Systematic Studies on the Sertulariidae.

By

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(With Plates IV—V).

In 1893 I published a paper on the Medusae, Ctenophores and Hydroids from the west-coast of Greenland, in which I made an attempt to introduce a more natural arrangement of certain families of Hydroids, advocating the view, that in the limitation of the genera the characters found in the single individuals of the colony, and especially in the trophosomes, ought to be preferred to such characters, which might be derived from their different arrangement on the stems and branches of the colony. As to the *Sertulariidae* I proposed a limitation of the genera on the basis of the diversities presented by the opercular apparatus, and by the margin of the hydrotheca, the form of which is always contingent upon the structure of the operculum. While a number of authors (Marktanner-Turneretscher, Schydlowsky, Broch, Sæmundsson and Kramp) have followed my view, it has been attacked by others, but before I undertake to answer the objections raised against it, I shall set forth some general remarks on the systematic value of the colonial form or the form of growth.

In all aggregate animals we have to discern between two categories of characters of very different systematic value, namely those presented by the single individuals (the zooidal ch.) and those derived from the different ways in which they may be arranged in the colony (the zoarial or colonial ch.). In the first attempts at a systematic arrangement of aggregate animals the latter characters

have of course always been the first used by the authors, who at that point of time had only a very imperfect knowledge of the single individuals composing the colony or none at all. The pictures presented by the different colonial forms captivated the eye, and through this mastered the arranging thought. Such an attempt is Ellis' renowned work on the Corallines[1]) under which common name he classes not only Hydroid polyps and *Bryozoa*, but also the articulate chalk-algae, while the first step to dissolve the systematic connection between the two first named divisions was made in 1828 by Milne-Edwards and Audouin[2]) who pointed out that *Flustra* in opposition to the polyps possesses an intestinal tube provided with two apertures, and in consequence of this discovery proposed the institution of a separate family comprising the *Flustrae* and relied forms. But the belief in the systematic importance of the outer habitus and the mode of growth is not so easily conquered, and ten years later Milne-Edwards[3]) says about the result of this proposal: „Ce premier essai d'une classification naturelle des Polypes fondée sur l'organisation de ces animaux ne fut pas adopté par les zoologistes. M. Cuvier, dans la seconde édition du règne animal, publiée en 1830, continua à distribuer ces zoophytes d'apres la conformation générale de leur Polypier et rangea encore les Flustres entre les Sertulaires et les Corallines tandis que les Eschares dont la structure diffère à peine de celle de ces Flustres se trouvaient relegués dans la tribu des Lithophytes à la suite des Coraux et des Madrépores." After Milne-Edwards had extended his investigations also into the anatomy of the strongly calcified cheilostomatous forms (the *Escharae*), and other naturalists as delle Chiaje, Ehrenberg and Lister had arrived at the same results, the *Bryozoa* were gradually separated from the Hydroid polypes, but still in the second edition of Lamarck's Histoire naturelle des animaux sans vertèbres (1836)

[1]) 18.
[2]) 6, p. 14.
[3]) 41, p. 16.

we find for inst. *Thujaria thuja* and *Thuj. lonchitis* referred to the genus *Cellaria* and placed between *Cellaria (Crisia) eburnea* and *Cell. (Bicellariella) ciliata.*

While the older Bryozoan systems are based entirely on diversities in the form of the colony Smitt and Hincks lay the chief stress on the form and structure of the zooids, and this view must at present be regarded as the dominant. As, however, in the Hydroids most authors as systematic characters still prefer zoarial diversities to zooidal, I think it might be of use in general to examine the question how great systematic importance may be ascribed to the form of the colony, and I shall first give some quotations from the few authors who have treated this question with respect to the *Bryozoa.* The first quotation is from the late Th. Hincks[1]) who has played a chief part in the working out of a more natural Bryozoan system, and has, besides, done such excellent work also in the Hydroid polyps. After having spoken about the slight help, which the polypide, and the avicularia give us in systematic regard, he continues: "There remain the characters of the cell[2]) itself and the habit of growth. It can hardly be deemed doubtful which of them should have the precedence in a natural system; we may go very much further, indeed, and say that in such a system the latter must hold a very secondary and subordinate place. The essential structure of the cell[2]), as one of the primary zooidal[3]) forms, must certainly be accounted the most important point both in itself and as a clue to relationship. The mere habit is, so to speak, a superinduced condition, which may be different in the most nearly related and similar in the most divergent forms, and groups based on it,

[1]) 23, Introd., p. CXXVIII.

[2]) By the "cell" is here meant the zooecium.

[3]) According to the old cystid theory the zooecium and the nutritive apparatus (the polypide) were both regarded as individuals (zooids). The above citation from Hincks has also been used in my work on the cheilostomatous bryozoa (35, p. 68), but by a mistake the word "zooidal" has been replaced by "zooecial".

instead of fitting in with natural affinities, are found to traverse them at all points." In 1884 the late G. Busk[1]) who has rendered so great services to the study of the *Bryozoa*, published his report on the cheilostomatous *Bryozoa* from the Challenger expedition. The author, who had hitherto laid the chief stress on the colonial characters, strives to a certain degree to accomodate himself to the systematic views of Smitt and Hincks, the correctness of which he partially acknowledges, but he thinks, however, that these authors have underestimated the colonial characters. The result of this mediation is, as he himself acknowledges, far from being satisfactory. I shall here quote the following part of his introduction: "As to the scheme of classification followed in this Report, ... it is scarcely necessary to remark that it has no pretension to be regarded as more than a convenient and to a considerable degree artificial arrangement, ... For allthough many of the family groups may in some measure be regarded as expressing natural alliances, many of them, ... can only be considered as artificial, and as such they must perhaps remain until we are better acquainted with the true significance of the minute parts or organs upon which the distinctive characters are in many cases founded. Nor at present, perhaps, are we in a position fully to appreciate the relative value of the zooecial as compared with the zooarial characters, which of late it appears to be the fashion, unduly as I think, to depreciate; the individuality of the zoarium as a continuous whole or entity having been too much overlooked in the almost exclusive consideration of its component parts or segments."

A somewhat similar standpoint has been taken up by Rev. A. M. Norman[2]), who has published a number of valuable papers on the *Bryozoa*. He expresses himself as follows: "It has been argued by recent writers that the form which a colony of a polyzoon belonging to the *Cheilostomata* assumes is of no moment in generic

[1]) 14 a.
[2]) 43, p. 122.

character. *Electra pilosa* lends strong support to this view. Yet it is a view nevertheless in which I am not prepared in all cases to acquiesce. The zooecial characters are unquestionably all important, but no lasting classification can be based on any part of the zooecium..... Why also in all instances is the ultimate growth and form of the zoarium to be excluded from generic character among certain families of the *Cheilostomata*, and at the same time to be recognized among the *Cyclostomata* and *Ctenostomata*, and even other groups of the *Cheilostomata*? This is surely scarcely consistent. In some instances, as for example in *Electra pilosa*, the form of the colony is of no generic and specific value, but in other cases it may be and, I believe, is."

In the systematic arrangement of most families of Hydroids the chief stress has not as in the earlier Bryozoan system been laid on the colonial form, but partly on the structure of the zooids partly on the different mode of reproduction, and the differences of opinion have arisen mostly from the question how great systematic importance ougth to be ascribed to the latter. The reason hereof is partly, that the zooids which are much larger and therefore much easier to examine than those of the *Bryozoa*, present a number of easily recognisable characters, f. inst. in the different form and arrangement of their tentacles, and in the different form of their proboscis and hydrothecae, partly, that the colonial form in most families does not present such differences which might tempt a systematist to the institution of genera. Such are on the contrary to be found in the *Sertulariidae*, in which the mode of arrangement of the hydrothecae together with the mode of branching is subject to very great variation, and, therefore, to a great extent has been used by the systematists. As soon as the operculum was detected and used as a systematic character there began a discussion about its systematic significance which still continues.

The first author who recognizes the systematic importance of this structure was Hincks[1]). While Grey had characterized

[1]) 22.

Sertularella by the strictly alternate position of its hydrothecae, Hincks lays the chief stress on the structure of the latter which are provided with 3—4 marginal teeth and with a similar number of opercular valves. While he has found no operculum in *Sertularia* and *Hydrallmania*, and in one of the two *Thujaria*-species named in his work, he characterizes *Diphasia* by the presence of an inner (adcauline) operculum, but as he has not seen that a quite similar operculum is also present in *Abietinaria abietina* and *Ab. filicula* he refers them to *Sertularia*. In the diagnosis of the different genera the author also uses the form of the colony and the structure of the gonothecae, but he expressly emphasizes that the whole arrangement must only be regarded as provisional:[1]) "Without the examination of a much larger number of foreign species, the genera of this family cannot be defined with certainty and precision; and the present grouping must be accepted as to some extent, provisional".

Professor G. J. Allman, who has published so many valuable works on the Hydroids, in opposition to Hincks has great confidence in the systematic importance of the colonial characters, and in one of his papers[2]) he even institutes a new family *Thujariidae*, solely based on the mode of division of the hydrocaulus into internodes. In his report on the Hydroids from the Challenger expedition he unites *Sertularella* with *Sertularia* as he has found an operculum in some species of the latter genus, and evidently cannot imagine that a generic difference might be expressed through the different form and position of something so delicate and perishable as the operculum, about the systematic significance of which he says[3]): "The valves in all these cases are so thin and perishable that it is only in recent or exceptionally well preserved specimens we can hope to meet with them, a fact which in itself deprives the distinctions, derived from them of that practical value

[1]) 22, pag. 260.
[2]) 2, pag. 267.
[3]) 5, pag. 51.

which ought if possible to be found in all well-selected systematic characters."

In my paper on the Greenland Hydroids I say about the colonial characters[1]): "A zoological system based on that kind of characters may be compared to a botanical in which the chief stress was laid on the inflorescences and not on the structure of the flowers. In both cases the genus would contain a number of heterogeneous species. It can hardly be deemed doubtful, that constant differences in the structure of the single individuals, in question of the hydrothecae or hydranths, ought to be preferred as systematic characters, and that colonial characters ought only to be used when structural diversities were not to be found."

When we compare the two categories of characters, the colonial and the zooidal, with respect to the question, which of them give us the most valuable information about the beings concerned, there can be no doubt that it is the latter which do so, as they inform us both about the structure of these beings and about the different modifications which this structure may present. The colonial characters only inform us of the form of the colony, and the different arrangement of the zooids, and in opposition to the combination of characters upon which the systematic position of the species is contingent the arrangement of the zooids may often be quite the same in species belonging to different classes. In the Bryozoan species *Gemellaria loricata* for inst. the colony as in many *Sertularia*-species is composed of pairs of zooids, each of which by a constriction is divided from the next one. If the colonial characters might be regarded as a true, though imperfect, expression of the natural affinity, it could only be on the supposition, that there always existed so close a relation between structure and colonial form that differences in the latter not only corresponded to a difference in class, but also to differences of order, family and genus. Everybody knows that this is not the case. In the vegetable kingdom we may at the one

[1]) 32, pag. 184.

side find the same form of inflorescence in different classes, ordines etc., and at the other side different inflorescences in the same family or even genus. In the *Bryozoa* we find the same unstable relation between structure and colonial form, and a great number of species may even appear in two or more different modes of growth, and with different arrangement of the zooecia. The most interesting example we possess is *Membranipora (Electra) pilosa* L. which according to A. M. Norman[1]) appears in the Trondhjem Fjord in 10 different modes of growth, a number of which were earlier regarded as the chief character of certain genera. The author says about these forms: "We see enormous changes brought about apparently at the will of individuals, who, building colonies after the various fashions characteristic of a large number of genera..... simulate the general forms of a *Membranipora*, a *Hippothoa*, a *Carbasea*, a *Flustra*, a *Cellaria*, a *Gemellaria* and an *Eucratea*. Numerous other examples are named in my work on the Cheilostomatous Bryozoa[2]).

As to the Hydroids there is no reason to believe that the arrangement of the zooids should in this division be a more true expression of the natural affinity than in the *Bryozoa*. I shall at this place only bring forward as an example the artificial genus *Selaginopsis* (Allman) Mereschkowsky, as Schneider[3]) regards it as one of the best defined genera in the family *Sertulariidae*. Nutting[4]) has given a new definition of it, according to which it only contains species of the genera *Thujaria* and *Sertularia*, but he does not mention where he will put the polyserial species of the genus *Diphasia*. According to the original definition of

[1]) 43, p. .

[2]) 35, p. 70.

[3]) „Deutlich sich aus diesem Chaos abhebend standen nur *Pasythea*... und *Hydrallmania*..... Auch *Selaginopsis* Allman kann wegen vielreihiger Anordnung der Hydrotheken an der einzelnen Sympodien nicht zweifelhaft gestellt erscheinen, obgleich Levinsen sie auf drei seiner Gattungen, *Sertularia*, *Thujaria* und *Diphasia* auftheilt (54. p. 521).

[4]) 44, p. 127.

the genus, which is followed by most authors, *Selaginopsis* is only based on the character, that the hydrothecae are arranged in more than two longitudinal series, and if an author were to institute a new genus for inst. for those species of the bryozoan genus *Caberea*, in which the zooecia present a similar arrangement, it would certainly be rejected as based on too feeble a foundation, but it would nevertheless possess this advantage over *Selaginopsis*, that its species would agree in all essential respects. Most species of the latter "genus" belong to *Thujaria*, but three must be referred to *Sertularia*, namely *Sel. mirabilis* Verr. (= *Sel. Hincksi* Mer.), *Sel. ochotensis* Mer. and *Sel. (Pericladum) bidentata* (Allm.)[1]), and two to *Diphasia*, namely *D. fusca* (Johnst.) (= *Thujaria salicornia* Allm.) and *D. Wandeli* Lev. Perhaps the same is the case with *Sel. Allmani* Norman[2]) (= *Sel. fusca* Allm.) Also *Sertularella* is represented within *Selaginopsis*, namely by *Sert. (Dictyocladium) flabellum* Nutt. and *Sert. (Dictyocladium) reticulatum* Krp., which both satisfy the claims put upon the species of this "genus", their hydrothecae being arranged in four longitudinal series, but they have by Allman[3]) been placed into another artificial genus, *Dictyocladium*, which differs from *Selaginopsis* therein that the branches are anastomosing. While the hydrothecae of all the species hitherto named are provided with opercula, no opercula are present in a number of other polyserial species, three of which have been referred to *Dictyocladium*, namely *D. dichotomum* Allm., *D. (Selaginopsis* Jäd.*) affine* (Jäd.[4]) and *D. (Selaginopsis* Jäd.*) dichotomum* (Jäd.[5]), and the same is the case with *Selaginopsis pachyclada* Jäd.[6]) and with a number of species referred to the artificial genus *Staurotheca* Allm. Allman[3]) characterized the latter genus by the possession of opposite hydrothecae which are arranged in

[1]) 2, p. 273.
[2]) 42.
[3]) 5.
[4]) 27 a, p. 32 and 59, p. 331.
[5]) 26 a, and 59, p. 332.
[6]) 27 a, p. 33.

decussating pairs, but Ritchie[1]) has enlarged it to also include species with more than four longitudinal series of hydrothecae, characterizing it by the arrangement of the hydrothecae in alternate transverse series, each containing two or three hydrothecae; but a somewhat similar arrangement is also found in a number of *Selaginopsis*-species and according to Broch[2]) we not rarely find in *Sel. mirabilis* four longitudinal series of hydrothecae in the place of six, and in that case the hydrothecae are, as in *Staurotheca dichotoma*, arranged in decussating pairs.

Even if all the species referred to *Selaginopsis* possessed a special form of operculum not found in any other genus, I should only regard the polyserial arrangement of the hydrothecae as a systematic character of lower rank, but it is evident from the above enumeration of species that there is not the slightest connection between this arrangement and the form of the operculum, and the former is as a rule not even constant within the colony, as in most species the hydrothecae are biserial in the stem, and besides, there has been found a number of species belonging to *Diphasia*, *Thujaria* and *Sertularia*, which present both biserial and triserial hydrothecae either in the same or in different branches, and sometimes in different colonies. *Diphasia Wandeli*, in the original specimen of which all the branches have three series of hydrothecae, is nearly related to *D. fallax*, and is perhaps only to be regarded as a variety of the latter species. Sæmundsson[3]) refers to *D. Wandeli* four colonies, three of which have only biserial hydrothecae while in the fourth, which possesses 17 pairs of branches, two at the one side and six at the other have only biserial hydrothecae in their proximal portion and triserial in the rest of their length. Broch[4]) has described a *Thujaria*, to which he has given no name as he is not sure of its identity. In the

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[1]) 50, p. 538.
[2]) 13, p. 173.
[3]) 56, p. 97.
[4]) 13, p. 177.

proximal part of all the branches the hydrothecae are arranged in three longitudinal series, and in one of them this arrangement is continued through its whole length while in the others the rest of the hydrothecae are biserial. In another *Thujaria*-species, described by Torrey[1]) under the name of *Sertularia incongrua* the branches in their proximal portion possess two series of hydrothecae, and usually three series in their distal half. Nutting refers this species to *Selaginopsis triserialis* Mer.; but according to Mereschkowsky the triserial arrangement of the hydrothecae is in the latter species constant through the whole colony. Lastly I shall mention that Bale[2]) in a variety of *Sertularia unguiculata* Busk has found in some of the pinnae "a third series of hydrothecae, running for some distance along the front of the first internode."

The fact that there is no constant relation between the structure of the zooids and the colonial form, or to express it in another way, that they are incommensurable values defined by different laws, must have the logical sequence that one of them cannot be substituted for the other, and, therefore, a genus ought never to be instituted solely on the base of a difference in the colonial form, when otherwise the zooids present distinct structural diversities. When that is not the case, as in the great plurality of the cyclostomatous *Bryozoa*, we have of course only the colonial form to rely upon. To regard the colonial characters as the true generic characters and the zooidal characters only as specific characters, as some authors have done, is to turn the systematic arrangement upside down. —

In 1897 Dr. C. Schneider[3]) published a paper on the Hydroid polyps from Rovigno[3]), in which, besides, he sets forth a number of systematic remarks, of which we shall here only mention those referring to the *Sertulariidae*. I may give here

[1]) 57, p. 69.
[2]) 7, p. 76.
[3]) 54.

a critical representation of his Sertularian system, and in order to make it more coherent and easier to read, I shall give most of the quotations, on which it is based, as notes. Schneider at first states [1]) that my system, which is based on diversities in the opercular apparatus, cannot in any way stand together with that of the former authors who divide the genera mainly according to the arrangement of the hydrothecae in the branches [2]). He admits that at first sight it looks seductive [3]), but though he does not seem to have subjected it to a real test, he comes to the result that the older authors are right in the main, and that such a great systematic importance cannot be ascribed to the operculum in opposition to the characters formerly used [4]). — Schneider gives three reasons why he has not been able to admit my systematic characters. The first is connected with my assertion that there exists a certain harmony between the margin of the hydrotheca and the structure of the operculum, and that we, therefore, even in colonies which have lost their opercula, may be able from the structure of the former to draw a conclusion as to the character of the latter. Schneider thinks it possible, therefore, that a great deal of my statements are only based on this form of investigation [5]), in which he evidently has no confidence. However, I

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[1]) „Levinsen begründet auf den Bau des Opercularapparats seine von der ältern durchaus abweichende Systematik. Es ist nothwendig, zu dieser sofort Stellung zu nehmen; denn, falls wir sie acceptiren müssen ist eine Besprechung der frühern systematischen Angaben überflüssig ja unmöglich" (p. 520).

[2]) „Die ältere Systematik hielt sich, wenigstens in der Hauptsache, an die Vertheilung der Hydrotheken an den Sympodien" (p. 521).

[3]) „Für den ersten Blick hat diese Eintheilung etwas Bestechendes" (p. 521).

[4]) „Indessen fragt es sich, ob wir der Deckelbeschaffenheit so hohe Bedeutung gegenüber den bis jetzt angenommenen Charakteren zuschreiben dürfen und ob letztere nicht doch wenigstens in den Hauptzügen zu Recht bestanden. Ich glaube nun, mich dieser letzteren Anschauung zuneigen zu müssen" (p. 520).

[5]) „Ueberhaupt mag Levinsen in den Auftheilungen wohl oft zu sehr der äusseren Beschaffenheit der Hydrothekenmündung, die meist doch nicht immer auf eine bestimmte Deckelbeschaffenheit schliessen lässt, Rechnung getragen haben" (p. 522).

have not used it for any of the species treated of in my paper. Schneider's second reason is due to a misunderstandig, as he namely has got the impression, that I regard the operculum of *Sertularia* as an internal structure placed under the original roof of the hydrotheca, and he cannot understand such an operculum[1]), in which I quite agree with him. I cannot, however, understand in what manner Schneider has got this impression. He declares[2]) that he only knows my investigations from the partial translation which has been given by Markthanner-Turneretscher[3]), but in this the position of the operculum in *Sertularia* is mentioned in the following way: „Die Mündung der Hydrothek ist an der abcaulinen Seite mit einer tiefen Einbuchtung versehen, in welcher das Deckel befestigt ist", and in my paper I say quite the same in Danish as well as in Latin. After having set forth the last named objection Schneider says: „Diese Bedenken lassen mich vor der Hand davon absehen, Levinsen's Gattungskaraktere als gute anzuerkennen" after which he adds: „Damit sei ihnen indessen nicht jeder Werth überhaupt bestritten." Schneider does not explain what he means by this sentence, but it seems permissible to understand his words as meaning, that the characters named may be used as species-characters.

I think that the chief reason for Schneider's different systematic standpoint from mine must be sought for in our different mode of working. While I have endeavoured to divide the genera as strictly as possible, deferring the question as to their mutual relation, till a sufficient amount of knowledge has been secured, Schneider's chief aim has been to unite and to find — as fast as possible — the unity in the multiplicity. Therefore he does not like strictly defined genera which apparently protest against this unity, and, besides, he has no time to wait, until the great bulk of the hitherto described species have been examined as to

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[1]) „Auf Grund dieser Erwägungen kann eigentlich von einem inneren Deckel nicht geredet werden" (p. 522).

[2]) 54, p. 511.

[3]) 37.

their opercula. The colonial form, in the systematic importance of which he implicitely believes, gives him in much shorter time a general view of the connection between all these forms, showing him that the different "groups" are mutually united by transitional forms, and that sharp contrasts do not exist at all. The following statement, however, seems to show that Schneider uses the term "transition" in a very singular manner[1]): „*Thujaria*, *Selaginopsis* and *Pasythea* sind durch Uebergänge vermittelt, wie schon daraus klar wird, dass Levinsen Vertreter jeder dieser drei Gruppen auf mehrere seiner Gattungen vertheilt." I cannot see the clearness of this argument. When I have shown that the species of the old genus *Selaginopsis* according to their opercular apparatus must be distributed into the genera *Thujaria*, *Sertularia* and *Diphasia*, and that other species provided with the same forms of opercula are contained within the frame of the old genus *Sertularia*, this fact does not prove, that *Selaginopsis* and *Sertularia* are connected by transitions, but only that they are artificial genera. On the other hand there are numerous transitions between the different colonial forms which have been used as generic characters, and Schneider, therefore, quite naturally comes to the result that all the *Sertulariidae* strictly speaking must be regarded as forming a single genus[1]). This he again divides into groups admitting at the same time that neither are they strictly divided. We shall later consider some of these groups. —.

While Schneider originally declared that my opercular system was quite inconsistent with one based on the arrangement of the hydrothecae, he at other places sets forth quite contrary statements, according to which we should believe, that there is the most complete agreement between the colonial form and the structure of the operculum. Thus he says[2]). „Aber wenn wir die typischsten Formen der *Sertularidae* ansehen, scheint Hand in Hand mit besondern Deckelformen auch eine besondere Anordnung

[1]) 54, p. 522.
[2]) 54, p. 522.

der Theken zu gehen. Ein kleiner Ueberblick soll dass erweisen." Further he says[1]): „Aber ein Ueberblick über die ganze Gruppe lehrt den innigsten Zusammenhang aller oft anscheinend so heterogenen Formen unter einander; von einer Gruppe zur andern vermitteln Zwischenglieder, und diese Zwischenformen vermitteln auch hinsichtlich der Form und Anheftungsweise der Deckel." However, Schneider's apparently contradictory assertions might perhaps be explained in this way, that he has found my statements regarding the structure of the different opercula incorrect, and therefore has undertaken a new investigation with another result. He says that the large collection of Hydroids in the zoological museum of Vienna, which have been identified by Marktanner-Turneretscher has been at his disposal, and there might be reason to believe that by the aid of this collection he had tested the correctness of my investigation. But he does not seem to have done such a thing, and the above assertion is directly contradicted not only by my investigations, but also by the contents of his own groups.

The central point in Schneider's system is that he regards *Sertularella* as the genus from which all the other genera have developed, but he makes no attempt to solve that question which in this connection should be the most important, namely, in what manner the different forms of opercula might have been developed from the operculum of *Sertularella*. Driesch[2]) in the *Sertularüdae* discerns between two chief colonial types, the *Diphasia*-type with opposite and the *Sertularella*-type with alternate hydrothecae, and he has tried to show that the former type may be derived from the latter. From this starting point Schneider[3]) gives the following sketch of the development of the different „groups" from *Sertularella* by means of a moving together of the hydrothecae: „Es verschwinden zunächst eine Anzahl Gelenke aus Ursache der

[1]) 54, p. 521.
[2]) 17.
[3]) 54, p. 524.

grössern Annäherung der Hydranthen; das ergiebt den *Thujaria*- und den *Dynamena*-Typus, letzterer vielleicht zum Theil direct aus dem *Sertularella*-, zum Theil aus dem *Thujaria*-Typus ableitbar. Noch grössere Annäherung führt zur Entwicklung der *Pasythea*-Gruppe, zum Theil von *Thujaria*, zum Theil von *Dynamena* aus; ferner zur *Selaginopsis*- und zur *Hydrallmania*-Gruppe, beide von *Thujaria* aus." When Schneider lets the joints disappear in order to produce the *Dynamena*-type, he forgets that according to his own definition of this type it is characterized by the possession of a joint between each two pairs of hydrothecae.

Of the six groups into which Schneider divides the *Sertulariidae* we have already regarded *Selaginopsis*, and we shall later speak about *Pasythea* and *Hydrallmania* on mentioning the systematic arrangement proposed by Professor Nutting. At this place, therefore, we have only to mention the groups *Dynamena* and *Thujaria*.

Schneider characterizes the *Dynamena*-group in the following way: „Die Hydrotheken opponirt, zwischen jedem Paar ein Gelenk; .....; Mündung der Theca meist mit zwei vorgetäuschten (Levinsen) Zähnen, Deckel einfach. — Hierher gehören: *Diphasia rosacea* L., *attenuata* Hincks, *fallax* Johnston, *pinaster* Ell. et Sol., *tamarisca* L., *pinnata* Pallas., *Sertularia pumila* L., *gracilis* Hassall, *operculata* L.; *Sertularia bispinosa* Gray, *minima* Thompson, *macrocarpa* Bale." Of the species here named *Diphasia rosacea*, *D. attenuata*, *D. fallax*, *D. pinaster* and *D. pinnata* have no teeth and an adcauline opercular valve and belong to my genus *Diphasia*, while *D. tamarisca* must be referred to *Sertularella* as it possesses a tridentate hydrotheca and three opercular valves. *Sertularia pumila*, *S. gracilis* and *S. minima* belong to my genus *Sertularia*, as the bidentate hydrothecae possess an adcauline collar and an abcauline opercular valve, while *Sertularia opercularis*, *S. bispinosa* and *S. macrocarpa* must be referred to a new genus, *Odontotheca*.

The *Thujaria*-group is characterized as follows: „Die Hydrotheken mehr oder weniger alternirend, oft fast opponiert gestellt, dicht benachbart und mehrere bis viele auf ein Internodium gehäuft; .....; Mündung der Theca meist glatt, Deckel einfach. — Hierher gehören: *Diphasia alata* Hincks, *Sertularia filicula* Ell. et Sol., *abietina* L., *argentea* Ell. et Sol., *cupressina* L., *Thujaria thuja* u. *lonchitis*; *Sertularia diffusa* Allmann, *elongata* Lmx., *tenera* Sars, *maplestonei* Bale, *huttoni*, *Diphasia mutulata* Busk, *Dynamena tubuliformis* Markt." Of the above species *Diphasia alata* and *D. mutulata*, *Sertularia filicula* and *S. abietina* belong to *Diphasia* (the two latter to the subgenus *Abietinaria*), *Sertularia argentea*, *S. cupressina*, *S. tenera* and *Dynamena tubuliformis* to *Sertularia*, *Thujaria thuja* and *Th. lonchitis* to *Thujaria* and *Sertularia maplestonei* to *Odontotheca*. An opercular apparatus has hitherto not been found in *Sert. elongata* and *S. huttoni*, both of which have the hydrothecal margin provided with 6—7 teeth, and if they possess an operculum I am most inclined to think that it consists of as many valves as there are teeth. In either case these two species cannot be referred to any of the hitherto described genera. —

Schneider[1]) after having given the above phylogenetic sketch declares, that to penetrate deeper into the phylogeny of the *Sertulariidae* the close examination of a large living material shall be necessary, especially in order to make a thorough study of the difficult opercular apparatus. I quite agree with the author on this point, but as long as he adheres to the view that the colonial characters are the true generic characters, I cannot see that the results of such a study may be of any great use to him. He concludes his phylogenetic considerations with the following wish: „So steht denn zu hoffen, dass die zukünftige Forschung wohl im Einzelnen das hier vertretene System näher ausbauen und erläuteren, nicht aber es zu Gunsten eines einzelnen diagnostischen

[1]) p. 524.

Charakters umstürzen wird; denn die Fundamente scheinen mir durch die innigsten Beziehungen zur Phylogenese als sichere erwiesen". I, on the contrary, take the liberty to express the collegial wish that the considerations and studies contained in this paper may help Dr. Schneider to change his view about the systematic significance of the colonial characters. —

Professor Kristine Bonnevie who has published several papers on Norwegian and North-Atlantic Hydroids, among which is the report on the Hydroids from the Norwegian North-Atlantic Expedition, quite agrees with Schneider in his systematic view, and in the last named work says about the systematic arrangement proposed by the present author[1]: "In this family as in *Campanulinidae* Levinsen has made a division of genera based upon the nature of the lid of the hydrotheca. But the remark that I made previously is also applicable here, namely, that the nature of the lid and of the margin of the hydrotheca, are very good specific distinguishing features, but that in basing a system upon these characters we ascribe to them too much importance." Though the author thus acknowledges the diversities found in the opercular apparatus at least as very good specific characters she does not mention the structure of the operculum in any of the species named in her work, not even in the new species described by her.

While Bonnevie gives to each species the name of the group to which it is referred, another follower of Schneider's system, Mr. H. B. Torrey[2] does not think it necessary, and, besides, as far as I understand him, thinks it an advantage not to do so. He expresses himself as follows: „Anyone who has had occasion to work among the *Sertulariidae* will admire the masterly way in which Nutting has dealt with the perplexing questions of classification in that family. I am not yet prepared, however, to abandon Schneider's plan of segregating the species into typical groups which shall take the places of genera. These groups do

[1]) 12, p. 76.
[2]) 58, p. 21.

not necessarily give their names to the species which the include. Thus they discourage the growth of synonyms, offer no awkward bars to the free passage of any species from one group to nearer relatives, and at the same time lessen the confusion which the present unsettled state of opinion regarding the relationships of existing species tends to produce." When the groups are to take the places of genera, one should believe that the generic names must be quite superfluous except as synonyms, and I am at a loss to understand in what manner this retention of them may be able to diminish the growth of synonyms or to lessen confusion of any kind, as I am much more inclined to think that this method would have quite the opposite result.

In the year 1904 Professor C. C. Nutting, Iowa, published a most valuable work on the American *Sertulariidae*, in which as a result of his systematic investigations into this family he sets forth the assertion that the characters taken from the operculum and the hydrothecal margin are insufficient in themselves to furnish a base for the classification of the *Sertulariidae*[1]), though he „thinks them most important aids in defining certain genera" and, besides, he quotes parts of an unpublished manuscript on the structure of the operculum written by Mr. J. H. Paarman[2]), according to which the representation the present author has given of the operculum in the *Sertulariidae* is incorrect. I am first to treat the latter point, and the following representation of the results to which the two authors have arrived chiefly refers to *Sertularia pumila*.

According to the named authors the hydrothecal margin is provided with two lateral teeth, between which there are stretched two quite homologous membranes of unequal size, the abcauline being considerably larger than the adcauline one. They form together the side-walls of an A-tent, the front and rear of the tent being closed by the two opposite hydrothecal teeth, and there-

[1]) 44, p. 41.
[2]) 44, pp. 20, 40.

fore, the two membranes which are both regarded as flaps meet in a straight line that would be represented by the ridge pole of the tent. When the hydranth emerges in the outer world for the first time the first cleavage takes place along this line, but it continues until there is room for the egress of the hydranth, leaving the bottom of both flaps still attached to the hydrothecal margin. Mr. Paarman's investigation seems to prove that..... "Sometimes the adcauline piece is attached while the other is free, and sometimes the reverse is true. Often the sides of a flap are attached for a greater or less distance proximally while they become free distally, the degree of attachment varying greatly in the same species. In most cases both flaps are functional". Paarman and Nutting seem to have overlooked, that in *Sertularia pumila*[1]) the adcauline wall is angularly bent from side to side and is provided between the two larger teeth with a much smaller one, which divides the adcauline sinus into two lateral halves but does not reach the free margin of the adcauline membrane stretched between the two larger teeth. This membrane which must be regarded as the distal part of the adcauline wall is of course also angularly bent, and the ridge dividing it into two lateral halves arises from the tip of the median tooth. The much larger abcauline membrane consists, as the corresponding part of a *Thujaria* and a *Diphasia*, or as one of the three or four corresponding parts of a *Sertularella*, of a proximal part, fixed in the abcauline sinus, and a distal free valvular part provided with an angularly bent margin which fits into the corresponding sinus formed by the adcauline membrane. When the hydrotheca is closed, the adcauline membrane on account of its thinness inclines a little towards the centre of the aperture, and its free margin meets that of the adcauline valve, but a perfect closing of the hydrotheca can only take place when both membranes are fixed in their corresponding sinusses to the very tips of the teeth, and this is always

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[1]) Pl. IV, fig. 14; 27, pl. 11, figs. 1—3.

the case in every undamaged hydrotheca. The one cause of Paarman's mistake is that he has regarded these opercula only from the side and not from the abcauline surface. When such a closed hydrotheca is regarded from the side we get the impression of an A-tent, as we see a straight line limiting two membranes which might be regarded as two flaps, but this line is only the one side of the free abcauline triangular valve, which on closing fits into the corresponding sinus formed by the angularly bent adcauline membrane. The other cause is that he has studied these opercula by the aid of microtomic sections, as there can be no doubt that the cutting in many cases must have in different degree loosened the connection between the fine membranes and the hydrothecal margin. Therefore he has found that the degree of attachment between the membranes and the hydrothecal margin is very different even in the same hydrotheca, but as a rule both membranes have been torn away from the hydrothecal teeth („as a rule both flaps are functional").

Though I must, therefore, maintain the correctness of my earlier investigation I am willing to admit, what I formerly denied, that the adcauline membrane may be regarded as a part of the opercular apparatus, and that the operculum of *Sertularia* therefore may be called a two-lipped operculum. For this renewed investigation I have examined fresh material taken in the Trondhjemsfiord by Mr. O. Nordgaard, and I have used the same mode of preparation as earlier, namely with a fine needle to cut off under the microscope the distal end of the hydrotheca and thereafter to examine it in different positions. Colouring matter may help to make the membranes more distinct.

After having expressed his agreement with Mr. Paarman's results Professor Nutting continues: "But there is still another and even greater objection to relying exclusively upon the characters of the margin and operculum in classifying the *Sertulariidae*, and that is that these characters are inconstant not only in some of its genera, but also in some individual species." To prove the

correctness of this assertion the author selects 8 species of the 128 treated in his work, in which the characters taken from the margin and operculum either are not found in some species of a certain genus as defined by him or in some species of two other genera show a supposed variation or inconstancy, and as a consequence hereof he prefers to use as chief characters in the limitation of most genera diversities in the arrangement of the hydrothecae or in the form of the colony, but at the same time he lays the chief stress on the opercular apparatus and the form of the hydrotheca in the diagnosis of the two genera *Diphasia* and *Abietinaria*. I intend here to undertake a critical examination of the genera proposed by Prof. Nutting, and under each genus I shall mention not only the species in which this author has thought he found inconstancy in the hydrothecal characters, but also those which to my opinion ought to be referred to another genus. —

In his work on the American *Sertulariidae* Prof. Nutting gives the following diagnosis of the genera as far as concerns the trophosomes, but as the gonosomes on the whole play a very insignificant systematic part, I have not found it necessary to refer to that part of the diagnosis concerning these structures. I shall later mention these structures in my own diagnoses of the same genera.

Sertularia (L.) Nutting.

"Hydrothecæ in strictly opposite or rarely subopposite pairs. Stem and branches normally divided into regular internodes, each of which bears a pair of hydrothecæ, but sometimes there are more than one pair to the internode, in which case the hydrothecæ are strictly opposite. Operculum normally of two flaps."

Thujaria (Flem.) Nutting.

"Hydrothecæ normally subopposite to alternate, and more than two to each internode. Internodes vary greatly in length. Hydrothecæ with smooth margin, or with one or two teeth usually more or less immersed in the hydrocaulus. Operculum of one abcauline flap, or of two flaps."

Pasythea (Lamour) Nutting.

"Hydrothecæ biserial, strictly opposite, arranged in groups of pairs, a group to an internode, the upper pair being smaller and differing in shape from the lower, margin bilabiate, with a too-flapped operculum."

Sertularella (Gray) Nutting.

"Hydrothecæ biserial, strictly alternate, usually with three or four marginal teeth and a well-marked operculum with three or four flaps. Rarely the teeth are obliterated, in which case the operculum is stretched across the hydrothecal aperture like a drumhead. Branches never regularly anastomosing to form a reticulate flabellate structure."

Dictyocladum Allm.

"Colony flabellate in form. Branches anastomosing and forming a rudely reticulate structure or network. Hydrotheca on more than two sides of the stem. Aperture without conspicuous teeth. Operculum variable."

Diphasia (Agass.) Nutting.

"Hydrothecæ biserial, opposite or alternate, aperture broad, operculum evident, of a single adcauline flap."

Abietinaria (Kirchenp.) Nutting.

"Hydrothecæ non strictly opposite, more or less bottle-shaped (the proximal portion turgid, distal portion narrowed), operculum of a single adcauline flap, margin usually without teeth.

Selaginopsis (Allm.) Nutting.

"Hydrothecæ arranged in more than two longitudinal series, at least on distal parts of branches, or in two or more series each of which has the distal ends of the hydrothecæ turned alternately to the right and left. Operculum of a single abcauline flap. Internodes long or absent."

As chief characters for the two genera *Sertularia* and *Thujaria*, to which the author only refers species with two-serial hydrothecæ, he uses both the different arrangement of the hydrothecæ and the length of the internodes. The hydrothecæ may be

opposite or alternate, but between these two conditions there is found all possible intermediate stages (strictly opposite, opposite, subopposite, subalternate, alternate, strictly alternate), and in many species a certain variation is found even within the same colony The internodes may be of very different length, bearing one to many pairs of hydrothecæ, and also in this respect many species present great variation within the colony. When the internodes are very short the hydrothecæ must of course be opposite, and the alternate hydrothecæ, therefore, must be found in longer internodes, but the latter are not rarely provided with opposite hydrothecæ (*Thujaria lichenastrum* Pall., *Th. sinuosa* Bale e. t. c,). In opposition to what is said in the diagnosis we very often in species of Nutting's *Thujaria* find internodes with a single pair of hydrothecæ, and the author f. inst. figures branches of *Th. polycarpa*, *Th. argentea* and *Th. tenera*, which bear a series of 2—4 such internodes. In *Sertularia grisea* Kirch, which is provided with internodes bearing 1—5 pairs of subopposite hydrothecæ, I have seen branches with up to 12 such internodes. According to the diagnosis of *Sertularia* there may be found in the genus subopposite hydrothecæ, but when the internodes bear more pairs of hydrothecæ the latter are said to be strictly opposite. I do not understand why they may not be subopposite, but in either case they seem to be so in a rudiment of *Sert. Challengeri* figured by the author. It is evident, that the different arrangement of the hydrothecæ cannot give us a distinct delimitation between the two genera, and if we use the different length of the internodes we meet with the same difficulty when we try to draw a boundary line; but even if it were possible by means of the above characters to divide the species into two sharply separated groups, the latter would still be artificial, if we paid no attention to the structure of the hydrothecæ and both groups contained species belonging to different natural genera.

Sertularia (L.) Nutting.

We may first regard the inconstancy in the structure of

the hydrothecal margin and the operculum which Prof. Nutting believed he found in *Sertularia desmoides* Torr., and which he mentions in the following way: "No marginal teeth as a rule, but at times the margin has two obscure teeth. Operculum usually of one flap attached to the abcauline side, others with two ill-defined flaps, and again there will be two flaps one above the other, both attached to the abcauline side." *S. desmoides*, of which Prof. Nutting has been so kind as to send me a number of specimens, is a good *Thujaria* according to my definition of the genus, though it corresponds well to his definition of *Sertularia*. It has a quite similar aperture to that found in *Th. lichenastrum* and *Th. (Pasythea) acrodon*, being provided with a freely prominent distal adcauline wall. In the specimens examined a number of hydrothecæ have been regenerated, and Prof. Nutting may have mistaken the freely prominent part of the new distal wall for an adcauline flap. The regeneration also explains the presence of two abcauline flaps one above another.

In the key to the species the author mentions that three of the species, *S. rathbuni*, *S. brevicyathus* and *S. flowersi* are provided with a small median tooth. Such a tooth, however, is also present in *S. pumila*, and according to the author's figures also in *S. mayeri*, and *S. cornicina*. *S. rathbuni* has not a three-flapped operculum; but the author has mistaken the angularly bent adcauline lip for two separate opercular valves.

S. operculata, *S. bispinosa* and *S. pulchella* belong to my new genus *Odontotheca* the definition of which is given later.

Thujaria (Flem.) Nutting.

Only four of the twenty species named in Prof. Nutting's work, namely *Th. thuja*, *Th. polycarpa*, *Th. immersa* and *Th. lonchitis* belong to my genus *Thujaria* while 10 belong to *Sertularia*, and in two of these, *Sert. tenera* and *Sert. robusta* the author seems to have found inconstancy in the structure of the hydrothecal margin and operculum. The named structures of *S. tenera* he mentions in the following way: "margin varying greatly, some-

times being round without teeth and often being curved, with two teeth of regular sertularian type. Operculum usually composed of one flap attached to the abcauline side of margin, but sometimes composed of two flaps." "This species appears to break down the generic distinctions proposed by Levinsen in that it has both a one-flapped and a two-flapped operculum in the same specimens." About the same parts of *S. robusta* he says: "operculum with two flaps on distal portion of branches, often with round margin and single abcauline flap on proximal portions."

Both in my paper on the regeneration of the Hydroids[1]) and in that on the Hydroids from Greenland[2]) I have pointed out, that in the new apertures produced by the regeneration of a hydrotheca in a *Sertularia* the contrast between the thicker and the thinner (membranous) parts of the wall often seem to be indistinct or quite lacking, and as a distinct example hereof I have named *Sertularia tenera*. As I have examined many colonies of this species without finding any other inconstancy in the parts named I am sure that the round apertures found by Prof. Nutting, must have belonged to regenerated hydrothecæ and Ritchie[3]) has come to the same result as I. Of *Sertularia robusta* I have examined a colony from Bering Sea sent to me by the National Museum of Washington. All the hydrothecae present the *Sertularia*-characters very distinctly, and when Prof. Nutting in a number of hydrothecae from proximal portions of branches has found a different form of aperture and operculum, it is no doubt due to cases of regeneration.

Nutting[4]) declares that the operculum is almost an ideal character to use in separating the genus *Diphasia*, but that he nevertheless prefers the colonial characters is seen from his reference of *Sertularia thujarioides* Clark to *Thujaria*, though it pos-

[1]) 32 a, p. 22.
[2]) 32, p. 189—190.
[3]) 53, p. 218.
[4]) 44, p. 44.

sesses an adcauline operculum and a horizontal margin, characters which have not been found in any *Thujaria*. Broch has already pointed out that it must be referred to *Diphasia*. To the latter genus I am also inclined to refer *Th. elegans* Krp. *Th. ramosissima* Allm. and *Th. plumosa* Clark belong to my new genus *Odontotheca*, and I shall later show that *T. plumulifera* Allm.[1]) belongs to the genus *Hydrallmania*. However, a fragment sent to me by Prof. Nutting under the name of *Th. plumulifera* does not belong to this species, but to a new species of the genus *Sertularia*.

Pasythea (Lamour.) Nutting.

This highly artificial genus is at present represented by three species, namely *P. qvadridentata* Ell. & Sol., *P. hexodon* Bale and *P. philippina* Markt. The first, which is a *Sertularia*, is nearly related to *S. pumila*, the second, of which I have examined a colony from Singapore, is a *Thujaria* with a similar form of aperture to that found in *Th. desmoides*, *Th. lichenastrum* and *Th. fruticosa*, and the original specimen of the third which I have had on loan from the Zoological Museum of Vienna is a young colony of *Idia pristis*. That neither the colonial characters are constant is evident from some observations made by Bale[2]) who says about specimens of *P. qvadridentata* from Bondi: "The Bondi specimens are peculiar, a considerable proportion of the internodes bearing only a single pair of calycles each; indeed some of the shoots are so arranged throughout, and thus differ in no respect from a typical *Sertularia*." Further he says about the hydrothecæ of *P. hexodon*[3]): "In most cases those on the two sides of the hydrocaulus are opposite to each other, but it is quite common to find them alternate, and the set frequently contains more on one side than the other, as three to four, or four to six.

[1]) I have examined a fragment of the original specimen, sent to me from the Museum of Comp. Zoology, Cambridge.

[2]) 8, p. 770.

[3]) 8, p. 771.

Sertularella (Gray.) Nutting.

Among the species which Nutting selects as examples showing inconstancy in the hydrothecal characters are the following three species, which he refers to the genus *Sertularella*. For each of them we shall quote that part of the author's description which refers to the hydrothecal margin and the operculum:

S. formosa Fewkes. "Aperture perfectly round and smooth. Operculum apparently wanting. Sometimes, however, it appears in the shape of a thin membrane stretched like a drumhead across the aperture."

S. Hartlaubi Nutting. "Margin perfectly smooth and even; operculum in some cases an adcauline flap; in others apparently an irregularly ruptured membrane, stretched across the aperture like a drumhead."

S. magna Nutting. "Operculum thick conspicuous, a simple membrane of a simple flap where the margin is even, with two flaps when there are two evident teeth, sometimes apparently with more than two flaps, but they are not well defined, probably because the teeth when three or four, are very low and inconspicuous. No better example could be found of the futility of basing generic distinction on the number of parts to the operculum. One branch could be placed in three different genera, were that criterion to be used."

I have not seen the two first named species, but the descriptions and the figures leave no doubt that they cannot be referred to *Sertularella*. There is not the faintest indication of marginal teeth, and the thin membrane stretched like a drumhead across the aperture is no doubt the original membranous roof of the hydrotheca, which is found in all *Thecaphora*. The author does not mention whether he has found this membrane also in old hydrothecae. It is possible that a number of *Sertularella*-species may have developed from that group, to which they belong, by a transformation of the membranous roof into a *Sertularella*-operculum, but as they themselves lack the chief-characters of

Sertularella I cannot refer them to this genus. We might with the same right refer f. inst. the inoperculate species "*Obelia*" *marginata* Allm.[1]), *Campanularia insignis* Allm.[2]) and *Camp. juncea* Allm.[3]) to *Thyroscyphus*, because they agree with the species of this genus in the form and the arrangement of the hydrothecae.

From the National Museum of Washington I have received a small fragment of the original specimen of *Sertularella magna* Nutt. It contains 12 hydrothecae, the 6 of which have the margin more or less injuried, while in the 6 others it is intact, and provided with three distinct curves, divided from each other by as many distinct teeth (pl. IV, figs. 27, 28). When regarded from above the aperture is distinctly triangular with curved sides. In none of them have I found a complete operculum, but in some of them small remnants of the opercular valves still adhere to the curves, and in a single hydrotheca two complete valves are fixed each in its curve while the third is missing. The species seems to be very fragile, but there can be no doubt that the hydrothecae when undamaged are provided with three opercular valves, and that Nutting's divergent statement must be explained as an incorrect interpretation of acccidental injuries. The hydrothecae have been regenerated 4—6 times.

Dictyocladium (Allm.) Nutting.

The latter part of Prof. Nutting's diagnosis of *Sertularella* does not mean that an operculum of three or four valves cannot be found in species which possess a flabellate colony with anastomosing branches, but only that such species are referred by the author to the artificial genus *Dictyocladium*. While *D. dichotomum* Allm. does not seem to possess an operculum the two other species referred to this genus, *D. flabellum* Nutt. and *D. reticulatum* Krp. belong to *Sertularella*. Of the latter species I have examined a fragment sent to me from the Zoological Museum of Hamburg, and

[1]) 1, pl. VI, figs. 1, 2.
[2]) 5, pl. IX.
[3]) 2, pl. 11, figs. 3, 4.

in the best preserved hydrothecæ I have found a distinctly three-toothed margin and three opercular valves.

Diphasia (Agassiz) Nutting.

Of the nine species mentioned in Nutting's work I must refer *D. corniculata* (Murray) to *Sertularia*, and *D. tamarisca*, which possesses a three-toothed hydrothecal margin and three opercular valves, to *Sertularella*.

Abietinaria (Kirchenpauer) Nutting.

Of the 16 species, which Nutting refers to this genus, I have here to mention three, namely *A. compressa* Mereschk., *A. Alexanderi* Nutt. and *A. greenei* Murray, and of the two latter species I have examined specimens sent to me by Prof. Nutting. The first-named species, which the author no doubt refers to *Abietinaria* because of the form of the hydrothecae, is according to Mereschkowsky provided with two lateral teeth, and as such are not found in any species of that genus, I cannot doubt but hat it belongs to *Sertularia*. *A. Alexanderi* is also a *Sertularia*, being provided with two lateral teeth, an angularly bent adcauline membrane, and an abcauline membrane, which ends with a free valve.

The hydrothecae of *A. greenei* are as pointed out by Nutting subject to great variation, the abcauline margin being in most of them provided with two more or less developed teeth, while a number of the proximal hydrothecae in each branch have a plain margin without teeth. The specimen examined by me seems to contain only dead hydrothecae, and I have found only a small number of opercular membranes, a few of which reached from the adcauline margin to the tips of the teeth, and, therefore, I am most inclined to refer this species to my new genus *Odontotheca*. In such hydrothecae which have no teeth the opercular membrane must be provided with a free abcauline margin, and this species therefore seems to form a connecting link between *Odontotheca* and *Abietinaria*. The hydrothecae are provided with a small internal adcauline tooth, and a similar more or less developed tooth I have

found both in a number of species belonging to the latter group and in *Odontotheca macrocarpa* Bale.

A species, which presents a still greater variation, is *Thujaria heteromorpha* Allm.[1]), which according to the author possesses two different forms of hydrothecae, some in which the margin is nearly circular and even directed away from the supporting internode, and others[2]) in which it is "directed towards the internode, and has its apocauline margin produced into a short, slightly incurved tooth." While the former are placed in the proximal part of the branches, the internodes of which carry many hydrothecæ, the latter are seated in the distal part, and here each internode bears a single pair of hydrothecæ. A further difference is that the hydrothecæ of every pair are in some internodes connate to one another, but in others separate.

Allman expresses his doubt as to the correct reference of this species to *Thujaria* in the following way: "Amid systematic characters pointing in so many different directions, it would seem difficult to decide on the true generic position of our Hydroid," and I shall hereto remark that we shall only be able to solve this question when we get information about the structure and position of the operculum, but otherwise the shape and position of the aperture in the two different forms of hydrothecæ leave little doubt that the species must belong to the genus *Diphasia*.

[1]) 4, p. 147.

[2]) According to the figures given by Allman the last named hydrothecae have quite the same form as those found in *Thujaria pharmacopola* Allm. (5, p. 66), but as pointed out by Billard (10, p. 1357) the latter species is identical with *Diphasia alata* Hincks, and the hydrothecae of this species have not the slightest likeness with Allman's picture, their abcauline margin being broadly rounded and not at all acuminate. Therefore I am not quite sure, whether the corresponding hydrothecae of *Th. heteromorpha* are correctly figured. In the same paper Billard points out that *Thecocladium flabellum* is a *Sertularella*, that *Thujaria pectinata* is identical with *Th. articulata* Pall. and *Th. vincta* with *Sertularella quadridens* Bale. Having examined myself fragments of the original specimens of the three first named species I can confirm as to them the correctness of Billard's observation.

The author further adds[1]): "The features here noted in *Thujaria polymorpha* bring to mind a phenomenon not unknown in the vegetable kingdom; as in the case of certain ephiphytical orchids, in which flowers whose differences of form are such as to have caused them to be regarded as characterizing so many distinct genera, are nevertheless found associated in one and the same plant." I do not think, however, that the last named case has induced any botanist to prefer systematic characters taken from the form of the inflorescences to those presented by the individual flowers.

Hydrallmania (Hincks) Nutting.

I shall later mention this genus to which Prof. Nutting besides *H. falcata* refers two other species, *H. distans* Nutting and *H. franciscana* (Trask).

Selaginopsis (Allm.) Nutting.

While Mereschkowsky to this genus refers all *Sertulariidæ*, the hydrothecæ of which are arranged in more than two longitudinal series, Allman excepts such species which may be referred to the artificial genera *Pericladium* Allm. and *Dictyocladium* Allm. According to the above definition Nutting only refers to *Selaginopsis* such polyserial species, which belong to my genera *Thujaria* and *Sertularia*, and of the species named in his work in either case *S. mirabilis* must be referred to *Sertularia*, but I am not sure, whether this may not be the case with some of the others, as f. inst. *S. ornata* and *S. pinnata*[2]).

Among the species which Prof. Nutting in the general part of his work selects to show the inconstancy of my systematic characters is also *S. mirabilis*, about which he says: "In *Selaginopsis mirabilis* (Verrill) there are two flaps to the operculum, while the one-flapped operculum is characteristic of the genus as a whole. I do not believe that any one would separate *S. mirabilis* and *S. cylindrica* (Clark) generically, and yet they differ in this feature upon which Levinsen bases his genera."

[1]) 4, p. 148.

[2]) I have not seen these two species.

That the genus *Selaginopsis* according to the different manner in which it is understood by different authors contains species with two, three or four different forms of opercular apparatus is to my opinion a proof that the genus is an artificial assemblage of species, belonging to different genera, and not as Nutting means a proof that my systematic characters are inconstant. But even if all the species contained in the genus were provided with the same form of opercular apparatus I should reject it as unnatural if it were based on the chief character, that the hydrothecæ are arranged in more than two longitudinal series, as I should reject a Bryozoan genus containing for inst. the *Caberea*-species provided with more than two longitudinal series of zooecia. I do not deny that *Sel. mirabilis* and *Sel. cylindrica* have a very similar habitus because of the similar arrangement of the hydrothecæ, but the outer likeness ought to have nothing to do with the systematic arrangement, and as the two species show a distinct difference in the structure of the hydrothecal margin I must put them into two different genera.

As Prof. Nutting has come to the incorrect result that the characters taken from the operculum and the hydrothecal margin are inconstant, he has in the systematic arrangement of the *Sertulariidæ* committed the same error as most authors, of laying chief stress on the colonial characters, and if his genera do not contain such a heterogeneous assemblage of species as Schneider's groups, it is only because he has paid more attention to the structure of the operculum. His best defined genera therefore, are *Abietinaria* and *Diphasia*, in which the chief character is the adcauline position of the operculum, while the colonial characters used are essentially negative.

Before proceeding to give definitions of the single genera of the *Sertulariidae* I shall set forth some considerations on the relation between the four families *Campanulariidae*, *Lafoëidae*, *Campanulinidae* and *Sertulariidae* in order to define the systematic position of the latter family.

The four families may be defined in the following manner: *Campanulariidae*: The campanulate or cup-shaped hydrothecae which not rarely present longitudinal ridges and marginal teeth are as a rule provided with a well-developed stalk, and with few exceptions (*Hypanthea, Silicularia*) show a poly-symmetrical structure. A diaphragm is always present, but sometimes only in the shape of a marginal thickening. Nematophores are never present. No operculum. [A club-shaped proboscis].

Lafoëidae: The elongate, cup-shaped, retort-shaped or tubular, short-stalked or sessil hydrothecae, which never present longitudinal ridges or marginal teeth, not rarely show a more or less pronounced bilateral symmetry, and their adcauline wall is in many cases in different extension more or less firmly connected with the stems and branches. A diaphragm may be absent or developed in different degree. Nematophores are sometimes present. No operculum. [A conical proboscis].

Campanulinidae: The more or less elongate, cup-shaped, pitcher-shaped or tubular, sessile or stalked hydrothecae, which never present longitudinal ridges or marginal teeth[1]), sometimes show a bilateral symmetry, and are rarely provided with a complete diaphragm. Nematophores are sometimes present. A differently formed operculum. [A conical proboscis].

Sertulariidae: The pitcher-shaped, retort-formed or tubular, bilaterally developed hydrothecae lack a free stalk, and the ad-

[1]) S. F Clark (16, p. 12) has described a species of *Campanulina, C. denticulata*, in the hydrothecae of which he thought he found besides an operculum of convergent segments an equal number of large castellated marginal teeth arising outside the latter. As both the marginal teeth and the operculum must have been formed as a secretion from the ectoderm we cannot understand the formation of the teeth, as the corresponding part of the ectoderm should have been placed outside the operculum. There can be no doubt but that the "castellated teeth" are only the worn segments of an old operculum. The figures 6 a and 6 b, therefore, represent two hydrothecæ, which have been regenerated three times, and the only hydrotheca (fig. 7) in which the author could "find no trace of teeth, only an operculum" is a hydrotheca which has not been regenerated.

cauline wall is as a rule in different extension firmly connected with the stems and branches. A complete diaphragm is as a rule developed. Nematophores are never present. An operculum is always present, consisting of 1—4 opercular membranes or valves fixed in corresponding sinuations of the margin. [A conical proboscis].

Of the characters named in the above diagnosis I have put that which concerns the form of the proboscis in parenthesis, as I have only been able to verify it myself in rather few forms, the proboscis being a structure, the form of which can only be examined with advantage in well-preserved material. I am not sure, therefore, that it really presents so sharp contrasts that the *Campanulariidae* by the aid of the above named character can be sharply divided from the three other related families. According to Allman[1]) and Hincks[2]) we have to discern between two forms of proboscis, a "conical", present in the large majority of the Hydroid families, and a "trumpet-shaped" which has only been found in the *Eudendriidae* and the *Campanulariidae*. While Hincks in the diagnosis of the latter family calls the proboscis "trumpet-shaped", in the diagnosis of the genus "*Campanularia*" he speaks about a "cup-shaped" proboscis, and as these two terms therefore must be synonymous, it is evident that Hincks when he uses the expression "trumpet-shaped" especially thinks of the expanded end of a trumpet. The two latter terms, however, are very unlucky and misleading, as every proboscis in its expanded state is "cup-shaped" or "trumpet-shaped", while at the other side the proboscis of *Eudendrium*, *Campanularia* and *Laomedea* is "club-shaped" or bulbiform, not only according to my own examination of well-preserved material, but also according to figures given by Allman and Hincks. In well-preserved specimens of *Sertularella tricuspidata* and *Halecium muricatum*, lately brought home from Greenland, I have found that the expanded proboscis is "cup-shaped" while it is conical in its contracted state, and when Hartlaub[3]) in his work on *Sertularella* says about the proboscis of this genus: "Die

[1]) 1 a. [2]) 22. [3]) 19, p. 12.

Proboscis der Hydranthen ist nach vortrefflich conservierten Exemplaren zu urtheilen nicht conisch sondern wie bei den *Campanulariden* trompetenförmig," I cannot doubt that he here speaks about the expanded proboscis. Besides in the monograph of Hincks, we find figures of the contracted campanularian proboscis also in a paper of Pictet[1]), in which he figures a number of *Clytia*-species, the proboscis of which he designates as "hypostome en trompette", but according to the figures it is club-shaped, and the same form shows the proboscis of *Hebella lata* Pictet, the hydrothecae of which are much more campanulate than in most members of the family *Campanulariidae*.

According to the systematic arrangement expressed in the above diagnosis, all the operculate forms have been referred to the two families, the *Campanulinidae* and the *Sertulariidae*, and all the inoperculate to the *Lafoëidae* and the *Campanulariidae*. While the presence of an operculum sharply divides the operculate from the inoperculate families, the two families contained in each of the two groups are not sharply divided from each other by a single character, if we do not possess such a difference between the *Campanulariidae* and the *Lafoëidae* in the form of the proboscis. Broch[2]) and Kramp[3]) believe they find such a distinguishing character in the different appearance of the gonothecae, which according to these authors in the *Lafoëidae* always present themselves united into more or less densely crowded aggregates ("Coppinia", "Scapus"), while in the *Campanulariidae* they appear singly. But in both families there are a number of exceptions to this rule. In the *Lafoëidae* large singly placed gonothecae have been found in *Lafoëa (Halisiphonia) megalotheca* Allm.[4]); *Hebella calcarata* Ag.[5]) and *H. cylindrica* v. Lend.[6]), and by the present author in

[1]) 46.
[2]) 13, p.
[3]) 30, p. 370—71.
[4]) 5.
[5]) 6 a, p. 122, figs. 190—191.
[6]) 46. p. 41, pl. II, fig. 36.

H. contorta Markt.[1]) (Pl. V, figs. 16, 17) and *Lafoëa venusta* Allm.[2]). Such large singly placed gonothecae have also been found in two species of the genus *Cryptolaria*, namely in *Cr. abyssicola* Allm.[3]) and *Cr. diffusa* Allm.[3]), while two other species, *Cr. longitheca* Allm.[4]) and *Cr. conferta* Allm.[3]) have a Coppinia. Nutting[5]), however, ascribes to the whole genus *Cryptolaria* "a compact Coppinia" mass much as in *Lafoëa*", and the reason hereof is the following. Pictet and Bedot[6]) have found in *Perisiphonia pectinata* a Coppinia surrounding a portion of the stem and, besides, two small singly placed gonothecae, seated each in the proximal part of an adjacent branch. As Nutting[7]) and Broch[8]) have found that the Coppiniæ, examined by them, contain gonothecae of both sexes, Bedot suggests that the single gonothecae found in the named *Perisiphonia* may represent a different sex from those in the Coppinia, and Nutting, therefore, no doubt, compares the single gonothecae found in the above *Cryptolaria*-species with those found in the *Perisiphonia*, and thinks that a coppinia may appear later. I do not think, however, that Bedot is right in his supposition. It is a well-known fact that a Coppinia may often

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[1]) 36. Pictet (46) regards *Hebella cylindrata* Markt., *H. contorta* Markt., and *H. scandens* Bale as identical with *H. cylindrica* v. Lend., and Billard thinks that the same is the case with *H. calcarata* Ag., but be adds the following remark: "Comme Pictet le fait justement remarquer on ne pourra être complètement fixé sur l'identité de toutes ces formes que lorsqu'on aura trouvé et comparé leurs gonosomes" (11, p. 17). The gonothecae of *H. contorta* seem to be very different from those of *H. calcarata* and *H. cylindrica*, figured by Agassiz and Pictet. Their (Pl. V, figs. 16, 17) distal end is divided into 4—6 triangular areas, which no doubt correspond to as many opercular valves. The gonothecae of *H. scandens* Bale (8, pl. XIII, fig. 18) seem to show a similar structure.

[2]) 3.

[3]) 5.

[4]) 15 a.

[5]) 45, p. 946.

[6]) 47, p. 21, pl. V.

[7]) 45 a.

[8]) 13, p. 155.

extend from a stem over more adjacent branches, and, therefore, I cannot doubt but that we have to do in the named case with the beginning of such an extension. In opposition to the numerous small gonothecae of the Coppinia, which take their rise from the peripheral tubes, the few large elongate sacs in the named *Cryptolaria*-species spring from the axial tube, and it is not reasonable to suppose, that in these species the gonothecae of the two different sexes should develop in two so very different manners.

While in the true "Coppinia" the gonothecae are mutually coalesced, the "scapus" is only a collection of more or less densely crowded, but mutually not connected gonothecae. But quite similar, more or less dense aggregates of gonothecae are also found in other families, f. inst. in species of the campanularian genus *Silicularia (= Hypanthea)*[1]), in *Campanularia integra* and in a number of *Halecium*-species, f. inst. in *Hal. muricatum*, in *Hal. groenlandicum* Kramp[2]), and in a new species from Japan, which differs from the last named species therein, that the hydrothecae are perfectly adnate. In the two latter species the gonothecae are borne together with a number of hydrothecae by a large, spongy, richly branched, free meshwork formed by a number of peripheral tubes.

To the *Lafoëidae* I refer besides the genera *Lafoëa (Halisiphonia)*, *Hebella*, *Grammaria*, *Cryptolaria*, *Perisiphonia*, *(Zygophylax*, *Brucella)* and *Lictorella* also the species referred to *Synthecium*, *Hypopyxis*, *Staurotheca*, and the inoperculate species referred to *Dictyocladium*, *Selaginopsis*, *Sertularia* and *Sertularella*. Also Schneider refers *Synthecium* to the *Lafoëidae* though from other reasons than I, but Hartlaub[3]), who earlier followed Schneider in this question, has altered his opinion, because he has found that the species of the latter genus are provided with a blind sack, a structure which he regards as characteristic of

[1]) 5, p. 26.
[2]) 30.
[3]) 21, p. 670.

the *Sertulariidae*. But Hartlaub[1]) has also found a blind sack in the campanularian genus *Silicularia*, and I have found it in *Lictorella pinnata* Sars. It is also found in the operculate species described as *Zygophylax operculata* Jäd. (Pl. IV, fig. 21) and *Zyg. grandis* Vanh.[2]), and I cannot doubt but that it is also present as well in the inoperculate species related to them as in the other species of the genus *Lictorella*. The presence of the blind sack in the named cases, therefore, seems to be contingent upon the more or less pronounced bilateral symmetry.

v. Campenhausen who also refers *Grammaria* to the *Sertulariidae* says about my reference of *Synthecium* and the other above named forms to the *Lafoëidae*[3]): „Abgesehen aber davon dass die erwähnten Formen so typisch alle übrigen Sertularien-charactere bezitzen ausser diesen einen .,.... und mir ..... eine Trennung nur auf ein Merkmal hin willkürlich vorkommt, scheint mir das Vorhandensein oder der Mangel eines Operculums durchaus nicht von so einschneidender Bedeutung zu sein." As v. Campenhausen does not seem to ascribe systematic significance to the arrangement of the hydrothecæ, the typical sertularian characters, about which he speaks, must be the bilateral symmetrical structure of the hydrothecae, and the more or less extensive connection between their adcauline wall and the corresponding axial structures[4]). As to the first named character there is no contrast between the named forms and the other *Lafoëidae*, as most members of this family and especially of its freely branched forms show a more or less distinct bilateral symmetry, which is found not only in species with sessile or adnate hydrothecae, but sometimes also in such species the hydrothecæ of which are provided with free stalks.

[1]) 19, p. 12, note.
[2]) 59, p. 315.
[3]) 14 a, p. 301.
[4]) Jf v. Campenhausen regards the presence of a well-developed diaphragm as a specific sertularian character, I may here point out that the diaphragm is quite lacking or imperfectly developed in a number of *Sertularella*-species.

We find f. inst. that the hydrothecae of *Lafoëa fruticosa* and *L. gracillima* show a distinct adcauline convexity. As to the other sertularian characters the genera *Perisiphonia*, *Cryptolaria* and *Grammaria* have their hydrothecae adnate to the hydrocaulus in a larger or smaller part of their adcauline wall, and in the two last named genera this connection is as in the *Sertulariidae* inseparable, while in *Perisiphonia* it can be loosened by the aid of reagents. As, therefore, the above named forms cannot by a single character be divided from the *Lafoëidae*, I, on the contrary, find it arbitrary to refer them to the *Sertulariidae*, and at the same time there can be no doubt, but that the latter family gains in firmness and coherence by only embracing operculate forms.

In animals of so simple a structure as the Hydroid polyps we can only expect to find a few distinguishing marks between the systematic divisions, and most families and genera are only divided from each other by one or two characters. The two chief divisions, the *Athecata* and the *Thecaphora* are only divided from each other by the presence in the latter of more or less developed protective cases for the hydrants and the gonophores, and it seems reasonable to ascribe systematic significance also to the operculum, a structure, which must be regarded as the complement of the protective cases and, so to speak, as the end-result of the same effort, which has led to the formation of the hydrothecae and gonothecae. We may further point out as an evidence of its systematic importance, that it has that in common with other structures of systematic significance that it presents a rich development of characteristic modifications which give excellent generic characters.

We may now regard the relation between the *Lafoëidae* and the *Campanulinidae*. If we compare the two above family diagnoses we shall find that the two families are only sharply divided by a single character, namely the presence or absence of an operculum, all the other characters being more or less relative, and, therefore, there can be no doubt, that they are very nearly related

as already pointed out by Broch.[1]) He especially points out the near relation between *Toichopoma obliquum* and *Lafoëa*, and not only refers the former genus to the *Lafoëidae*, but is most inclined to refer the named operculate species to the genus *Lafoëa*, and when he provisionally uses the name *Toichopoma* it is only because the gonothecae of this species were at that time unknown. Kramp[2]) has later found that it possesses a "coppinia", but while he like Broch refers it to the *Lafoëidae*, he at the same time maintains that the presence of an operculum entitles this species to represent a proper genus. In a later paper Broch[3]) unites the *Campanulinidae* with the *Lafoëidae* and again divides the latter family into two sub-families, the *Grammariina*, in which the gonothecae are united into aggregates and the *Campanulinina*, in which that is not the case. From the reason given above I cannot accept this division.

The connection between the *Campanulinidae* and the *Lafoëidae* must no doubt be expressed in this way, that the *Campanulinidae* have arisen from the *Lafoëidae*, and this transformation has taken place in such a manner, that different members of the latter family have developed an operculum.[4]) Broch[5]) has pointed out the great likeness between *Toichopoma obliquum* and *Lafoëa gracillima*, but *Calycella syringa* and *Tetrapoma quadridentatum* present a similar likeness to such *Lafoëa* species as *L. pocillum* and *L. pygmaea*. At the other side the species of the genus *Cuspidella* seem to stand in a similar relation to the species of the genus *Filellum*, in which we find two different forms of sessile hydrothecae, some,

[1]) 13, p. 159.
[2]) 30, p. 375.
[3]) 14, p.
[4]) As I do not believe in a sharp division between the *Lafoëidae* and the *Campanulariidae*, I think it likely that also a number of species of the latter family have developed an operculum, and we have no doubt two such examples in *„Campanularia" marginata* Bale (7, p. 54) and *„Camp." macrocyttara* (Bale (7, p. 56), the wide cup-shaped hydrothecae of which have a four-toothed margin, and, therefore, no doubt, possess a *Thyroscyphus*-operculum. The double margin in the hydrothecae of the former species is no doubt due to a regeneration.
[5]) 13, p. 159.

the proximal half of which is adnate, and others which are cylindrical and erect. The first form of hydrothecae is represented in *Cuspidella procumbens* Kramp, and the second in such species as *C. humilis* and *C. costata*. The genus *Zygophylax* (*Perisiphonia*) which is provided with cylindrical nematothecae has given its contingent of operculate forms in the two species, *Z. operculata* Jäderh.[1]) and *Z. grandis* Vanh.,[2]) for which I must propose a new genus *Abietinella*, and *Oplorhiza parvula* Allm.,[3]) in which we find stalked, globular nematothecae stands in a similar relation to „*Campanularia*" *armata* Pict & Bed.[4]) as the above new genus to the species of *Zygophylax*. The genus *Lafoëina* [5]) which possesses a similar form of operculum as *Cuspidella* and *Oplorhiza* only differs from the latter genus in the possession of very long vermiform nematothecae. The long slender, sometimes tubuliform hydrothecae of the genus *Stegopoma* leave no doubt as to the near connection of the latter genus with the *Lafoëidae*, and the different modes of growth of the different species show distinctly how little systematic significance we ought to ascribe to the colonial form. The operculum of this genus is very characteristic, consisting of two plaited membranes, fixed each in a curve, formed by the hydrothecal margin, and thus divided by two triangular hydrothecal teeth. When we find such an operculum in a number of species, presenting a different habit of growth, it is to my opinion more reasonable to think that they belong to the same natural genus, and that the different forms of growth have been produced by the influence of outer circumstances, than to divide these species according to the different colonial form, and to suppose that the same form of operculum may have arisen independently more than once. The latter standpoint has been taken by Prof. Nutting[6]) who has described three new

[1]) 26, p. 376.
[2]) 59, p. 315.
[3]) 3, p. 14.
[4]) 47, p. 9.
[5]) 32.
[6]) 45, p. 943.

species of *Stegopoma*, but at the same time he refers a species provided with the same form of operculum to the genus *Cryptolaria*. However, he thinks it likely that a separate genus should be instituted for this species and for *Cryptolaria geniculata* Allm., which possesses a similar form of operculum. As a consequence of this standpoint Nutting mentions the genus *Stegopoma* as follows: "This genus ..... seems to me to be practically convenient whether a natural one or not." We meet in this genus with three different forms of growth. While *St.* (*Crypt.*) *operculata* Nutt. and *St.* (*Crypt.*) *geniculata* Allm. have a fascicled stem with an axial tube, *St. plicatile* and *St. gilberti* Nutt. possess a fascicled stem, in which all the tubes bear hydrothecae, and *St. fastigiatum* a creeping stem. The gonothecae are of two different forms which seem to be independent of the colonial form. In two species with a creeping stem, described by Nutting, we find sessile gonothecae of a similar form as the hydrothecae, and the same is the case in *St. gilberti*, while in *St. plicatile* and *St. geniculatum* the gonothecae are elongate sacs without an operculum.

Schneider[1]) thinks that the operculum of *Campanulina* (and *Operculariella*) must be derived from the hydrothecal teeth of certain *Campanulariidae*, which by attaining a sufficient length and thinness have been able to collapse and cover the hydranth after its retraction, but this is a more theoretical consideration, not sustained by any fact, and it may have been called forth by a comparion for inst. of the figures given by Hincks of *Gonothyraea gracilis* and *Campanulina turrita*, as the hydrothecal teeth in the former figure are very much like the segments of the operculum in the latter. But in *G. gracilis* as in all other dentate *Campanulariidae* the hydrothecal teeth are divided from each other by interstices which have once been filled by membranous parts, and these have been thrown off together with the hydrothecal roof. On the contrary in *Cuspidella*, *Lafoëina* and *Oplorhiza* as in *Campanulina* and *Operculariella* the operculum is formed by a continuous

[1]) 54, p. 512.

belt representing the upper part of the side-walls after the roof has been thrown off, and the only difference between the operculum in the three former genera and that of the two latter is that in *Campanulina* and *Opercularella* it has been cleft in a number of segments, which, however, together represent the whole belt. These segments are really not triangular, but about rectangular or tongue-shaped, and only seem to be triangular because they cover each others' margins. Besides, the proboscis of *Campanulina* and *Opercularella* is according to Hincks conical and not claviform as in the *Campanulariidae*, and on the whole there can be no doubt but that the two genera must be derived from the *Lafoëidae*.

The species of the genus *Thyroscyphus*[1]) remind us, both in the form of their short-stalked hydrothecae and in the structure of the colony, of such inoperculate species as „*Obelia*" *marginata* Allm.,[1]) „*Campanularia*" *insignis* Allm.,[2]) „*Campanularia*" *juncea* Allm.[3]) and „*Campanularia*" *rufa* Bale,[4]) all of which possess more or less elongate, somewhat bilaterally symmetrical hydrothecae. The form of the proboscis is not known in any of these species, but in *Th. simplex* I have found a conical proboscis, and the same form of proboscis has also been found by Ritchie in *Thyroscyphus simplex* Lmx. (non = *Th. simplex* Allm.), for which he has instituted the genus *Parascyphus*. The latter species is distinctly bilaterally symmetrical and provided with a blind sack, and Ritchie, therefore, refers it to the *Sertulariidae*, but as the hydrothecae have a short stalk I prefer to refer it to the *Campanulinidae*. It is, however, doubtful whether this species is sufficiently different from the species of *Thyroscyphus* to represent a proper genus. The tripartite operculum is not a sufficient, distinguishing character, and also the other species of *Thyroscyphus* present a more or less developed bilateral symmetry. Perhaps they also possess a blind sack.

A comparison between the different opercula found in the

[1]) 3.
[2]) 5.
[3]) 2.
[4]) 7.

Campanulinidae shows that we have to discern between 6 different types, and in two of these the operculum is formed of the whole hydrothecal roof. This is the case with the univalvular adcauline operculum of *Abietinella*, and with the three- or four-valvular operculum in *Thyroscyphus*, and *Tetropoma*.[1]) A third type is represented by the operculum of *Calycella*, which, as shown by Kramp,[2]) is formed of the peripheral part of the roof, while in the three last types it is formed of a smaller or larger distal part of the side-wall after the roof has been thrown off. In *Toichopoma* it is formed by an infolding of the side-wall at the one side, while in *Cuspidella*, *Lafoëina*, *Oplorhiza*, *Campanulina* and *Opercularella* it is formed of the whole distal part of the side-wall. The sixth type is represented by the operculum of *Stegopoma* about which we have already spoken. The difference between the named forms of opercula is really so great, that there can scarcely be any doubt but that they have developed independently, and I shall here point out the significant phenomenon that a number of different forms independently and in different manner have developed a protecting roof to the hydrotheca.

I have already given my reasons why I must regard the presence of an operculum as a family character, and I shall lastly add that if we were to refer all these operculate forms to the *Lafoëidae* we should also be obliged to refer the *Sertulariidae* to the latter family.

A comparison between the diagnoses given above of the two operculate families, the *Campanulinidae* and the *Sertulariidae*, shows that they are very nearly related, and the most significant characters, which distinguish the members of the latter family, are that they are always bilaterally developed, always sessile, and as a rule have a larger or smaller part of the adcauline wall coalesced with the corresponding stem or branch. Further in all the *Sertulariidae*

[1]) This genus must, no doubt, be united with *Thyroscyphus*.
[2]) 30, p. 380.

the whole roof of the hydrotheca is transformed into the operculum while this within the *Campanulinidae* is only found in *Tetrapoma*, *Thyroscyphus* (with *Parascyphus*) and *Abietinella* n. g.

The interesting species for which I have found it necessary to institute the last named new genus has been described by Jäderholm [1]) under the name of *Zygophylax operculata*. Like a number of nearly related species, referred to the genera *Zygophylax*, *Perisiphonia*, *Brucella* [2]) and *Lictorella*, it possesses short-stalked, bilaterally symmetrical hydrothecae, at their base provided with one or two nematothecae, and the colony consists of an axial tube, which bears at least the great plurality of the hydrothecae, and a number of peripheral tubes. The hydranth is provided with a blind sack, which no doubt is found also in the other related species, but in opposition to the latter the hydrothecae possess quite a similar adcauline operculum to that found in the genera *Diphasia* and *Abietinaria*, being at the same time of a similar form as in the latter genus, and especially presenting a similar neck-shaped narrowing at the adcauline side. In opposition to *Zygophylax* (*Brucella*) *armata* Ritchie, the diaphragm of which is perforated by a large round opening, the diaphragm-opening of *Abietinella operculata* (pl. IV, fig. 22 a) has a similar form to that found in a number of *Abietinaria* species (pl. IV, fig. 22 b), being pear-shaped and surrounded by a projecting margin. If the proximal half of such a hydrotheca were to coalesce with the branch we should find in continuation of the line, indicating the concrescence between the hydrothecal wall and the corresponding wall of the branch, another line running downwards from the adcauline end of the diaphragma and indicating the corresponding concrescence between the stalk and the branch. Such a line, which I shall call the „stalk-mark", we find more or less developed in all the species of *Diphasia* (pl. IV, fig. 26) and *Abietinaria* (pl. IV, fig. 24), and it is distinct evidence that these species must be derived from forms, which have

[1]) 25, p. 276, Taf. 12 figs. 7—8.
[2]) 50.

been provided with a free stalk. Another species *Zygophylax grandis* Vanh., which must be referred to the same genus, has later been described by Vanhöffen.[1]) Though *Abietinaria* lacks both peripheral tubes and nematothecae the agreement between the species of this group and those of *Abietinella* in the form of the hydrothecae and the structure of the operculum is so great, that I cannot doubt but that the former genus must be derived from the latter. The presence and the development of the nematothecae in the nearly related species, referred to *Zygophylax*, *Perisiphonia* and *Lictorella*, is subject to very great variation, and the same holds good for the composition of the colony, not only in the same form-group, where the peripheral tubes have a very different extension, but also in a number of genera belonging to the *Campanulinidae* and *Sertulariidae*. I have already spoken of the differences in the form of the colony within the genus *Stegopoma*, and I shall still only mention that while the stem in the *Sertulariidae* is monosiphonic, as a rule, a small number of *Sertularella*-species possess a polysiphonic stem. The gonothecae have not yet been found in any of the two *Abietinella*-species, but it is permissible to suppose that they are arranged in the form of a Coppinia, as this arrangement has been found in the related species *Perisiphonia conferta*, *Zygophylax* (*Brucella*) *armata* and in a new species of *Zygophylax* from the Philippine Islands. As the presence of a Coppinia in a freely growing colony seems to be contingent upon the presence of peripheral tubes, the disappearance of the latter might explain the quite different arrangement of the gonothecae in *Abietinaria*, where they as in the great plurality of the *Sertulariidae* are placed in the neighbourhood of the single hydrothecae.

The short-stalked *Thyroscyphus*-species *Th.* (*Parascyphus*) *simplex* Lmx.[2]) *Th. Torresi Busk* (= *Th. simplex* Allm.[3]) and *Th. vitiensis* Markt.[4]) stand in a similar relation to *Sertularella* as

[1]) 50.
[2]) 58, p. 158.
[3]) 5.
[4]) 36, p. 210 and 9, p. 343.

Abietinella to *Abietinaria* and *Diphasia*. They only differ from species of that genus in their hydrothecae being short-stalked, and, therefore, a concretion between the stalk and the corresponding axis would convert them into *Sertulareila*-species.

There has not yet been found operculate short-stalked species, corresponding to the other genera of the *Sertulariidae*, but that such forms have existed is evident from the fact, that a more or less developed stalk-mark is present in most species belonging to this family[1]) When a branch is regarded from one of the sides, this mark as a rule appears as a narrow chitinous process forming a continuation of the inner hydrothecal wall and running either downwards or obliquely inwards, but when we regard a hydrotheca from its inner, adcauline wall we see the whole stalk-mark (Pl. IV, figs. 25, 27) which is provided with a curved or sometimes angularly bent proximal margin, and, therefore, its middle part is much shorter than the two lateral margins seen from the sides of the branch. Sometimes, however, we may also be able to see the whole stalk-mark, when a branch is regarded from the outer surface, f. inst. in *Hydrallmania falcata*. (Pl. V, fig. 7.) In some species, f. inst. in *Sertularia pumila*, *Odontotheca trispinosa* and *Abietinaria Coei* the stalk-mark when regarded from the side has the form of a short coecum-like projection, and in that case the stalk must have been provided with an adcauline concavity, which has prevented it from coalescing with the branch in its whole length. In the two former species it is evident already from an outer inspection that this projection contains an inner cavity (Pl. IV, figs. 13, 15, Pl, V, figs. 11, 14), the presence of which is confirmed by means of a sagittal section through a hy-

[1]) While many authors have seen and figured the stalk-mark I have only found it mentioned by Clarke (15a) and Ritchie (51). Clarke who has seen it in *Sertularia complexa* describes it in the following way:...: »chitinous processes extend downwards from the base of each hydrotheca, surrounding an aperture through which the body of the polypite is connected with the cœnosarc of the stem.« Ritchie who has seen it in *Sertularia heterodonta* and *S. rathbuni* mentions it in the latter species as »two chitinous processes which project downwards and lie alongside the wall of the internode.«

drotheca. It is however completely closed outwardly. Also in *A. coei* (Pl. IV, fig. 23) a number of the corresponding projections contain a distinct inner cavity, but in most of them it seems to be completely filled by a chitinous secretion.

According to the investigations contained in this paper I must maintain that the *Campanulinidae* have developed from the *Lafoëidae* or partly from the *Campanulariidae*, and that the *Sertulariidae* must be derived from that group of the *Campanulinidae* in which the whole roof of the hydrotheca has been transformed into an operculum.

Thujaria (Fleming) Lev.

The aperture is vertical or obliquely ascending and provided with an abcauline sinus, in which is fixed an opercular membrane, the distal part of which is a free valve.

The gonothecae of the species hitherto examined are smooth without transverse rings and without spines.

In most biserial species the hydrothecae are almost symmetrical, being only in a very slight degree turned towards the frontal face[1]) of the colony.

Of this genus I have examined the following species: *Th. thuja* (L.) *Th. lonchitis* (Ellis & Sol.), *Th. articulata* (Pall.), *Th. lichenastrum* (Pall.), *Th. annulata* Krp., *Th. carica* Lev., *Th. polycarpa* Pöpp., *Th. variabilis* Markt., *Th. cedrina* (L.), *Th. cupressoides* (Lepech.), *Th. sinuosa* Bale, *Th. tuba* (Bale), *Th. desmoides* (Torr.), *Th. hexodon* (Bale), *Th. juncea* (Vanh.), *Th. Hartlaubi* (Nutt.), *Th. Hincksi* (Mer.), *Th. pinnata* (Mer.), *Th. cylindrica* (Clark.).

Sertularia (L.) Lev.

Dynamena (Lamour.)

The aperture is oblique and provided with two lateral teeth, between which there are found a deeper abcauline and a lower

[1]) »Frontal» we call that face of the colony on which the gonothecae are placed.

adcauline sinus, the latter of which is in most cases divided into two lateral halves by means of a median projection. In each sinus is fixed an opercular membrane, the abcauline of which is in most species provided with a free distal valvular portion.

The gonothecae present a very different habitus, being either smooth, ringed or provided with two or more spines.

In most biserial species the apertnre is distinctly turned towards the frontal surface.

In the large plnrality of the species the adcauline sinus is divided into two lateral halves by means of a more or less developed median projection. In all such cases the adcauline membrane is at the same time more or less distinctly angularly bent from side to side, the ridge of the membrane rising from the median projection. In all such cases the abcauline membrane is provided with a free, triangular, valvular portion, fitting into the angle formed by the adcauline membrane, and the length of this portion depends on the development of the median projection and the size of the angle in such a manner, that a more developed median projection gives a smaller angle and a longer valvular portion. In such species as f. inst. *S. argentea* L, S. *mirabilis* (Verr.) and *S. Birulae* Schydl.[1]) the median projection and the angular bending of the adcauline membrane are only feebly developed while they are well-developed in *S. pumila* and in all such species, in which the hydrothecae of each pair are contignous on the frontal side of the colony. Snch species are f. inst. *S. Versluysi* Nutt. e. t. c. A still larger development is attained in *S. tubuliformis* (Markt.[2]) in which species the median projection has the same length as the lateral teeth, and the adcauline membrane is at least of the same size as the abcauline. When a closed hydrotheca of such a species is regarded from the side, the ridge of the adcauline membrane forms an obtuse angle with the adcauline wall, and when regarded from the frontal surface its opercnlar apparatus might seem to be composed of three valves, two adcauline and an

[1]) 55.
[2]) 36.

abcauline. In such a manner the opercular apparatus of *S. Rathbuni* has been interpreted by Nutting[1]) and Ritchie[2]), and that of *S. heterodonta* by the latter author[2]), but the supposed two distal valves are really only the two halves of the angularly bent adcauline membrane.

I have already pointed out that Nutting regards the opercular apparatus in *Sertularia* as "shaped like the side walls of an "A" tent, the front and rear of the tent being closed by the two opposite hydrothecal teeth", and as a typical example he describes the development and structure of the operculum in *S. pumila*. At the same time, however, Nutting's figures of *S. cornicina*, *S. Mayeri*, *S. brevicyathus* and *S. flowersi* distinctly show that the operculum in these species cannot be constructed in the above manner, the aperture being provided with an adcauline median projection and an angularly bent adcauline wall In such of the author's figures which present the hydrothecae regarded from the side, as f. inst. those of *S. Pourtalesi*[1]) and *S. exigua*[1]), only the one lateral half of the angularly bent adcauline membrane is seen. I have seen, however, a few species, in which the operculum is constructed in the manner described by Nutting, and that is the case in *S. Suensoni* n. sp. (pl. IV, figs. 16—20), *S. grisea* Krp. (= *S. similis* Clark), and in that form which Marktanner-Turneretscher[3]) has described under the name *S. diffusa* Allm., var. To judge from the figure given by the author *Sertularia (Sertularella) Clarki* Mer. seems to have a similar operculum. In these species the adcauline sinus has no median projection, the adcauline membrane is not angularly bent, and both opercular membranes, which have an almost straight free edge, form with each other an acute angle. An adcauline median projection and an angular bending of the adcauline wall we also lack in *S. Nuttingi* n. sp. (pl. IV, figs. 1—4) in which the bottom of the sinus is convex and the adcauline membrane very short. The same

[1]) 44.
[2]) 51.
[3]) 36.

is the case in the nearly related species *S. intermedia* (pl. IV, figs. 7—10) in which, however, the lateral teeth are less developed, and the adcauline membrane only indistinctly defined from the rest of the adcauline wall. I must regard both species as intermediate forms between *Thujaria* and *Sertularia*, and I cannot doubt but that the latter genus has developed from the former by a transformation of the distal part of the adcauline wall.

Sertularia Suensoni n. sp.

(pl. IV, figs. 16—20).

The colony, the height of which is 67 mm, has a thin, but rather rigid geniculate stem, which increases in thickness towards the tip, and is divided into distinct internodes, each of which bears a branch. The branches, which rise from the stem at an angle of about 70°, present a spiral arrangement, the sixth being placed over the first. They are regularly and richly dichotomously branched, each being divided 7 times, and, therefore, they form a very dense tuft, which in the colony examined takes up the distal half, the branches in the proximal half being only represented by a few proximal internodes. The internodes of the branches bear 5—13 hydrothecae.

The hydrothecae, the length of which is c. 0,5 mm, are alternate or subalternate, provided with a short free, obliquely ascending, not outwardly curved distal end, and divided from each other by interspaces which increase in length towards the end of the branches, where they may attain the length of a hydrotheca. The aperture, which is turned a little towards the frontal surface of the colony and is provided with two large, triangular lateral teeth, has a concave adcauline sinus without a median projection, and the adcauline membrane, which is not angularly bent and slopes a little outwards has an almost straight free edge, which meets the corresponding edge of the abcauline membrane at an angle of c. 50°. In opposition to what is found in the large plurality of *Sertularia*-species the abcauline membrane, therefore, has no free valvular

portion, and the egress of the hydranth takes place only through the fissure between the edges of the two membranes. In this species, therefore, the opercular apparatus is formed as the walls of an "A" tent.

A single colony was taken at lat. 42° N, long. 130° 30′ E. by Capt. E. Suenson. Depth 60 fathoms.

This species is nearly related to *S. Fabricii* Lev. which also lacks a median adcauline projection, but in the latter species the adcauline membrane is not sloping outwards, and being, besides, slightly convex from side to side the abcauline membrane is provided with a feebly developed free valvular portion.

Sertularia decipiens n. sp.

(Pl. IV, figs. 11, 12).

The colonies, the largest of which attains a height of 22 mm, are singly pinnate with alternate branches, and the stem is divided into regular internodes, each of which as a rule bears a single branch. An exception is found in the lowermost branchiferous internode which always bears two opposite or subopposite branches, and in a small number of the colonies examined the same is the case with still another internode, in a single colony even with two. While the furrows dividing the single internodes from each other are as a rule sloping very little towards the frontal surface of the colony, those bounding the proximal end of the internodes with two branches are very different from the others, being very long and deep and the two lateral halves of each forming with each other two acute angles of about 35°—40°, a distal on the dorsal and a proximal on the frontal surface of the colony. The lowermost non-branchiferous portion of the colony has the length of 3—4 internodes, and as a rule is not divided into distinct internodes, but in a small number of the colonies the distal end presents 1—2 short internodes, the proximal end of which is bounded by similar characteristic furrows as those above mentioned. The branches, of which the largest colonies bear 8—9 on each side,

are divided into internodes of different length, each bearing 1—4 pairs of opposite hydrothecae, and as a rule the internodes of the proximal half of the branch have a larger number of hydrothecae than those of the distal half, in which, therefore, most of the short internodes are found.

The hydrothecae, which are placed on the frontal side of the colony, are adnate to the stem and the branches with a portion of their adcauline wall which rarely attains the half length of the latter. Besides, the hydrothecae of each pair are contiguous in the two thirds of their length and the single pairs of hydrothecae belonging to the same internode are connected with each other in such a way, that a larger part of the adcauline wall of a proximal hydrotheca is adnate to a smaller part of the abcauline wall of a distal hydrotheca. They are elongately vase-shaped, and their free distal ends are turned obliquely outwards, those belonging to each pair of hydrothecae forming with each other an angle of c. 70°. The aperture is twice as broad as high and provided both with well-developed lateral teeth and with a well-developed median projection, which divides the adcauline sinus into two lateral halves. There is found a well-developed, outwards sloping, angularly bent adcauline membrane.

Each branchiferous internode of the stem is provided with a pair of subopposite hydrothecae, which in the proximal part of the stem are divided from each other by an interstice, the breadth of which gradually decreases distally according to the decreasing breadth of stem, and at last they coalesce with each other in a similar way as in the branches. Sometimes this coalescence may take place already in the fourth internode, sometimes not before the seventh. Besides there is found a single hydrotheca distally to each branch. In most colonies more or less of the proximal stem internodes have lost their hydrothecae which, however, have left distinct traces of their presence.

Of this species I have seen 70 colonies which rise from an interlacing stolonic network, fixed to a worm-tube. Paumben (India). Depth 1 fathom. (C. Fristedt).

Both the form of the hydrothecae and their unilateral arrangement give to this species a great outer resemblance to *Hydrallmania falcata*.

Sertularia Nuttingi n. sp.

(Pl. IV, figs. 1—4).

The colonies, the largest of which has a height of 117 mm, have a thin slender stem, which is as a rule only indistinctly divided into internodes, but in some of them the internodes of the distal part are rather distinct and each provided with 3 branches. In the youngest colony, which has a height of 50 mm. and is provided with 15 pairs of alternate branches, the stem has very distinct internodes which are provided with 4—8 branches. We can discern in the colony between a proximal, somewhat longer part, in which the branches are simple and alternate, and a distal part, the branches of which are composite and spirally arranged, the sixth being placed over the first. The latter branches are provided on each side with 1—3 alternate branchlets, a few of which may rarely be bifurcate. The branches diminish in length towards the end of the branch, and as they have their ends lying in the same circle-segment these branches look as if they were flabellate. The simple branches and the longest branchlets are only divided into two, rarely three internodes.

The hydrothecae, which are alternate, show some difference in the proximal and in the distal portion of the colony, being in the former wholly adnate and provided with an almost vertical or very little ascending abcauline wall, while in the latter they have a very short, free distal end and a distinctly ascending abcauline wall. While further the single hydrothecae in the former are nearly approximate, they are in the latter divided from each other by an interstice which may attain the half length of the hydrotheca. The above differences, however, are not equally large in all colonies, and, besides, there may be found some difference also between the hydrothecae in the proximal and those in the

distal part of the branches. The aperture, which is turned a little outwards and frontally, is provided with two well-developed roundedly triangular lateral teeth and lacks an adcauline median projection. The bottom of the adcauline sinus is convex, and the short adcauline membrane is convex from side to side.

The gonothecae are pyriform, smooth, and the short annular aperture is surrounded by 6—8 short spines.

Of this species I have seen 8 colonies from Japan (33° 10′ N. 129° 18′ E.), depth 33 fath. (Schönau).

Sertularia intermedia n. sp.

(Pl. IV, figs. 7—10).

The colony, which has a height of 95 mm. is provided with a thin slender stem, presenting a number of indistinct internodes with 6—12 branches. It is divided into a proximal half with simple alternate branches, and a distal half, the branches of which are spirally arranged and composite, each being provided on each side with 3—5 branchlets, which gradually decrease in length towards the tip, and, therefore, these branches give the impression of being flabelliform.

The hydrothecae which are alternate and divided from each other by an interstice, which may attain the length of a half hydrotheca, are in the whole length of the colony provided with a distinctly obliquely ascending and gracefully outwards curved abcauline wall, and with a rather short free distal end. The aperture which is turned directly towards the margin of the colony, is provided with two broadly rounded, but low lateral teeth, and with a convex or indistinctly angularly bent adcauline wall, the membranous portion of which is very low and indistinctly defined.

The gonotheeae are pyriform, and the short ring-shaped aperture is surrounded by 6—8 short spines. Besides the above described mature colony there are found two small (height 32—

40 mm) pinnate ones, provided with 12—15 pairs of alternate branches.

From the Korea-Strait (Capt. E. Suenson). Depth 50 fath.

Hydrallmania (Hincks) Lev.

The aperture is provided with two lateral teeth between which are found a deeper adcauline and a much lower abcauline sinus, which is not divided by a median projection. The opercular apparatus is formed by a much larger adcauline and a small abcauline membrane, the former of which is provided with a free valvular portion (Pl. V, figs. 1—7).

I have already pointed out[1]) that the characters on which Hincks has instituted the genus *Hydrallmania* are only of specific value, and, therefore, the question if the genus has a right to stand depends on whether the aperture and the opercular apparatus present sufficiently great differences from those found in the other genera. The above diagnosis shows that the aperture may be regarded as an inverse *Sertularia*-aperture, and, therefore, there may be set forth reasons both pro and contra the independence of the above genus, which, for the present I propose to keep. Besides the three species, *H. falcata* L., *H. distans* Nutt.[2]) and *H. fransiscana* Trask[2]), all of which have their bases placed in the same longitudinal belt and only differ from each other in minor details regarding the form and mutual position of the hydrothecae, I must to this genus still refer the species which Allman has described as *Thujaria plumulifera*.

Hydrallmania plumulifera (Allman).

Thujaria plumulifera Allman, Memoirs Mus. Comp. Zoology Vol. V, No. 2, Cambridge 1877, p. 27, pl. XVII, figs. 3—6.
— — Jäderholm, Bihang till K. Svenska Vetensk. Akadem. Handl. B. 21, Afd. IV, No. 6, 1896, p. 12, Taf. II, fig. 4.

[1]) 33.
[2]) 44.

non *Thujaria plumulifera* Nutting, The Sertularidae, p. 67, pl. IX, figs. 9—13.

(Pl. V, figs. 1—6).

The colony is provided with an extremely thin and slender stem, divided into distinct internodes, each of which bears a branch, but while a number of the proximal branches are alternate, simple, and rather short (length 8—10 mm), the rest of the branches, which are borne by very long internodes, are spirally arranged, much longer (19—30 mm) and each provided with 4—7 pairs of alternate branchlets. Their axes are like the main-stem divided into distinct internodes, a few of which may be without branchlets.

The hydrothecae, which are provided with a convex adcauline and a somewhat concave abcauline lateral margin, are turned outwards and more or less frontally, but in opposition to what is the case in *H. falcata* (Pl. V, fig. 8) not only their distal ends, but also their bases are in the single branchlets arranged into two distinct longitudinal series, and the single hydrothecae of a branchlet either do not touch each other at all or only in a very small degree, a small proximal and adcauline portion of a distal hydrotheca being in connection with or covered by a proximal one. For the rest they are very like those of *H. falcata*, and their distal fourth is freely projecting.

The distance between the hydrothecae of the two series as also their direction varies according to their place in the branchlet, in such a way that the more proximally the hydrothecae are placed the greater is the distance between the two series, and the less distinct is the frontal turning of the hydrothecae. A corresponding difference is also contingent upon the more or less proximal or distal position of the branchlet in the branch, and of the branch in the stem, and, therefore, the distance between the two series of hydrothecae attains its maximum in the proximal part of the proximal branches, and here the frontal turn of the hydrothecae is almost imperceptible. A line dividing one of these branchlets into two lateral halves, in the distal end only cuts off a small

adcauline portion of the diaphragms. Each branchlet is divided into 3—6 internodes, each of which bears 3—10 hydrothecae, the number of the latter in each internode decreasing as a rule towards the distal end. In the stem as also in the axes of the composite branches the hydrothecae are arranged into two well-divided longitudinal series, but while the internodes of the proximal portion of the stem bear 3 hydrothecae those of the distal portion are only provided each with a single one, placed at the origin of the branch. The axial internodes of the composite branches bear 3—6 hydrothecae.

The gonothecae, of which I have seen a few borne by the stems and by the proximal part of a number of branchlets, are elongate, smooth, from the middle decreasing in thickness towards both ends, the distal of which is somewhat tubiform.

Georgia from off the mouth of the river Savannah. Depth 4 fathoms.

I have examined two incomplete colonies sent me from the Zoological Museum of Upsala[1]).

Allman's short and incomplete description as also his accompanying figures agree very well with the present species, and the only disagreement is that according to Allman "the hydrothecae are adnate for nearly their whole length", but this difference may very well be the result of variation. The author especially points out that "*Thujaria plumulifera* has a good deal of the habit of *Hydrallmania falcata*." On the other side Nutting's species, of which he has sent me some fragments, is not identical with Allman's. It is a *Sertularia*, the hydrothecae of which are provided with a rather long, free distal portion and have the adcauline sinus feebly divided into two lateral halves. In opposition to what is the case in *H. plumulifera* there is no spiral arrangement of the branches, and the internodes which are not sharply divided from each other and each of which bears a branch, are of very unequal length, each bearing 3—15 hydrothecae.

[1]) I have later received a fragment of the original specimen from the Museum of Comp. Zoology, Cambridge.

I propose to name this species, the examined fragments of which are from the Albatross' station 2015, **Sertularia extensa** n. sp.

In some young colonies of *H. falcata* from Hellebaek, Denmark, which have a length of 29 mm I have also found a proximal portion with shorter internodes and provided with 8—13 pairs of rather short alternate branches, but these internodes differ from the corresponding in *H. plumulifera* therein, that they are only provided each with an axillary hydrotheca. In the youngest of these colonies the distal portion, which bears a few rudimentary branches, has a length of 10 mm.

To the present genus may perhaps still be referred *Sertularella limbata* Allm. [1]).

Odontotheca n. g. [2]).

The aperture is provided with two strongly developed, sometimes unequal abcauline teeth, between which there are found a much larger and deeper adcauline and a much smaller abcauline sinus. In each sinus is fixed a thin opercular membrane, which ends in a straight edge, and, therefore, lacks a free valvular portion. In a few cases there is found a median adcauline tooth, and in such species (f. inst. in *O. trispinosa* Cought) the adcauline membrane is angularly bent, and the abcauline provided with a free valvular portion. The gonothecae have a very variable habitus, being either smooth, ringed or provided with two spines.

To this genus I must refer the following species: *Sertularia operculata* L. (22.), *S. aperta* Allm. (4.), *S. minima* d'Arcy Th. (4.), *S. unilateralis* Allm. (4.), *S. crinis* Allm. (4.), *S. crinoidea* Allm. (4.), *S. megalocarpa* Allm. (4.), *S. bispinosa* Gray (7.), *S. Maplestonei* Bale (7.), *S. macrocarpa* Bale (7.), *S. pulchella* d'Arcy Th. (7.), *S. bidens* Bale (7.), *S. trispinosa* Cought (7.), *Sertularella trochocarpa* Allm. (4.), *Sert. episcopus* Allm. (2.), *Sert. rectitheca* Ritchie (50.), *Thujaria ramosissima* Allm. (4.), *Th. plumosa* Clark (44.) and *Abietinaria greenei* (Clark) (44.).

[1]) 4. [2]) Pl. V, figs. 8—15.

I have only been able to examine the opercular apparatus of *Sert. operculata* (Pl. V, figs. 8—10) and *Sert. trispinosa* (Pl. V, figs. 11—15), but the form of the aperture in the above species leaves no doubt that they must be referred to the same genus. In *Thujaria bidens* Allm. (2.) the aperture seems to be an inverted *Odontotheca*-aperture, and this species must, therefore, no doubt, be referred to a new genus.

Diphasia (Agassiz) Lev.

The aperture, which is horizontal or very little oblique, has no teeth and is provided with an adcauline sinus in which is fixed an opercular membrane with a large free opercular valve.

The above genus not only comprises most species referred to *Diphasia* but also those belonging to *Abietinaria* Kirchenpauer, a genus based solely on the form of the hydrothecae which have been characterized by the author in the following manner: „es sind flachenförmige, bauchige, mit ihrer Basis angewachsene Behälter, deren nach aussen gerichtete Öffnung das Ende eines engen, mehr oder weniger langen, nach einer Seite geliegenen Halses bildet." Nutting who accepts *Abietinaria* as an independent genus next to *Diphasia* characterizes it not only by the form of its hydrothecae ("more or less bottle-shaped'[1]) and gonothecae, but also by the presence of an adcauline operculum, while Broch[2]) proposes to divide the genus *Diphasia* into two subgenera. *Eudiphasia* and *Abietinaria*. As both the form of the hydrothecae and the structure of the gonothecae are subject to great variation, and the same forms of hydrothecae and of gonothecae are found in a number of different genera, I cannot regard *Abietinaria* as a distinct genus, and I think that we may, at least provisionally, accept Broch's proposition to divide *Diphasia* into two subgenera or groups.

[1]) 28.
[2]) 13.

Group **Eudiphasia** (Broch).

The hydrothecae increase in breadth towards the distal end, and attain their largest breadth at the aperture. The gonothecae are always provided with a number of projections (leaves, spines), of different form and size, either placed in the distal end or spread over a larger portion of the gonotheca.

To this group belong the following species: *D. rosacea* (L.) (22.), *D. attenuata* Hincks (22.), *D. fallax* (Johnst.) (22.), *D. Wandeli* Lev. (32), *D. pinaster* (Ell.-Sol.) (22.), *D. pinnata* (Pall.) (22.), *D. alata* Hincks (= *Thuj. pharmacopola* Allm.) (22.), *D. paarmani* Nutt. (44.), *D. palmata* Nutt. (45.), *D. tropica* Nutt. (44.), *D. bipinnata* Allm. (4.), *D. scalariformis* Kirkp. (29.), *D. mutulata* (Busk) (7.), *D. digitalis* (Busk) (7.) = *Desmoscyphus acanthocarpus* Allm. (5.) and possibly *Thuj. heteromorpha* Allm. (4.).

Group **Abietinaria** Kirchenp.

The hydrothecae decrease in breadth towards the distal end, and the breadth of the aperture is smaller — as a rule much smaller — than the largest breadth of the hydrotheca. The gonothecae are smooth or ringed, and rarely provided with two spines.

Besides the 10 species, referred by Kirchenpauer to his genus *Abietinaria*, I also refer the following species to this group: *A. coei* Nutt. (44.), *A. Traski* Torr. (44.), *A. amphora* Nutt. (44.), *A. gracilis* Nutt. (44.), *A. costata* Nutt. (44.), *A. annulata* (Krp.) (44.), *A. turgida* (Clark) (44.), *A. gigantea* (Clark) (44), *Diphasia Kincaidi* Nutt. (44.), ? *D. pulchra* Nutt. (44.), (= *Dynamena unilateralis* Bonnevie (12, p. 78), *Thuj. thujarioides* (Clark) Nutt. (44.) and *Sertularia* (*Selaginopsis*) *fusca* Johnst. (= *Th. salicornia* Allm.) (1.). Lastly I shall set forth some few remarks on the structure and synonymy of a number of the above species.

In a number of them I have found an internal, median, adcauline tooth-shaped projection of different form and size, which is placed a little proximally to the free edge, and only seems to be present in such forms in which there is a well-developed ad-

cauline collar-like narrowing. This projection has been found in *A. Tilesi*, *A. melo*, *A. costata*, *A. juniperus*, *A. filicula*, *A. coei*, (Pl. IV, fig. 22), *A. gracilis* and in those forms which Kirchenpauer has designated as *A. abietina*, var. *minor*, *A. abietina*, var. *purpurea* and *A. filicula*, var. *tornata*.

In *A. Traski* the diaphragm is on each side provided with a triangular, pointed, ascending portion.

Thujaria salicornia Allman,[1]) which, as far as I know, has not been mentioned since it was described, is identical with *Sert. fusca* Johnst., and the reason why this fact has not been earlier detected is, no doubt, that the hydrothecae look very different in the figures given by Hincks and in those given by Allman. The pinna figured by Hincks is namely seen from one of the broad sides, while the two pinnae figured by Allman are seen from one of the narrow sides.

Broch regards *Diphasia pulchra* Nutt. as a synonym to *Thuj. thujarioides* (Clark), and the two forms, which have quite similar gonothecae, are no doubt nearly related, but a comparison between specimens of both has led me to the result, that they must be regarded as distinct species. I shall here only point out that in *A. pulchra* the very short free distal portion of the hydrothecae, which is provided with an adcauline collar-like narrowing, is only by a very narrow interspace divided from the adjacent portion of the branch, while in *A. thujarioides* the much longer distal portion has no narrowing and is divided from the stem by a rather broad and deep sinus.

The abcauline wall of *Diph. digitalis* (Busk) presents a feebly developed membranous collar, and, therefore, the aperture is provided with two feeble lateral teeth.

Sertularella (Gray) Hincks.

The aperture is provided with 3—4 marginal teeth, between which are found as many curves. In each curve is fixed an opercular membrane provided with a large free, valvular portion.

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[1]) 1, p.

In the large plurality of species the gonothecae are ringed, and with the exception of a single species (*S. tamarisca*) the hydrothecae are regularly alternate.

As in most genera the form and direction of the hydrothecae are subject to great variation, but in opposition to what is found in more or fewer species of all the other genera, the turning of the hydrothecae towards the frontal surface of the colony is never so strong that the hydrothecae of the two opposite series come in contact with each other, and this cannot be regarded as a consequence of the alternate arrangement of the hydrothecae, as such a coalescence is found both in *Hydrallmania* and in *Idia*, the hydrothecae of which are alternate.

In opposition to what is found in all other genera with many species the arrangement of the hydrothecae is exceptionally constant, opposite hydrothecae having hitherto only been found in *S. tamarisca.*

In respect to the extent in which the hydrothecae are adnate to the respective axis *Sertularella* is the only genus, in which a number of species have their hydrothecae only affixed by their bases (*S. quadrata* Nutt., *S. catena* Allm., *S. cylindritheca* Allm., *S. magna* Nutt.), and, besides, in a large number of species the adcauline wall of the hydrothecae is only adnate in its proximal third or fourth (f. inst. in *S. areyi* Nutt., *S. amphoriformis* Nutt., *S. fusiformis* Hincks, *S. tricuspidata* (Alder) e. t. c.), a condition which outside the genus *Sertularella* has only been found in a few species of the subgenus *Abietinaria.* Only in a few species (*S. lata* Bale, *S. distans* Allm., *S. albida* Krp.) are the hydrothecae adnate in their whole length.

Corresponding primitive conditions are also presented by some species in the structure of the diaphragma, and by others in the composition of the colony.

While all other members of the family seem to possess a complete diaphragma perforated by a narrow abcauline, pearshaped or ovate opening, the diaphragma in a number of *Sertularella*-species

is more or less incomplete, and in *S. lata* (Bale) and *S. distans* Allm. it is quite absent, being only represented by the somewhat thickened proximal edge of the adcauline hydrothecal wall. In *S. magna* Nutt. and *S.* (*Thecocladium*) *flabellum* Allm. it is only developed as a narrow adcauline belt, while in *S. qvadrata* Nutt. and *S. cylindritheca* Allm. a corresponding belt is found in the whole circumference of the hydrotheca. It is broader in the dorsal than in the frontal surface of the colony, and, in the old hydrothecae of the stem I have found it closed with the exception of a round or pear-shaped opening. In a number of species I have found the diaphragma perforated by an unusually large rounded opening, for inst. in *S. pinnata* Clark, *S. tricuspidata* Alder, *S. fruticolosa* Til., *S. Tilesii* Krp., und *S. infracta* Krp. A large ovate opening is found in *S. tamarisca.*

While a fascicled stem is so common a feature in the *Lafoëidae*, the *Campanulariidae* and the *Campanulinidae*, it very rarely occurs in the *Sertulariidae* outside the genus *Sertularella*, namely in *Diphasia alata* Hincks. "*Thujaria*" *diaphana* Allm., *Thujaria bidens* and *Sertularella cuneata* Allm.; but it has been found in the following *Sertularella*-species: *S. gayi* (Lmx.), *S. megastoma* Nutt., *S. catena* Allm., *S. pinnigera* Hartl., *S. tropica* Nutt., *S. pluma* Krp., *S. arborea* Krp., *S. crassicaulis* Heller. *S. antarctica* Hartl. *S. annulata* Allm. and *S. crassipes* Allm.

Short-stalked hydrothecae have been found in the creeping *Sert.* (*Calamphora*) *parvula* Allm.,[1]) and in a form which Hartlaub has provisionally designated as *Sert. tenella* (?).[2]) I think the hydrothecae of the latter are much more like those of *Sert. Areyi* Nutt.[3]).

The above facts, therefore, seem to show that *Sertularella* is the most primitive genus in the family *Sertulariidae.* Lastly, we must still mention that though the large plurality of the gonothecae in *Sertularella* are ringed, the two other forms, which have been

[1]) 5.
[2]) 19, p. 64, pl. V, fig. 24.
[3]) 44, p. 83.

found in most genera, namely, the smooth and the spinous ones are also represented in this genus. Hartlaub names five species, in which the gonothecae are smooth while spinous gonothecae have only been found in *S. quadrata* Nutt., *S. turgida* (Trask) and *S. tamarisca*.

As the large plurality of the *Sertularella*-species are provided with a stalk-mark, there can be no doubt that they have developed from stalked forms, and as the hydrothecae in the genus *Thyroscyphus* are provided both with a stalk and with a *Sertularella*-operculum, it is permissible to suppose that a large number of these ancestral forms have been short-stalked *Thyroscyphus*-species. I have found the gonothecae of *Th. ramosus* Allm. and *Th. Torresi* Busk, in which two species they are indistinctly ringed, and therefore they present no difficulty to such a supposition. Neither does the diaphragma, which is developed as a marginal thickening in the whole circumference of the hydrotheca and, therefore, corresponds to the thickened marginal portion of the diaphragma found in most *Sertularella*-species. But such species as *S. lata* (Bale), *S. distans* Allm., *S. magna* Nutt. and *S. flabellum* (Allm.), in which the diaphragma is either quite absent or only represented by a narrow adcauline belt cannot have developed from *Thyroscyphus*, and the same, no doubt, holds good also for the earlier mentioned group of species, the cylindrical hydrothecae of which are free in their whole length, but quite lack a stalk-mark. To *Sertularella* have also been referred a small number of species provided with free cylindrical hydrothecae, but without an operculum, namely "*Sertularella*" *integritheca* Allm., "*Sertularella*" *formosa* Fewkes and "*Sertularella*" *Hartlaubi* Nutt. In "*S.*" *integritheca*, the only one of the three species, which I have been able to examine, the diaphragma has a somewhat similar structure as in "*S.*" *cylindritheca*, and I am inclined to think, that the same is the case, with the two other species. I cannot refer the three species to *Sertularella* as they lack the chief character of this genus, but it is possible that the *cylindritheca* group may have developed from the

integritheca group by the transformation of the hydrothecal roof into an operculum. In either case I cannot doubt but that *Sertularella* is a polyphyletic genus.

Idia Lamouroux.

(Pl. V, figs. 18—22).

The obliquely ascending aperture is surrounded by two very thin lips, which are bordered on each side by a small tooth, and are provided with a very much convex free margin. While the presence of an abcauline opercular membrane is only faintly indicated on each side by the bounding of the lateral tooth, there is found a large, well-defined adcauline sinus, which is divided into two lateral halves by a well-developed median tooth, and the adcauline opercular membrane, which is provided with a median fold and with a free valvular portion, is in opposition to the abcauline lip very movable.

In the only species hitherto known the two series of subalternate hydrothecae are with the exception of the outwards bent distal ends, in the pinnules (but not in the stems) aduate to each other along the frontal surface of the colony. The gonothecae are urn-shaped, and with the exception of the short broad aperture their surface is divided into a number of longitudinal belts.

In the structure of the hydrothecal margin and the opercular apparatus this genus presents the greatest likeness to *Hydrallmania*, but it differs from this genus in the possession of a median adcauline tooth, and therein that an abcauline opercular membrane is only faintly indicated by the abcauline bounding of the lateral teeth.

Also in the possession of subalternate hydrothecae, and in the more or less extensive coalescence, which takes place between the two opposite series, the species of *Hydrallmania* show likeness to *Idia pristis*.

Allman[1]) who has misunderstood both the structure of the

[1]) 5.

opercular apparatus, and the composition of the colony has referred the genus *Idia* not only to an independent family, but also to a new section *Thalamophora*. A correct description of the colony has been given by Bale[2]), and Billard[3]) has pointed out the presence of an adcauline operculum.

Plate IV.

Fig. 1. *Sertularia Nuttingi* n. sp. Hydrothecae from the distal portion of the colony. Frontal surface. × 57.

— 2. The same species. Distal portion of the colony. Dorsal surface. × 47.

— 3. The same species. The distal end of a hydrotheca, seen from the frontal surface. × 66.

— 4. A gonotheca of the same species. × 34.

— 5. The distal end of a hydrotheca of *Sert. Fabricii* Lev., seen from its frontal surface. × 47.

— 6. The distal end of the same hydrotheca, seen from the side. × 47.

— 7. *Sertularia intermedia* n. sp. Hydrothecae from the distal portion of a colony. × 34.

— 8. The same species. The distal end of a hydrotheca, seen from its frontal surface. × 66.

— 9. The same species. The one side-half of the distal end of a hydrotheca, extended. × 66.

— 10. A gonotheca of the same species. × 34.

— 11. *Sertularia decipiens* n. sp. A portion of a branch, seen from the side. × 20.

— 12. The same species. A portion of a branch. Front view. × 20.

— 13. *Sertularia pumila* L. A pair of hydrothecae showing distinct stalks, and distally to each of them a translucent inner cavity. Trondhjem-fiord. × 34.

— 14. The same species. Frontal view of the end of a hydrotheca × 66.

— 15. The same species. Longitudinal section through a portion of a hydrotheca showing the stalk and the inner cavity between the latter and the hydrotheca. × 47.

— 16. *Sertularia Suensoni* n. sp. A portion of a branch. Front view. × 34.

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[2]) 7.

[3]) 9.

Fig. 17. The distal end of a hydrotheca from the abcauline surface. × 66.
— 18. The distal end of a hydrotheca from the adcauline surface. × 66.
— 19. The distal end of a hydrotheca showing the "A"-tent, formed by the two opercular membranes.
— 20. The "A"-tent seen from above. × 66.
— 21. *Abietinella operculata* (Jäd.). × 34.
— 22 a. The diaphragm of the same species. × 66.
— 22 b. The opening of the diaphragm in *Abietinaria Traski*. × 66.
— 23. A hydrotheca of *Abietinaria coci* Nutt. showing the stalk-mark and the adcauline internal tooth. × 34.
— 24. A hydrotheca of *Abiet. abietina* L. showing the stalk-mark. × 20.
— 25. Two hydrothecae of *Abiet. variabilis* after their abcauline projecting portion has been cut away. Distally is seen the boundary line of the adcauline hydrothecal wall, and proximally the diaphragm, the aperture of which is surrounded by a projecting margin, and the stalk-mark. × 20.
— 26. A hydrotheca of *Diphasia pinaster* L, with stalk-mark. × 20.
— 27. A hydrotheca of the same species after its abcauline projecting portion has been cut away. Proximally are seen the stalk-mark and the diaphragm.
— 28—29. *Sertularella magna* Nutt. The distal end of a hydrotheca seen from the opposite sides. × 66.

Plate V.

Fig. 1. *Hydrallmania plumulifera* Allm. A portion of a proximal branch. Dorsal view. The hydrothecae, which show distinct stalk-marks, have been regenerated. × 34.
— 2. The same species. A portion of a distal branch. Frontal view. × 34.
— 3. The same species. A portion of a distal branch. Lateral view. Distinct stalk-marks. × 34.
— 4. The distal end of a hydrothecae, seen from the abcauline surface. × 66.
— 5. The distal end of a hydrotheca, seen from the side. × 66.
— 6. The distal end of a hydrotheca, seen from the adcauline surface. × 66.
— 7. *Hydrallmania falcata* (L,). A portion of a branch. Lateral view. Distinct stalk-marks. × 34.
— 8. *Odontotheca operculata* (L.). A portion of a branch. Frontal view. Distinct stalk-marks. × 34.
— 9. The same species. The Distal end of a hydrotheca, seen from the abcauline surface. × 66.
— 10. The distal end of a hydrotheca, seen from the adcauline surface and partly from above. The translucent abcauline sinus is seen. × 66.

Fig. 11. *Odontotheca trispinosa* Cought. A pair of hydrothecae, seen from the frontal surface of the branch. The stalk-mark shows a translucent inner cavity. × 47.

— 12—13. The same species. The distal end of a hydrotheca, seen in two slightly different positions, but mainly from the adcauline surface and partly from above. In fig. 13 is seen the translucent abcauline sinus. The line springing from the adcauline tooth indicates the ridge of the angularly bent adcauline membrane. × 66.

— 14. An optical longitudinal section of a hydrotheca showing the inner cavity of the stalk-mark. × 75.

— 15. The same species. A hydrotheca seen from the abcauline surface. Distally is seen the abcauline opercular membrane. For the rest compare with Pl. IV, fig. 24. × 47.

— 16. A gonotheca of *Hebella contorta* Markt. × 34.

— 17. The same gonotheca seen from the distal end. × 34.

— 18. *Idia pristis* Lmx. A portion of a branch seen from the frontal surface. Near to the distal end of each hydrotheca is seen the fold of the adcauline opercular membrane (also seen in the other figures). × 34.

— 19. The same species. Dorsal view. Distinct stalk-marks. × 34.

— 20. The same species. A somewhat oblique longitudinal section, which has cut away the distal ends of the one series of hydrothecae. Distinct stalk-marks. × 34.

— 21. The same species. The distal end of a hydrotheca, seen from the adcauline surface. × 66.

— 22. The same, seen from the abcauline surface. The presence of a special abcauline opercular membrane is only faintly indicated. The adcauline sinus with its median projection is seen through the thin wall. × 66.

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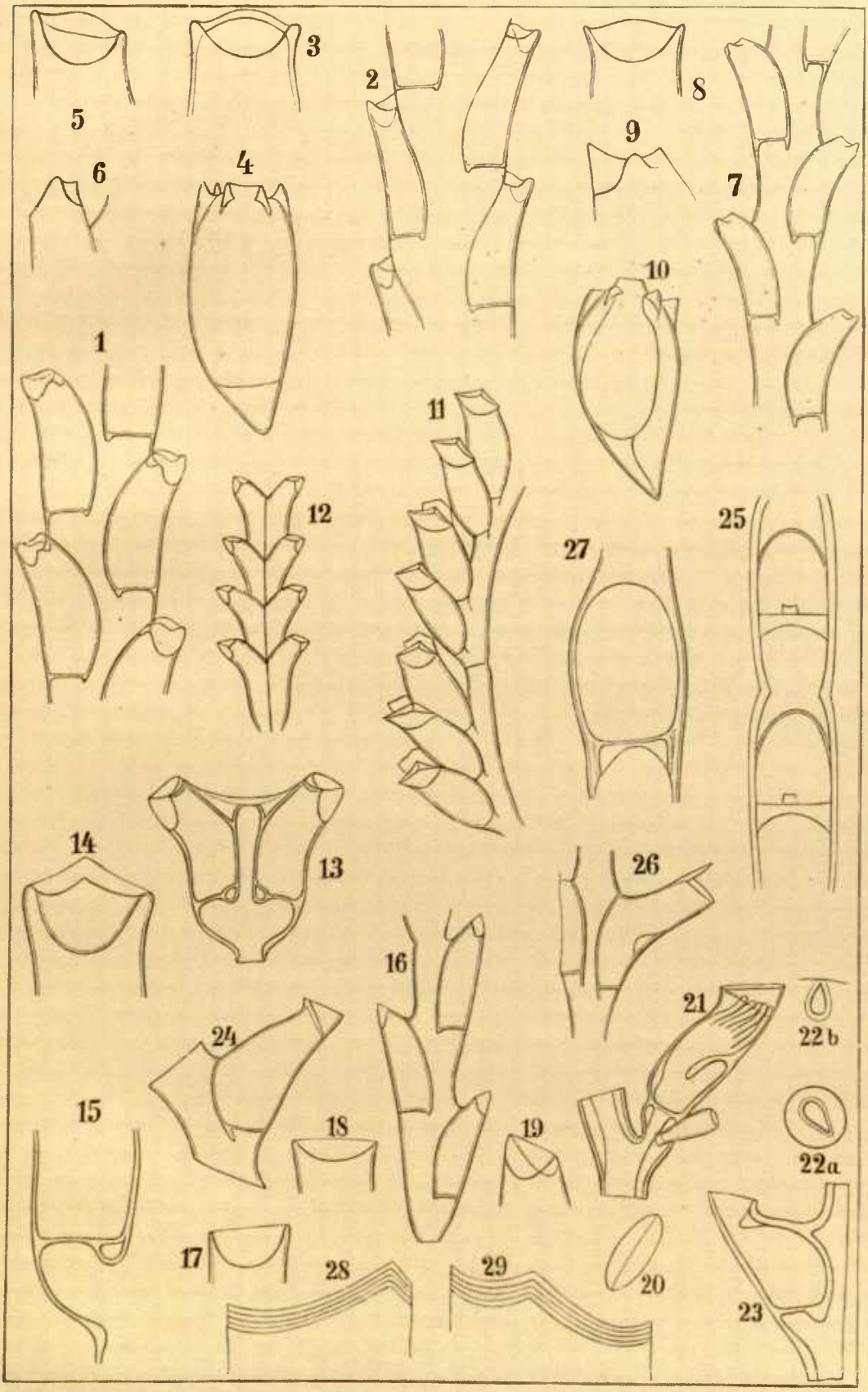

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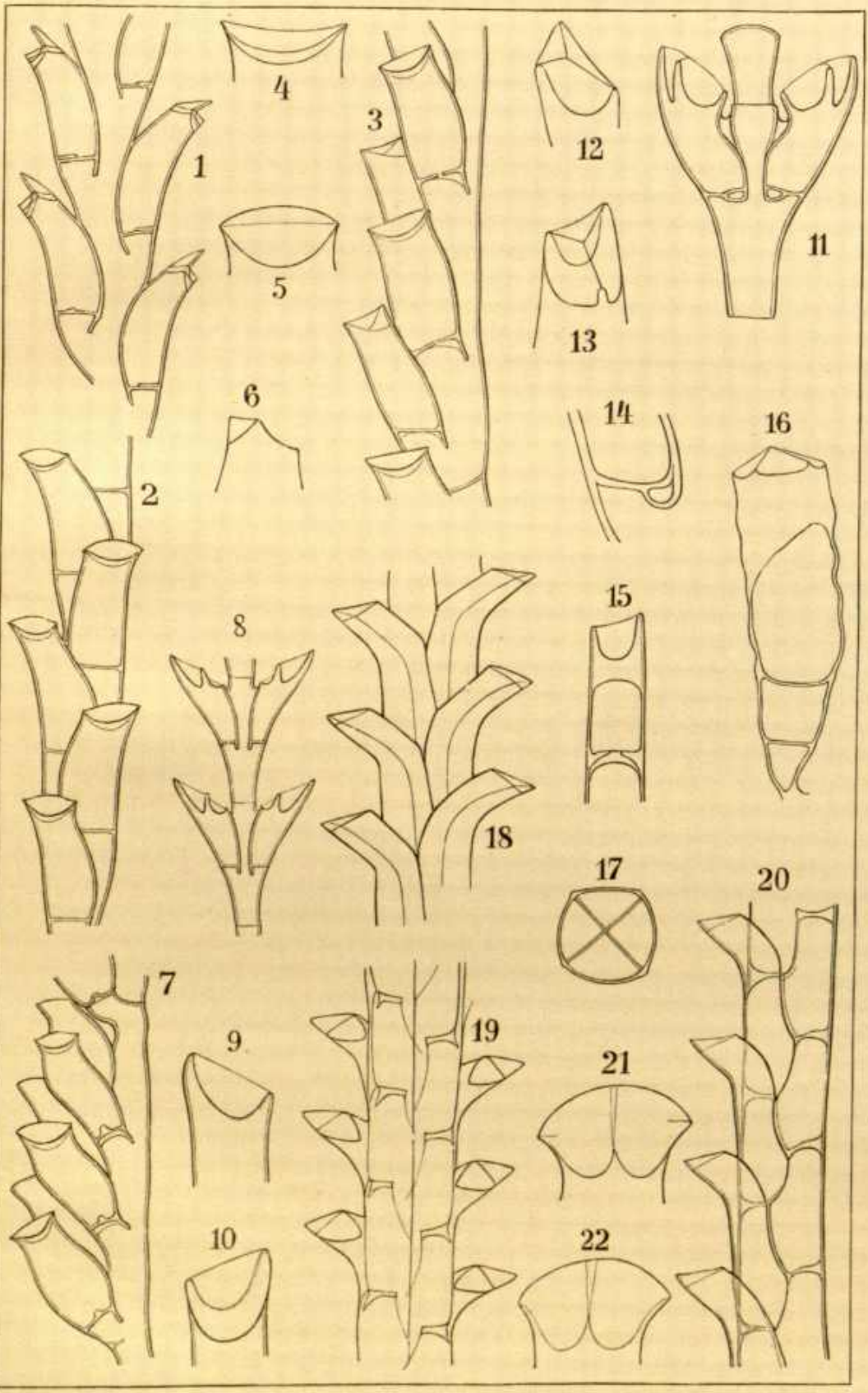
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