author having found that the calcified front wall both in *Coi-*

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[1]) Journ. R. Mic. Soc. 1896, Pl. VIII, fig. 6–8 cb.
[2]) Waters, On Membraniporidae, Journ. Linnæan Soc. Zool. Vol. XXVI, Pl. 47, fig. 5.
[3]) loco. cit, Pl. 47, fig. 19.
[4]) Contributions à l'histoire naturelle des Bryzoaires éctoproctes marins. Montpellier et Paris, 1900.

lostega and in *Camarostega* is separated from the covering membrane by a space containing both leucocytes and mesenchymal tissue and therefore to be regarded as a part of the original cavity of the zooecium.

While the calcified part of the frontal wall in most *Cheilostomata* is developed under the covering membran and therefore to be described as a cryptocyst, a name originally proposed by Jullien, I have not been able to find a membrane covering the calcareous skeleton of the front wall in the families *Onchoporidae*, *Catenicellidae* and *Electridae*, and here this skeleton, for which provisionally we will use the name a calcified ectocyst, seems to proceed directly from a calcification of the covering membrane. Also in those members of the families *Bicellariidae* and *Cellulariidae* in which there is found a calcified postareal part of the front wall, most part of this extension is a calcified ectocyst and only the foremost concave part of it is seated under the covering membrane of the area and consequently to be named a cryptocyst. As already pointed out by Harmer the whole of the calcareous skeleton in *Euthyris obtecta* is a cryptocyst and the same is the case in *Calymmophora lucida*.

The operculum. While the operculum in most *Malacostega* is a simple membranous valve, within its margin provided with a chitinous bow for the attachment of the opercular muscles, we meet in some species of the genus *Chaperia* (*Ch. spinosa* and *Ch. capensis*) with a form of operculum for which we will propose the name a compose operculum because the opercular valve and the membrane filling up the remainder of the zooecial aperture are fused together into a chitinous plate, both in its darker colour and in its greater firmness differing from the membrane covering the calcified part of the front wall. Only the foremost part (the valvular part) of this „operculum“ opens under the protrusion of the polypide. In the other *Chaperia*-species we can hardly speak about a compose operculum, because the correspondent part is scarcely stronger chitinized than the membrane covering the calcified part of the front

wall. While a number of *Camarostega* (*Smittia*, *Ramphostomella*, *Umbonella verrucosa* etc.) are provided with a similar simple opercular valve as most *Malacostega*, the chief bulk of that division possesses as the two named *Chaperia*-species a compose operculum, but as the compensation-sac in these forms opens immediately behind this, its proximal margin is not continued in the covering membrane of the zooecium, but in the posterior wall of the compensation-sac. In such an operculum we can distinguish between the valvular part and the accessorial part, and the hinge-line of the operculum forms the limit between these two parts. When the valvular part opens under the expansion of the polypide the accessorial part at the same time draws back into the zooecium and gives the water access to the compensation-sac. In a few cases (*Schizoporella Cecilii*, *S. circinnata*, *Megapora ringens*, *Foveolaria elliptica*) the valvular part and the accessorial part are separated by a low non chitinized transverse band. In the two ends of the hinge-line the operculum is strongly connected with the corresponding margin of the orifice, generally in such a manner that a tooth-formed process from the later is coalesced with a chitinous ridge seated within the margin of the operculum. A similar connection is also found in *Steganoporella* and *Thalamoporella*. Also the secondary orifice can sometimes be provided with tooth-formed marginal processes which have been (for instance in *Exochella longirostris* and *E. tricuspis*) confounded with hinge-teeth. While the hinge-teeth are connected with the inner surface of the operculum a median impaired extraopercular tooth is not rarely met with (*Mucronella Peachii*, *Porella struma*, *Smittia* etc.). This tooth, as well as the median avicularium in many *Camarostega* seated immediately behind the orifice, no doubt serves to protect the entrance to the compensation-sac. In opposition to the compose operculum the simple operculum corresponds only with the valvular part of the former and differs only from the opercular valve in most *Malacostega* by being chitinized or (rarely) calcified and therefore separable. In *Malacostega* a simple chitinous operculum is found in some members of the family

Cellulariidae (for instance in *Caberea Darwini, C. Boryi* etc.) in whom the so-called fornix, a scutiform marginal spine which in a number of species protects the membranous area, has reached its maximum. The proximal margin of the operculum is here limited by the distal margin of the fornix. In *Coilostega* it is found in *Micropora, Monoporella, Chlidonia* and *Cellaria* and besides in a number of *Camarostega* (*Microporella, Tubucellaria, Onchopora Sinclairi, Chorizopora Brognarti* etc.). With the exception of *Chorizopora Brognarti* all those *Camarostega* which possess a simple operculum are also provided with a median pore no doubt serving as opening into the compensation sac. A simple calcified operculum is found in *Membranipora monostachys, Monoporella crassatina* and *Micropora coriaca* [1]), but while in the first named species the calcified operculum lacks a covering membrane, the calcified layer of the operculum in the two other species is invested with the same membranous epitheca as the front-wall of the zooecium. Consequently we have to do here with a similar distinction between a calcified ectocyst and a cryptocyst as that which we have earlier spoken of. Also in the species of *Cellaria* [2]), in *Micropora perforata* and *Mic. borealis* I have found the operculum composed of two corresponding layers, an outer membranous and an inner chitinous.

Rosette-plates and pores. After some times boiling in a solution of caustic potash most colonies of *Bryozoa* can be split in longitudinal rows of zooecia and the single zooecium conseqvently must have independent side-walls. On the contrary the proximal and the distal wall are common for every two contiguous zooecia.

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[1]) Under this name I think two different species have been confounded, but possessing only a very little rudiment of each I shall confine myself to point out some chief differences between the two forms. In one of them (Hastings, Peal) the operculum is calcareous, there is found an avicularium, and the ooecium is provided with a short, very narrow pore. In the other (Guernsey, Norman) the operculum is chitinous, there is no avicularium and the lower part of the ooecium is separated from the superior minutely granular part by an angular projection.

[2]) Calvet. op. cit. Pl. VI, fig. 11, op.

By such a splitting of a colony in singular rows of zooecia each lateral rosette-plate is divided in two very different parts, namely in a watch-glass-formed chief-part, whose convexity faces inwards, and in an annular marginal part belonging to the side-wall of the neighbouring zooecium. Although both parts together constitute the whole rosette-plate, we will for simplicitys sake in the following exposition call the chief-part the rosette-plate and the annular part the hole. When the zooecia according to the general rule are disposed in the so-called quincunx-position, namely in such a manner that the zooecia in two neighbouring rows are alternating, the anterior half of each lateral wall shows a number of rosette-plates and the posterior half a number of holes corresponding with as many rosette-plates in the anterior half of a neighbouring zooecium [1]). On the contrary, if two zooecia are contiguous in their whole length, each lateral wall will show either rosette-plates or holes. A singular exception to this rule makes *Electra pilosa*, for although this species as a rule shows the regular quincunx-position, the lateral walls through a whole row of zooecia in the same side are provided either with rosette-plates or with holes. In many cases (for instance in *Membranipora Dumerilii*, *Cribrilina punctata*, *Diazeuxia hyalina*, *Mucronella coccinea* etc.) the rosette-plates have their place in the inner wall of small additional structures from the zooecia for which I have earlier proposed the name of pore-chambers [2]). The basal wall in such a pore-chamber is continuous with that of the zooecium, whereas the outer wall in which the entrance to the chamber is situated forms an acute angle with the basal wall. Like the watch-glass-formed chief-parts of the rosette-plates the pore-chambers are as a rule only to be found in the anterior half of a zooecium, and the posterior half, in which the walls form obtuse angles with the basal wall, is provided with holes corre-

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[1]) G. M. R. Levinsen Mosdyr, Zoologia danica, 9. Hefte, 1894. pag. Tab. I—IV.

[2]) G. M. R. Levinsen, Op. cit., pag. 7, Tab. IV—V.

sponding with as many pore-chambers in the anterior half of a neighbouring zooecium. As can be seen in the growing edge of a colony, originally only the inner wall in which the rosette-plates are seated is present, and later the two other walls grow forth. Rosette-plates, or pore-chambers, are constantly present on all lateral and terminal walls but are also in a number of species to be found both in the dorsal and in the front wall. In the dorsal wall they are rarely to be found in one-layered colonies f. i. in *Beania radicifera* which is fixed to its substratum by a great number of connecting tubes, each of which takes its rise from a rosette-plate with a single pore. One or more pore-chambers are present on the dorsal wall of each zooecium in *Mucronella castanea* and *Lepralia dorsiporosa* and, in the later at least, connecting tubes take their rise from the smaller of these pore-chambers. Also in *Euthyris obtecta* the dorsal wall is under the covering membrane provided with a number of rosette-plates with a single pore. Rosette-plates I have further found on the dorsal wall of more or less zooecia in a number of species growing in two-layered colonies, namely in *Flustra biseriata*, *Beania nobilis*, *Porella elegantula*, *P. compressa*, *Thalamoporella Smitti*, *Steganoporella magnilabris*, *Microporella marginata* and *Mic. flabellaris*. On the contrary I have in vain sought for such rosette-plates in the dorsal wall of *Flustra foliacea*, *Fl. securifrons* etc. On the front wall rosette-plates are present in all the members of the family *Onchoporidae* to which family I refer *Onchoporella bombycina*, *Onch. bicornis*, *Calwellia Sinclairi*, *Urceolipora dentata*, *Ichthyaria oculata* and *I.* (*Carbasea*) *Moseleyi*. The rosette-plates which have a single pore are as a rule seated in the foremost part of the body and the same is the case in *Calymnophora lucida* and *Euthyris obtecta*. The marginal pores which can be met with in many *Camarostega* (f. i. in *Mucronella Peachii*, *Smittia reticulata*, *Umbonella verrucosa* etc.) and which in elder zooecia as a rule are seated in more are less deep pits or areolæ are really rosette-plates with one or more (f. i. in *Umbonella verrucosa*) pores. In the quite joung zooecia they have their place im-

mediately on the surface of the zooecium, but subsequently they get surrounded by raised lines and the small compartments formed in this manner can be regarded as superficial pore-chambers. In the figure of *Smittia reticulata*, given by Hincks[1]), the whole row of these chambers on each side is externally limited by a raised line, forming an immediate continuation of the lateral wall of the zooecium, while the single chambers are separated from each other by a row of parallel raised lines, forming right angles with the longitudinal one. The latter meets a corresponding line from the neighbouring zooecia and by the splitting of a colony in singular rows of zooecia these raised longitudinal lines which are the lateral walls of the superficial pore-chambers will separate from each others. When regarded from the side-wall of an isolated zooecium these pore-chambers will shine through as channels crossing the side-wall of the zooecium. In species possessing both such marginal rosette-plates and a median avicularium behind the orifice the avicularium is connected with the first, and sometimes also with the second pair[2]) of these rosette-plates, through two or four channels which originate from the fore-part of the avicularium.

In *Myrizoum coarctatum* the whole front wall is perforated by closely set backward-directed bag-shaped tubes, each of which ends in a rosette-plate with a single pore. In every tube can be seen a string of mesenchymal tissue dilating towards the rosette-plate. All the other, so-called pores in the *Cheilostomata*, hitherto looked upon as perforations of the calcified wall, are really in the bottom closed by a membrane without pores, but in a number of species this membranous bottom is calcified in a greater or lesser part of its surface. In the species of *Tubucellaria* and of *Haswellia* the greater part of it is calcified and only a little median circular part is membranous. In *Micropora borealis* the membranous part of

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[1]) Hincks, British marine Polyzoa, Pl. 48, [redacted]. 1.

[2]) Sometimes only with a single rosette-plate. G. M. R. Levinsen, Op. cit., Tab. IV, Fig. 18.

the pores is divided in a number of triangular areas by calcified rays. Finally it shall only be stated that the „pores“ of the ooecia are also closed by a membrane.

While the authors who have hitherto examined the rosette-plates have mainly used these structures in the description of the species, it is my conviction that they are to be regarded as some of the best and most constant systematical characters.

The ooecia. When I here try to give a general view of the different types of ooecia and their distribution among the *Bryozoa* I must premise that I have not yet succeeded in getting fresh decalcified material, and therefore my researches on the ooecia deal chiefly with the calcified parts of these structures, however, I hope later to be able to supply these researches. We can at present distinguish between 8 different types of ooecia.

1) *The endozooecial ooecia.* These ooecia which are seated internally between two contiguous zooecia in the same longitudinal row but as a rule chiefly project into the bottom of the higher one, are best known in the family *Flustridae.* As shown by Vigelius [1]) such an ooecium commences as a vesicular invagination from the membranous front wall and later coalesces with the incompletely developed distal wall. As a rule only its upper half is calcified and in the angle between its lower membranous half and the membranous front wall of the zooecium is fixed a muscular string serving to open the ooecium. Vigelius is not right in his supposition that the lower membranous half of the ooecium later disappears, and I have found it still existent in ooecia containing eggs. Hence follows that the cavity of the ooecium is always perfectly separated from the zooecial cavity. In *Flustra foliacea* also the lower half of the ooecium is calcified. In a number of species (f. i *Fl. membranaceo-truncata, Fl. Barleei, Fl. flustroides* etc.) a calcified band is formed between the lower margin of the calcified part of

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[1]) Bijdragen tot de Dierkunde, 11. Aflevering, 2 Ged. 1884, p. 47, Tab. 3—4.

the ooecium and the wall of the zooecium. It commences as two distinct processes from the lateral walls which finally coalesce. In *Fl.* (*Membr.*) *flustroides*, whose ooecia project on the zooecial surface this band subequently increases in height and at last covers the whole front part of the ooecium. In the family *Farciminariidae* the construction and the position of the ooecia are mainly the same as in *Flustridae*, but the ooecia always project on the surface of the zooecium. In the group of species represented by *Farc. magna* the superior part of the ooecium is on each side covered by a little vaulted calcified plate projecting from the lateral wall and seated between the ooecium and its covering membrane.

To this type we provisionally refer a number of ooecia found in very different families and as far correspondent with the ooecia in the *Flustridae* that they are seated internally between two zooecia and are coalesced with an incompletely developed distal wall. For want of suitable material I cannot at present give any information about the membranous or muscular parts of these ooecia. While the covering zooecia in a number of forms (f. i. *Micropora coriacea*, *M. perforata*, *Lepralia sincera*, *Catenicella pulchella*, *C. pusilla*, *C. gracilis*, *C. formosa* etc.) are autozooecia, in most cases they are kenozooecia. Ooecia covered by kenozooecia are found in most members of the family *Diazeuxidae*, and besides within a number of different families, namely in the *Bicellariidae* (*Didymia simplex*, *Eucratea chelata*, *Bicellaria infundibulata*), *Cellulariidae* (*Menipea crystallina*, *M. cervicornis*), *Cribrilinidae* (*Cribrilina punctata*, *Cr. Gattyae*), *Mucronellidae* (*Mucronella diaphana*, *M. abyssicola*) and *Catenicellidae* (*Catenicella plagiostoma*, *v. setosa*, *C. ventricosa*, *C. margaritacea* etc.). In all the here named forms the zooecial operculum when opened to a certain extent closes an opening whose proximal margin is the hinge-line of the operculum while distally it is limited by the free margin of the ooecium. It is the outer opening of a space which can be regarded as a fore-court common for the zooecium and the ooecium and which we will name an atrium. While Jullien has found no polypide in the ooeciferous

zooecia of *Diazeuxia hyalina*, in the corresponding zooecia of *Didymia simplex* I have found a polypide of much smaller dimensions than those found in the other zooecia.

2) *The hyperstomial ooecia.* With the exception of the ooecia in *Thalamoporella* which must be referred to another type, we unite under this name all the external, two-layered ooecia, seated over the zooecia or between two contiguous zooecia in the same longitudinal row. In most cases it is obvious that the inner layer (the endoooecium) can be regarded as a continuation of the distal wall while the outer layer (the ectoooecium) is formed from the front wall of the distal zooecium. This however cannot be the case with the ooecia of *Cellepora* and *Schismopora* whose zooecia, produced by superficial, irregular gemination, are erect and not connected wich distal zooecia. Here consequently both layers take their rise from the terminal part of the zooecium. An opercular apparatus is hitherto found in *Bicellariidæ*, *Membraniporidae* and in *Microporella* (Calvet [1]). It is a membranous fold taking its rise from the anterior edge of the distal wall and in *Membranipora* and *Microporella* continuous with the posterior wall of the tentacular sheat. In *Bugula*, where an zooecial operculum is not developed, it is continuous with the posterior lip of the zooecial opening. An atrium is sometimes present. The ooecia belonging to this type we can divide into two groups, namely into ooecia with, and ooecia without, a cryptocyst.

Hyperstomial ooecia without a cryptocyst. To this group belong the ooecia in the families *Bicellariidae*, *Cellulariidae* et *Onchoporidae*. In the first family the ooecia can be characterized as free, their ectoooecium having only a very little basal part common with the front wall of the distal zooecium and otherwise projecting freely. While the endoooecium always seems to be calcified it is not always the case with the ectoooecium. In *Bugula Murrayana* f. i. the ectoooecium is for the most part membranous and only

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[1]) Op. cit. pag. 57, 169, 262.

its basal part is calcified, whereas it is completely calcified in *Bugula flabellata* and *Bicellaria ciliata*. In *Cellulariidae*, both layers are calcified, and the ooecium is in its whole length firmly connected with the front wall of the distal zooecium. As an exemple we will shortly describe the development of such an ooecium in *Scrupocellaria scabra* [1]). At a point of time when the front wall of the distal zooecium is still wholly membranous a calcified plate, which we will name the endoooecial plate, grows out from the margin of the distal wall and soon fills up the space between the calcified lateral walls outside the membranous front wall in the lower part of the distal zooecium. Next two processes from the lateral walls meet over the endoooecial plate which is now surrounded by a calcified frame, the first beginning of the ectoooecium, and finally both the endoooecial plate and the surrounding frame grow out from the zooecium in order to form the vaulted part of the ooecium. The back-wall of the ooecium consequently consists only of a single calcified layer belonging to the endoooecium. In *Onchoporidae* the ooecia are also with their back-wall firmly connected with the front wall of the distal zooecium, but the ectoooecium is wholly membranous.

Hyperstomial ooecia with a cryptocyst. These ooecia are always covered with a membrane, continuous with that investing the front wall of the zooecium and corresponding with the ectoooecium in the former group. The calcified part of the ooecium in many cases consists of two distinct layers (f. i. in. *Membraniporidae* [2]), *Cribrilinidae, Reteporidae, Ramphostomella* etc.) of which the inner is the endoooecium while the outer must be regarded as the cryptocyst of the ectoooecium as it takes its origin from the cryptocyst

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[1]) G. M. R. Levinsen, Op. cit. pag. 26, Tab. 1, Fig. 21, a—h.

[2]) In some *Membraniporidae* f. i. in *M. unicornis, M. imbellis, M. aurita* etc. the ectoooecium does not cover the whole of the endoooecium the lower part of which can be seen as an area of different shape separated from the ectoooecium by the more or less projecting lower margin of the later.

of the distal zooecium. A feeble beginning to such an ooecial cryptocyst are the two above mentioned small calcareous plates found in some species of *Farciminaria*, and the calcareous band found in some species of *Flustra*. In a number of forms (*Mucronella Peachii, Muc. coccinea, Schizoporella Cecilii* etc.) the ooecium apparently possesses only a single calcareous layer, but I have no doubt that it is really formed by the fusion of two layers. If we isolate the outer calcareous layer in a species possessing distinctly two-layered, pore-bearing ooecia we will find that the pores as those in the front wall of a zooecium are closed by a membrane, which however will disappear after some times boiling in a solution of caustic potash. On the contrary, if we examine an apparently single-layered, pore-bearing ooecium (f. i. of *Mucronella coccinea*) having been boiled in a similar solution we will find that each pore is closed by a calcareous membrane which no doubt is the endoooecium here coalesced with the cryptocyst. While the ooecia of *Membraniporidae* and *Cribrilinidae* can be compared with those of *Cellulariidae* in that their back wall is only formed by the endoooecium, in other forms f. i. in *Reteporidae* and in *Ramphostomella* the ooecia are in their whole extent formed by two distinct calcified layers and are as the ooecia of *Bicellariidae* free and separable, at least in the quite young zooecia. In most *Reteporidae* they get later firmly connected with the front wall of the distal zooecium by means of covering layers of calcareous substance from the front wall of the zooecium growing out over the ooecium.

3) *The epistomial ooecia.* These ooecia hitherto only found in *Thalamoporella* are external, large, kidney-formed, two-layered structures whose inner layer takes its rise from the margin of the orifice while the outer layer is a continuation of the distal wall. I have not been able to find any covering membrane. The outer aperture of the ooecium is closed by a cup-shaped strongly chitinized operculum, at its base connected with the membranous operculum of the zooecium. In contrast to the hyperstomial ooecia which are seated outside the lower part of the distal zooecium, these ooecia

are seated outside the upper part of the lower zooecium and completely hide the orifice.

4) *The peristomial ooecia.* As indicated by the name, these ooecia are formed by a dilatation of the peristomium, and consequently they consist only of a single layer. Such an ooecium can be formed either by a pyriform enlargement of the whole peristomium (*Tubucellaria opuntioides, T. hirsuta, „Porina“ magnirostris*), or only the inferior part of the peristomium is provided with a hemisperical enlargement of its front wall, whereas the rest of it continues its way as a simple tube (*Lekythophora hystrix, Turritigera stellata*).

5) *The mesotoichal ooecia,* which are only found in *Calymmophora lucida,* are internal one-layered calcified ooecia which take their rise from the distal wall and are seated between the cryptocyst of the distal zooecium and the covering membrane.

6) *The endotoichal ooecia* [1]). These ooecia, which are only found in the family *Cellariidae,* are cavities hollowed out in the thick front wall of the zooecium, and it looks as if they were formed by a gradual resorption of the calcareous substance of this wall. By a grinding of elder and younger parts of a colony these ooecia can be found in all degrees of size, from very little cavities seated in the middle of the wall increasing till they occupy most of the thickness of the wall. Finally they open outwards. The operculum of such an ooecium is as that of the zooecium two-layered, and the inner chitinous layer must be looked upon as a non calcified part of the cryptocyst.

7) *The bivalvular ooecia,* which are only met with in *Catenaria parasitica,* are somewhat compressed, acorn-formed bodies consisting of two two-layered arched valves, each of which has its place a little outside the orifice of the zooecium. They are seated on zooecia whose anterior half forms a right angle with the posterior half and the basal part of the oeecium covers the whole ante-

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[1]) G. M. R. Levinsen, Op. cit. Tab. II, Fig. 19.

rior part of the zooecium, whose orifice opens into the bottom of the ooecium. The two valves composing the latter can perhaps be regarded as corresponding with the two little spines present in the other zooecia.

8) *The acanthostegal ooecia*, which are only found in two species of the genus *Electra* (*E. zostericola* and *E. amplectens*) are cavities internally limited by the covering membrane of the zooecium and externally by a cover made up of two rows of hollow spines.

As to the way in which the eggs get into the ooecium, in respect to the epistomial, the peristomial and the valvular ooecia, there can be no doubt that the migration must take place through the orifice of the zooecium, which opens directly into the ooecium. As the hyperstomial ooecia have their place quite outside the zooecial wall in which there is no perforation, here neither can we have any doubt that the eggs do pass into the ooecium by this way and the same must be the case in *Flustridae* and *Farciminariidae*, in which the ooecial, and the zooecial cavities are separated by the lower membranous half of the ooecium. According to Calvet [1]), in *Cellaria* there exists an opening in the calcareous wall between the zooecium and the ooecium. I must however deny the existence of such an opening which I have not been able to find even by grinding the colonies in several directions. Though we at present only know the calcareous parts of those ooecia, previously referred to the endozooecial ooecia, it is not probable that there should here exist an internal connection between the zooecium and the ooecium, therefore I must suppose that in all *Cheilostomata* the migration of the egg from the zooecium into the ooecium, must take place through the orifice. At first glance the supposition may perhaps appear strange that the egg should first pass out through the orifice of the zooecium and afterwards enter the ooecium through its outer opening, but firstly there is no other way left, and secondly I do not think that this passage will be much more difficult than that which

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[1]) Op. cit. pag. 265, Pl. VI, fig. 11.

takes place in the epistomial, the peristomial, and the bivalvular ooecia. In all such species in which there exists an atrium the closing of the atrial opening by the zooecial operculum, will at the same time, when the opercular apparatus of the ooecium is drawn back by means of its muscles, form a perfectly safe passage from the ooecium to the zooecium. But even in such cases where there is no atrium and the distal margin of the operculum cannot reach the free margin of the ooecium, the distance between these two margins is so short that the egg by a protrusion of the tentacular sheat can have no difficulty in getting safely into the ooecium. In some *Ctenostomata* (*Valkeria*, *Bowerbankia*) the egg after the death of the elder polypide is inclosed in the tentacular sheat of a newly formed one having a rudimentary intestinal canal, and therefore it is probable that also in the *Cheilostomata* an admission of the egg into the tentacular sheath precedes its passage into the ooecium.

Systematical remarks. The main causes of the great difficulties connected with the classification of the *Cheilostomata* are partly the great variation found in the different characters and partly the fact that a number of characters (f. i. the median pore and the different forms of orifice) either have risen independently or have developed in a similar manner (parallel characters) in widely different families and genera. Families and genera have hitherto mainly been based upon a single easily perceptible character, and as most of the leading characters hitherto chosen are partly such parallel characters, partly characters taken from structural features subject to considerable variation, the result has been, that most families and genera contain a number of heterogeneous species. One of the principal characters used in the classification of Hincks is the form of the orifice, but from more reasons this character is not fit to be a leading one, for in the first place, I have found the same forms of orifice within a number of different families, secondly it is impossible to put up sharply separated types of orifices. So for instance the forms of orifice regarded as characteristic for the genera *Le-*

pralia and *Schizoporella*, are connected by a number of transitional forms not only with each other, but also with the orbicular and the suborbicular orifice. A character apparently of much greater classificatory value than the form of the orifice (though it is subject also to a considerably variation and can be found in different families) is a structure which we will name the oral bow. It is an arched projection from the whole of the distal margin of the orifice, extending more or less deeply into the zooecial cavity, in most cases (f. i. in *Reteporidae*, *Porella*, *Microporella*) forming only a low internal collar, but sometimes developed into a rather large concave plate (*Mucronella diaphana*). It reaches the greatest development in the species of *Mucronella* (ch. emend.), in *Escharoides Sarsii* and „*Porina*“ *magnirostris*, and is very well represented in a number of figures in Busk's Crag Polyzoa [1]) (f. i. in Pl. IV, fig. 4, Pl. V, fig. 8, Pl. VI, fig. 4). In the *Cheilostomata* it is not unusual to find that characters, which as a rule are subject to variation, in certain families can show great constancy and therefore it is not an easy matter to set forth common rules for the relative value of systematic characters. Nevertheless I have no doubt that the structural features, generally most to be relied on, for the distinction of families and genera, are the rosette-plates and the ooecia.

While in a work later to be published I intend to give detailed definitions of all the families of *Cheilostomatous Bryozoa*, which I have been able to study, I shall now merely confine myself to making a few remarks upon a part of them.

Flustridae. From the other families of *Malacostega* the *Flustridæ* are best distinguished by the endozooecial ooecia and the vicarious avicularia. In a number of species exists a feebly developed cryptocyst. The species described under the name of *Flustra*, but provided with free hypostegial ooecia (*Fl. nobilis*, *Fl. crassa* and *Fl. dissimilis*) must be referred to the *Bicellariidae*, whereas

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[1]) A Monograph of the fossil Polyzoa of the Crag, Palæontographical Society, 1857, London 1859.

Bugula versicolor appears to be a *Flustra*. *Membranipora flustroides* and *M. serrata* Mac Gill, both of which possess endozooecial ooecia and vicarious avicularia, must be regarded as incrusting species of *Flustra*. Most of the species have only rosette-plates with a single pore, and in this division the lower half of the ooecium is membranous. Of the species possessing rosette-plates with several pores only a single one, namely *Fl. foliacea* is provided with ooecia in which also the lower half is calcified.

Bicellariidae. From the *Flustridae* with which family the *Bicellariidae* agree in the feeble calcification and in many cases in the form of the colony, the members of this family are easily distinguished by the free hypostegial ooecia, and the non vicarious, freely mobile avicularia. The lateral walls are provided with rorette-plates with several pores and the distal wall is more or less ascending and generally angular from side to side. Waters has made the interesting observation that an operculum is not developed in the species of *Bugula* in which the orifice is formed in a similar manner as in the *Ctenostomata*. Another resemblance with the *Ctenostomata* are the stolons and stalks not uncommon in this family. In *Beania?* (*Flustra*) *nobilis* Hincks, which has hitherto been understood as consisting only of a single layer of zooecia, I have in some (dried) colonies (which I owe to the liberality of Miss Jelly) on the supposed back-side, discovered a layer of wholly uncalcified zooecia without operculum (and consequently without ooecia and avicularia), whereas the zooecia of the front side of the colony are provided with a distinct operculum, but also with a similar diaphragma (a „setose operculum“) as that found in the *Ctenostomata*. The back-walls of the calcified zooecia are provided with rosette-plates. These *Alcyonidium*-like zooecia, which I have found in colonies both from Africa and Australia, are of the same size as the calcified zooecia with which they alternate. Therefore I cannot doubt that both forms of zooecia are really members of the same colony. The peculiar dimorphism of this species, together with the above mentioned points of resemblance between the

Bicellariidae and the *Ctenostomata*, support the view long ago proposed by Smitt, that the *Cheilostomata* must be derived from the *Ctenostomata*.

Cellulariidae. The distal wall consists of a posterior horizontal and an anterior ascending part, of which the former is provided with a group of rosette-plates with a single pore. Every lateral wall has two rosette-plates with several pores (to speak strictly a rosette-plate in the superior half and a hole in the interior half). Fixed, hypostegial ooecia. To this family belongs „*Flustra*“ *armata.* While all hitherto known avicularia are external, I have in *Flabellina* (*Flabellaris* Waters) *roborata* discovered an internal avicularium. In the posterior half of the front wall of this species there is generally found a single avicularium seated now in the right, now in the left side, very seldom two. In the zooecia provided only with a single avicularium, I have always found an internal avicularium seated exactly inside the empty place on the outside of the front wall.

Thalamoporellidae. From the nearly related *Steganoporellidae* (with which they have hitherto been put together and with which they agree in a number of characters, particularly in the structure of the cryptocyst), the *Thalamoporellidae* are distinguished by the possession of epistomial ooecia, vicarious avicularia and free calcareous spicules in the form of bows and compasses. These spicules, which have been found in all the species examined (10) are seated partly in the zooecial (as well as in the avicularian and ooecial) cavity, partly in the space between the cryptocyst and the covering membrane. The distal wall consists of a posterior horizontal and an anterior ascending part, of which the former is provided with a semilunar group of single-pored rosette-plates. Each lateral wall has two rosette-plates with several pores. A simple operculum generally with a more or less concave posterior margin.

Cellariidae. The members of this family differ from all other *Cheilostomata* in that the hexagonal areas in which the surface of the colony is divided, neither in the length nor in the breath corre-

spond with the real zooecia, which are very narrow and elongated. Endotoichal ooecia seated in the superior part of an area but in the inferior part of a zooecium [1]). Every distal wall is provided with a single rosette-plate with several pores and every lateral wall with two[2]).

Chlidoniidae. Every row of zooecia of the fan-shaped colony of *Chlidonia* terminates in 3—4 slender cylindrical internodes and new zooecia gradually rise by a transformation of these (internodes), which in the same colony can take place in two different ways. In some cases such an internode seems to be transformed into a zooecium by a gradual dilatation, while in others a cup-shaped growth of the same form as the basal part of a zooecium is formed under the internode. In both these singular instances of a postembryonal metamorphose, which for lack of sufficient material I have not been able to study at full length, a resorption must take

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[1]) G. M. R. Levinsen, Op. cit. Pl. II, fig. 19, o.

[2]) *Melicerita dubia* Busk (Challenger, Zoology, Vol. X, P. 1, pag. 97, Pl. XXXIII, fig. 10), which I refer to a new genus (*Membranicellaria*) and a new family (*Membranicellariidae*), differs from the *Cellariidae* only by the possession of a membranous area and an opercular valve. The ooecia have been overlooked by Busk. To this family, whose members no doubt must be considered the ancestors of the *Cellariidae*, I think the following cretaceous Bryozoa must be referred: *Eschara Aceste* d'Orb. (Op. cit. Pl. 662), *E. Achates* d'Orb. (Pl. 662), *E. Ægea* d'Orb. (Pl. 663), *E. Amata* d'Orb. (Pl. 665), *E. Calypso* d'Orb. (Pl. 669), *E. cymodoce* d'Orb. (Pl. 674), *E. Danae* d'Orb. (Pl. 675), *Biflustra rhomboidalis* d'Orb. (Pl. 691), *B. mæandrina* d'Orb. (Pl. 695), *Eschara striata* Goldf. (Hagenow, Die Bryozoen d. Maastrichter Kreidebildung, Cassel, 1851, Tab. VIII, 6—7), *E. rhombea* Hag. (Op. cit, Tab. VIII, 8) and *Biflustra Pražàki* Novák, (Beitrag z. Kenntniss d. Bryozoen d. Böhmischen Kreideformation, Taf. III, 20—25, Denkschriften d. Kais. Akad. d. Wissenschaften, math.-natur. Cl., XXXVII B). That *B. Pražàki* which according to Canu (Revision d. Bryozoaires du Crétacé, pag. 390, Bullet. Soc. Géol. de France, 3. S. T. 28, 1900) is identical with *Onychocella Acis* d'Orb. belongs to this family is evident from the figures 21, 22 and 25, clearly showing that the elongated, narrow zooecia do not correspond with the broad, hexagonal areas. *Escharella argus* (Waters, Annals nat. hist. 6 S., Vol. VIII, Pl. VI. fig. 7) seems to belong to the Cellariidae.

place. In dried colonies of *Catenaria parasitica* I have sometimes found the zooecial rows ending in similar cylindrical internodes, but in this species I have not yet been able to find traces of a similar metamorphose. The distal wall of *Chlidonia* is provided with one single-pored rosette-plate, while in *Cat. parasitica* there is a transverse row of similar rosette-plates. A simple operculum.

Diazeuxidae Jullien. To this family, at present only containing the genus *Diazeuxia*, I must further refer *Chorizopora Brognarti*, *Microporella impressa* (*Haplopoma* n. g.), *Schizoporella venusta* (*Trypostega* n. g.) and the species of the genus *Hippothoa* which I think must be merged in *Diazeuxia*. While in all other families of *Camarostega* the zooecia in the growing edge of the colony are only calcified in their posterior part, in this family the calcification always keeps pace with the growth. The thin-walled, finely striated zooecia are provided with pore-chambers, and the ooecia which possess an atrium, and are connected with a rudimentary distal wall are covered either by kenozooecia (*Diazeuxia*, *Hippothoa*, *Haplopoma*) or by rudimentary zooecia (*Trypostega*) or by avicularia (*Chorizopora*).

Reteporidae. This very natural family not only contains species growing in free ramose colonies, with or without reticulation, but also a number of incrusting species (f. i. *Schizotheca fissa*, *Rhynchopora bispinosa*, *Schizoporella scintillans*). The zooecia, whose walls are very compact and strongly calcified, are provided with a distal bow, generally beaded, and with very few single-pored rosette-plates. Generally the distal wall has only a single, and each lateral wall two rosette-plates. The ooecia are hypostegial and originally free [1]). In all the species growing in free colonies the back-side of the colony is invested with a layer of kenozooecia, very seldom possessing a distinct cavity (f. i. in *R. tesselata*, *R. lata*, *R. Wallichiana*) and immediately continued in the layer of keno-

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[1]) G. M. R. Levinsen, Mosdyr, Tab. VI, Fig. 27.

zooecia forming the basal expansion. In the elder parts of a colony there can be found several layers of such kenozooecia not only on the back-side but also on the front side (the inner side) of the colony. A colony of *Retepora* does not, as Hincks states, take its origin as a basal expansion, consisting of rudimentary zooecia, but (as I have found it in *R. Beaniana*) in the same manner as all other colonies of *Bryozoa*, namely as a single zooecium and the named basal expansion does not commence to develop, untill the colony has reached a certain size. Figure 18 in Hincks, British marine Polyzoa, pag. 394 which is a copy after Busk's figure of *Lepralia lobata* [1]) is not as Hincks supposes the young state of a *Retepora* but on the contrary the relics of a pretty old colony, the greatest part of which has been broken of.

Adeonidae. This family which I must maintain with the limitation given by Busk, is a very natural one. The very thick-walled zooecia, always lacking spines, are provided with numerous single-pored rosette-plates, in each wall arranged in a single row. No ooecia, but sometimes supposed gonozooecia. Although the zooecia as well as the avicularia are very strongly calcified, the avicularia always lack a cross-bar between the opercular and the sub-opercular area, and as already mentioned by Busk, the avicularian mandible always exhibits an articular process at each end of the base. While I am following Waters in referring the species provided with a peristomial pore to the genus *Adeonella,* I shall retain the name *Adeona* for those species whose median pore enters into the zooecial cavity and which at present are referred to the very different genus *Microporella.* A third genus (*Lobopora*) must be instituted for such species as „*Microporella*“ *coscinopora* Reuss. possessing a concave area perforated by a number of fimbriate pores, while „*Schizoporella*“ *bimunita* Hincks must be regarded as a representative of a fourth genus.

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[1]) Busk. The fossil Polyzoa of the Crag, Pl. XXII, Fig. 4.

Catenicellidae. The members of this family all growing in the form of free articulated colonies are mainly distinguished by the peculiar lateral chambers (loculi Busk) with which the zooecia are provided. Typically there are four such chambers to each free lateral wall. With the exception of the second (numerated from the anterior part of the zooecium), in most species in more or less zooecia developed into an avicularium, the other three are kenozooecia whose outer wall is wholly or partially uncalcified. The distal wall consists of a posterior horizontal and an anterior ascending part of which the former as well as the wall between two neighbouring zooecia is provided with a group of single-pored rosette-plates. The named lateral chambers are also connected either with the zooecium or with one another by a number of single-pored rosette-plates. The ooecia which are in connection with a rudimentary distal wall and provided with an atrium are covered either by zooecia or by kenozooecia. A compose operculum. Here we shall only give definitions of the two chief genera: *Catenicella* (Blainv.) M. Gill [1]) char. emend. The operculum with a straight or concave posterior margin; the front wall with 3—14 greater or lesser pyriform or oval non calcified spots (fenestrae); the front wall of the compensation-sac is protected by an inner, originally free, semielliptical, calcareous plate, rising from the posterior margin of the orifice and distinctly visible through the fenestrae [2]). In old zooecia the orifice is closed by a calcareous plate growing out from the line of union between the horizontal and the ascending part of the distal wall.

Caloporella M. Gill [3]) char. emend. The operculum with a convex posterior margin; the front wall without fenestrae, at the

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[1]) Tertiary Polyzoa of Victoria, Transact. Royal Soc. of Victoria Vol. IV, 1895, pag. 8.

[2]) This plate can be seen in Busks figure of *Cat. plagiostoma* in Catalogue of marine Polyzoa, Part. 1; Pl. V, fig. 1.

[3]) Tertiary Polyzoa of Victoria, Transact. Royal Soc. of Victoria Vol. IV, 1895, pag. 8.

outside with very fine pores; no inner calcareous plate; the fourth pair of loculi (vittae Busk) very narrow, elongated, seated on the front wall; in the old zooecia the closure is performed by three calcareous growths (two superior and one inferior) rising from the circumference of the orifice and uniting in the centre.

Mucronellidae n. f. The orifice is provided with a more or less developed distal bow; hyperstomial ooecia, generally without pores; porechambers or rosette-plates with several pores. To this family I refer the following genera, which shall be characterized in a later work: *Mucronella* (with the species *M. Peachii*, *M. variolosa*, *M. abyssicola*, *M. diaphana*, *M. spinosissima* etc.), *Peristomella* n. g. (*P. coccinea*, *P. præstans*). *Exochella* Jull., *Anarthropora* (*A. monodon*), *Microporella*, *Porella* and *Mastigophora* (*M. Dutertrei*, *M. Alderi*, *M. spinifera*, *M. dædala* etc.).

Smittiidae. Hyperstomial ooecia, generally with pores; both the distal wall and the lateral walls with a number (ca. 4—8) of single-pored rosette-plates. Besides the genus *Smittia* whose orifice is provided with two slender hinge-teeth and a median extra-opercular teeth, all the species with single-pored rosette-plates, hitherto referred to *Schizoporella* and *Lepralia*, must be referred to this family. For the reception of all such species I propose a provisional genus *Monoporina* and another provisional genus *Polyporina* for the reception of all the species of *Schizoporella* and *Lepralia* which possess perforated ooecia and rosette-plates with several pores. The last genus must together with *Ramphostomella* be referred to another family (*Polyporinidae*). — Finally I shall call attention to the fact that *Bifaxaria denticulata* Busk, of which species I have been able to examine a number of exemplars, is nearly related to *Porina borealis* and that *Euthyris obtecta* is the nearest relative of *Calymmophora lucida*. In both, the thin and fragile cryptocyst is provided with a number of single-pored rosette-plates and surrounded by a covering membrane held at a distance from the cryptocyst by means of projections from the later. In

Euthyris obtecta as pointed out by Harmer[1]) this task is performed by a number of calcareous processes, and in *Calymmophora lucida* by a keel running down the side-walls of the zooecia. In both species the distal wall and the wall between the neighbouring zooecia are perforated by a large number of single-pored rosette-plates.

The renewal of the zooecia. Besides the well known renewal of the polypide a renewal also of the whole bryozoid has been found in a number of *Bryozoa*, namely in the Ctenostomatous genera *Valkeria*, *Bowerbankia* and *Triticella* in which the old zooecia are deciduous and can be replaced by new zooecia taking the place of their predecessors. But also in the *Cheilostomata* such a renewal can take place and the presence of a double margin in the zooecium of a *Membranipora* is a proof that a new zooecium has here been developed inside an elder one. This form of renewal can be compared with that found in the thecaphorous Hydroids[2]) in which a new hydrothek is formed inside an elder one, whereas in the athecate forms the „heads“ of the hydranths are deciduous and replaced by new ones in the same manner as the zooecia in the above ctenostomatous genera. Besides in a few recent species I have found double (or sometimes triple) margins in numerous cretaceous species of *Membranipora* and such double-margined zooecia have been figured by several authors, for instance by d'Orbigny[3]). In regard to this renewal we can discern four different cases, found in the species examined: 1) a new zooecium can be developed in an old one, 2) an avicularium can be developed in an old zooecium, 3) a new avicularium can be developed in an old one and 4) a zooecium can be developed in an old avicularium. Besides in *Membranipora* I have found such a renewal in some *Cribrilinidae* and in *Porina flabellata* d'Orb.

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[1]) Op. cit.

[2]) G. M. R. Levinsen, Om Fornyelsen af Ernæringsindividerne hos Hydroiderne, Vidensk. Meddel. fra naturh. Forening, 1892, pag. 14.

[3]) Paléontologie française, Terr. cret. Bryozoaires, Pl. 699, fig. 2.

Remarks on the Eleidae and the Ceidae. In a paper: „On Chilostomatous characters in Melicertitidae and other fossil Bryozoa“ Waters[1]) has shown that some structures occurring in this division of exstinct *Bryozoa*, which have earlier been described as ooecia, are really avicularia, and he is inclined to suppose that these *Bryozoa* have also been provided with an operculum, but of this he has not been able to convince himself. The division *Eleidae* (= *Melicertitidae*) was founded by d'Orbigny[2]) who in opposition to all the later authors regarded the calcareous plate in many species closing the orifice of more or less zooecia, as a real operculum. It is a well known fact that the orifice of old zooecia in many species both of *Cyclostomata* and of *Cheilostomata* is closed by a calcareous plate, no doubt for the purpose of protecting the elder zooecia deprived of their polypide, therefore the whole colony from destruction, and the named calcareous plate is at present regarded as a similar closure. In many species of *Eleidae* we can find the orifices closed in two different ways, namely in some zooecia by a convex calcareous plate with distinct, free margins and flabelliform striation, and in others by a concave not striated plate continuous with the inner surface of the zooecium. In most cases the superior part of this plate is provided with a projection, perforated by an opening, and very similar closures provided with a projecting tube have been found in a number of *Cyclostomata* and even in some *Cheilostomata*[3]). In other species we can only find orifices closed in the last named manner. While there can be no doubt that the concave plate is a closure of the same kind as that found in many *Cyclostomata* and *Cheilostomata*, the convex striated plate must be regarded as a true, calcareous operculum and in such species in which it has not been found we

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[1]) Annals nat. hist. S. 6, Vol. VIII, pag. 48.
[2]) Op. cit. pag. 606.
[3]) Waters, North-Italian Bryozoa, Quart. Journ. Geol. Soc. 1891, Vol. XLVII, Pl. III, fig. 4.

must suppose there has been a chitinous operculum. In *Melicertites Royana* Waters [1]) has found the closure consisting of three (two superior and one inferior), rarely four calcareous growths starting from the margin and uniting in the centre and as above mentioned the orifice is closed in a similar manner in the species of *Caloporella*, only that the three growths have a somewhat different position.

While the *Eleidae* are provided with opercula and avicularia they lack ooecia but have sometimes gonozooecia of the same structure as those found in some *Cyclostomata*. As further the form, the structure and the mode of combination of their zooecia are cyclostomatous I cannot doubt that they are nearly related to the *Cyclostomata*. Therefore I agree with Gregory [2]) in considering the presence of avicularia (as also of opercula) as a case of parallel development. Besides, these avicularia do not quite agree with those found in the *Cheilostomata*. While the latter are always provided with a membranous area (the subopercular area), seated behind the operculum and separated from the opercular area either by a calcareous cross-bar, or only partially by the hinge-teeth of the operculum, a such subopercular area has not been developed in the avicularium of the *Eleidae* in which of course the operculum or mandible has filled the whole aperture, consequently terminated by a straight posterior margin.

As to the *Ceidae*, Gregory [3]) considers that the *Bryozoa* referred to this division are only specimens of different species of *Eleidae* which have lost their front wall. Gregory, however, is not right in his supposition. In most *Cyclostomata* we can in each zooecium distinguish two different portions of the front wall forming obtuse angles with one another, an inferior portion hidden in the interior of the colony and a superior superficial portion

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[1]) Op. cit. pag. 49.
[2]) Catalogue of cretaceous Bryozoa, Vol. 1, pag. 288.
[3]) Op. cit. pag. 291.

which can be either convex, flat or concave. While the same is the case in the *Eleidae*, in the *Ceidae* on the contrary as in the genus *Ceriopora* there is no front wall visible on the surface of the colony, but very large hexagonal zooecial orifices, meeting in sharp edges. The most characteristic feature of the zooecium is, however, that the orifice begins with a funnel-shaped vestibular portion in the bottom of which is seated a much smaller round or oval opening, the entrance to the narrow, very thick-walled zooecial tube only dilating very little from beneath upwards. Each of the very thick partition-walls between two zooecial cavities does not end in a single plane but in two somewhat concave planes forming an angle with one another, and each zooecium being surrounded by six other zooecia, the funnel-shaped vestibulum is formed by the melting together of six concave planes sloping towards the zooecial entrance. The zooecial entrance is sometimes seated in the inferior part of the vestibulum, and in that case the observer at the first look will regard this as the superior part. A grinding away of the surface will not give an Eleid species the appearance characteristic to a Ceid. After such a grinding the colony will show a number of oval apertures separated by plane facets and not of funnel-shaped areas separated by sharp edges. If the superior part of the zooecial tube of an Eleid can be compared with a funnel, then the bottom of the funnel is seated a way down in the zooecial cavity, but in an Ceid the bottom of the funnel is identical with the entrance of the zooecial cavity. A similar funnel-shaped vestibulum has only been found in some palæozoic *Bryozoa*, f. i. in *Rhombopora*[1]), but here the inner very thin-walled part of the zooecium strongly contrasts to the very thick-walled vestibular part. While no member of the *Eleidae* has been found still living I shall call attention to the interesting fact that the *Ceidae* which have hitherto been regarded as exstinct with the

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[1]) E. O. Ulrich, Palæozoic Bryozoa, Geolog. Survey of Illinois, Vol VIII, Part. II, Section VI.

Cretaceous formation, possess a recent representative in *Cinctipora elegans* Hutton [1]) from New Zealand, of which interesting species Dr. S. Harmer has had the kindness to send me some dried examplars. As in *Filicea subcompressa* d'Orb., *F. rhomboidalis* d'Orb. and *Cea rustica* d'Orb.[2]) the entrance to the zooecial cavity is seated in the inferior part of the funnel-shaped vestibulum, and not being able to see any generic difference between the named cretaceous forms and Hutton's species, I propose to name the latter *Filicea elegans* Hutton.

My studies on the *Bryozoa*, whose chief results here are shortly referred, have been supported by a subvention from the Carlsberg Fund.

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[1]) F. W. Hutton, Catalogue of Marine Mollusca of New Zealand, p. 103; Manual of the New Zealand Mollusca, p. 198; Waters, On Tertiary Cyclostomatous Bryozoa from New Zealand, Quarterly Jour. Geol. Soc. 1887, Vol. XLIII, p. 341.

[2]) Op. cit. Pl. 786—787.

5. April 1902.