THE DANISH

INGOLF-EXPEDITION.

VOL. V, PART 1.

CONTENTS:

HECTOR F. E. JUNGERSEN: PENNATULIDA.

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THE DANISH INGOLF-EXPEDITION.

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1.

PENNATULIDA.

BY

HECTOR F. E. JUNGERSEN.

WITH 3 PLATES, 1 CHART AND 3 FIGURES IN THE TEXT.

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Pennatulida.

By

Hector F. E. Jungersen.

In the present treatise an account is given, not only of the Pennatulids brought home by the «Ingolf», but also of material in later collections from within the territory of the Ingolf-Expedition and from the adjoining regions which were investigated afterwards. Thus it comprehends the results from the surveying cruises of the «Diana» at Iceland and the Faeroe Islands, from the expedition to East-Greenland by Messrs. Amdrup and Hartz, from the participation of cand. mag. Ad. Jensen in the investigation of the «Michael Sars» in the North Atlantic during the summer of 1902 under the direction of Dr. Hjort, and from the cruise of the «Thor», the steamer for the international investigations of the sea, during the summer of 1903 under the direction of Dr. Joh. Schmidt; finally it includes also the material sent to our museum from Mr. Jónsson, district physician on the Vestman-Islands, and by Mr. Müller, agent in Thorshavn.

Our knowledge of the Pennatulids rests in several respects on a rather slight footing; this holds good also for the apparently so well examined Scandinavian forms, in spite of the numerous and beautiful treatises which have appeared from Norwegian scientists. I have tried personally therefore to examine all the forms that have hitherto been described from the coast-regions of Scandinavia, as well as the forms from the territory adjoining the one which was investigated by the «Ingolf». For this purpose I have examined the collections in Christiania, Bergen and Stockholm; from the museums in these towns I have received later all that I wished to examine more closely and to compare with our own material here in Copenhagen; for this great liberality I beg to offer my best thanks to Professors R. Collett and Hj. Théel, and to Conservators Dr. A. Appellöf and Mr. J. Grieg. I have further had the opportunity at the British Museum of bringing into the comparison part of the material of the Challenger-Expedition; on the other hand, I have searched in vain in several English museums for the Pennatulids from the expeditions of the «Porcupine», the «Triton», and the «Knight-Errant». The result of my endeavours has thus been a revision of the Pennatulid-fauna of a large sea-territory, viz. the Polar Sea between Europe and Greenland, the sea to the West of Greenland, and the northern part of the Atlantic down to 55° Lat. N. and to the meridian of Cape Farewell. This revision, as will be seen, has led to a somewhat new conception of several species hitherto established; further, several forms have been added, of whose occurrence within territory so far north we have hitherto known nothing, and could know nothing; of undescribed species only two have been added.

I have followed Kölliker in regard to the terminology; some of his terms have been used from much older times, and are based on the external resemblance to a feather, especially conspicuous in forms like *Pennatula, Pterocides* etc. The stem of the colony is accordingly divided into the shaft, rhachis, carrying all the individuals, and the peduncle, which is naked and under natural conditions sunk into the bottom of the sea; polyp is the name used only for the individuals possessing the entire equipment of an octocoral, tentacles etc., zooid for the dwarf individuals wanting sexual organs and tentacles (only in *Umbellula* do they carry one tentacle). The individual is said to be provided with a calyx, when the basal part of its body[1]) is stiff so as not to be retractile, but the upper part of the polyp with mouth and tentacles can be retracted and hidden in it. The upper edge of the calyx may be more or less marked, in the former case it is provided with lobes, up to eight in number; the axial (dorsal) side of the individuals is turned towards the stem, the abaxial (ventral) away from the stem. Wings, alæ or pinnæ, is the name of the oblique series of polyps placed transversely on the stem, where the polyps are mutually coalesced.

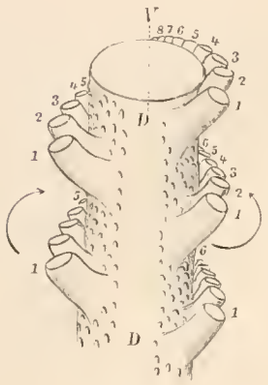

Fig. 1.

Diagram, part of a Pennatulid-rhachis. *V—D* indicates the direction of the middle plane. 1—8 polyps in one transverse series; the figures give the age of these polyps, no. 1 being the eldest one; the arrows indicate that the polyps accordingly appear and are developed to either side away from the naked streak *D—D*.

I have differed only in one point from Kölliker; what he describes as the ventral side of the colony, I call the dorsal, and vice-versa (except in *Renilla*, see below); this I shall try to explain more closely.

In the great majority of Pennatulids the colony, as is well known, is constructed bilaterally. The plane that divides the stem longitudinally into two corresponding parts, has quite naturally always been interpreted as a dorso-ventral one (*V—D* in the annexed figure); but whether the side of the stem in the figure denoted by *D*, is to be called the dorsal (posterior), or the ventral (anterior), has always been decided quite arbitrarily. The earlier authors — with the exception of Lamarck — have generally called it the dorsal, or posterior side. Kölliker, in his monograph (p. 5), declares it to be the ventral for no other reason than that it is »am zweckmässigsten». Later, all authors have adopted the decision of Kölliker although some of them (e. g. Verrill, Koren and Danielssen) had earlier used the contrary designation. The feature distinguishing this side of the colony, is first and foremost that new polyps develop on either side, away from the median line; thus, the polyps placed nearest to this line are the oldest in each transverse series; further, the median line itself is always »sterile» in so far as polyps are never formed in it; only rarely is it covered with zooids (for instance *Kophobelemnon*); generally along the median line there is a more or less narrow »naked» streak, increasing in breadth down towards the peduncle.

The opposite surface of the stem (*V* in the figure) is characterized by the fact that the new polyps are developed from both sides in the direction towards the median line; accordingly, the

[1]) By the body of the polyp is understood the part of the polyp projecting from the surface of the stem; in reality some portion of each individual issuing from the stem is inclosed in the latter.

youngest polyps in each transverse series are those nearest to this line; the median line and its more immediate surroundings is often also «sterile» of polyps; when this is the case the naked streak, however, is narrower here than on the opposite surface, with the exception of the lower part towards the peduncle (*Renilla*, however, is a remarkable exception). Thus the two median surfaces of the stem are generally easily distinguished[1]). Making the median line our starting-point we might say that the surface *D* shows a «centrifugal» development of the polyps, the surface *V* a «centripetal» one; so far we might well abandon the terms ventral and dorsal side, and instead of them use centrifugal and centripetal side; these latter names, however, are somewhat clumsy in descriptions, as is also the case, I think, with the terms proposed by Bourne[2]): prorhachis (for *D*) and metarhachis (for *V*); dorsal and ventral side are, and will always be, the most handy names, if only a rational choice were agreed upon. In my choice I have started from the following consideration: the stem of the sea-pens, rhachis + peduncle, is the direct product of the individual developed from the egg (the «oozooite» of Lacaze Duthiers); this primary individual is for some time a solitary polyp of the typical octocorallian structure; accordingly, it is bilaterally symmetrical with respect to a plane naturally called a dorso-ventral plane; the mouth and pharynx (stomodaeum) are oval with the longer axis in the plane of symmetry; this plane bisects two median chambers, mutually different and differing from all the others: only one of them contains retractor muscles, and this one is on the same side as the ciliated groove (sulcus, siphonoglyphe[3]) of the pharynx; it has long ago been agreed on calling this «sulcar side» the ventral side in all polyps of octocorals. If we will keep this designation here, we must accordingly be consistent, and also use it for the corresponding, homologous side of the stem of the sea-pens. Several years ago by following the development of *Pennatula phosphorea*, I have shown that the «sulcar side» of the primary polyp is really the side *V*, the «centripetal side»; only this side, then, can justly be called the ventral side.

Whichever appellation, however, is preferred it is obvious that in all Pennatulids the same name is to be used for the same (homologous) side. This, Kölliker (and with him the later authors) has

Fig. 2.

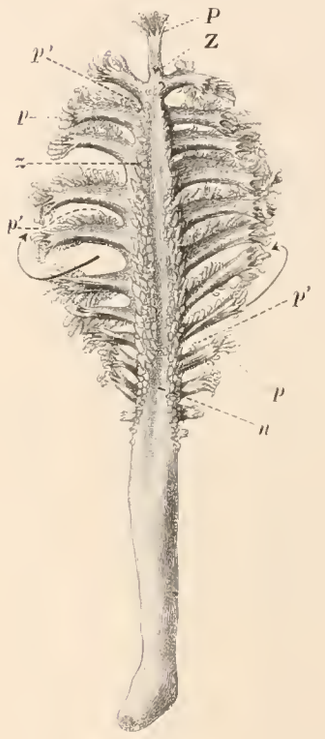

Fig. 3.

Young specimens of *Renilla reniformis* (Pall.) and *Pennatula phosphorea* L., seen from the dorsal-side; about 2½ times the natural size. *P* terminal or primary polyp, *p*, *p'* lateral polyps, *p'* younger than *p*; *Z* terminal zooid, *z* dorsal zooids; *z'* (only in *Renilla*) zooids placed on the polyps; *n* naked dorsal streak. The arrows indicate that the polyps grow in the direction of the unseen ventral side of the colony.

[1]) Even in such a form as *Distichoptilum* (Pl. I, Figs. 12—14) or in young stages for instance of *Virgularia* (Pl. II, Fig. 25). The polyps placed in a single series on either side of the rhachis will always incline somewhat towards the side *V*.

[2]) *Anthozoa* in Ray Lankester: Treatise on Zoology. Part II. 1900. p. 31.

[3]) The ciliated groove, as is well known, is not developed in the older polyps of the sea-pens, but very highly developed in the zooids and the quite young polyps (Hicksou, Phil. Tr. 1883).

not done, in so far as he has made a mistake in the comparison with regard to one form, *Renilla*. Kölliker decided, without further explanation, that the most naked surface in all bilateral Pennatulids was to be termed the ventral side; now, in all pennate and spicate forms the most naked side is really homologous, being the «centrifugal side»; it is easily seen however that the naked «underside» of the reniform disc is the «centripetal side», new polyps budding only at the margin of the disc, and the direction of their development is seen to be away from the centre of the polyp-bearing «overside». This may be seen in every specimen of *Renilla*; but it has been further proved by the examination of its development by Wilson. From his examination it is also seen that the naked side of the *Renilla* corresponds to the ventral or sulcar side of the primary polyp; but Wilson has not seen either that it corresponds to Kölliker's «dorsal side» in the other Pennatulids; I have, however, proved this fact in my treatise, quoted above, on *Pennatula phosphorea*. Nevertheless the matter does not seem to be understood yet with regard to *Renilla*; Delage and Hérouard (Traité de Zoologie concrète, T. 2, 2, 1901) take the same erroneous view as Kölliker, so does Moroff; whether it is also the view of Bourne is not distinctly seen, but from his endeavours to derive *Renilla* from an *Umbellula*-like original form I am inclined to think so. To prevent any misconception in future I figure here a *Renilla* and a *Pennatula*, seen from the same — homologous — side, the side I designate as the dorsal one.

Remarks on the systematic classification of the Pennatulids.

Recent authors have generally adopted the system set forth by Kölliker in the Challenger Report vol. I, 1880. According to this, the order *Pennatulida* is divided into four groups (sections), in the first three of which the colony has a bilateral formation; when the sub-sections are omitted this system is as follows:

I. *Pennatuleæ*.

Fam. *Pterocididæ*.
- *Pterocides* Herkl.
- *Godeffroya* Köll.
- *Sarcophyllum* Köll.

Fam. *Pennatulidæ*.
- *Pennatula* Lam.
- *Lcioptilum* Verr.
- *Ptilosarcus* Gray.
- *Halisceptrum* Herkl.

Fam. *Virgularidæ*.
- *Virgularia* Lam.
- *Scytalium* Herkl.
- *Pavonaria* Köll.

Fam. *Stylatulidæ*.
- *Stylatula* Verr.
- *Dübenia* Kor. & Dan.
- *Acanthoptilum* Köll.

II. *Spicatæ*.

Fam. *Funiculinidæ*.
- *Funiculina* Lam.
- *Halipteris* Köll.

Fam. *Stachyptilidæ*.
- *Stachyptilum* Köll.

Fam. *Anthoptilidæ*.
- *Anthoptilum* Köll.

Fam. *Kophobelemnonidæ*.
- *Kophobelemnon* Asbjörns.

Sclerobelemnon Köll.
Bathyptilum Köll.
Fam. *Umbellulidæ*.
Umbellula Lam.
Fam. *Protocaulidæ*.
Protocaulon Köll.
Cladiscus Kor. Dan.
Fam. *Protoptilidæ*.
Protoptilum Köll.
Lygomorpha Kor. Dan
Microptilum Köll.
Trichoptilum Köll.
Leptoptilum Köll.
Scleroptilum Köll.

III. *Renilleæ*.

Fam. *Renillidæ*.
Renilla Lam.

IV. *Veretilleæ*.

Fam. *Cavernulariidæ*.
Cavernularia Val.
Stylobelemnon Köll.
Fam. *Lituaridæ*.
Lituaria Val.
Veretillum Cuv.
Policella Gray.
Clavella Gray.

Studer (Versuch eines Syst. der Alcyonaria. Arch. Naturgesch. 53. Jahrg. 1. 1887, p. 22, and Challenger Report vol. 31, p. XXVII) has followed Koren & Danielssen[1]), and like these authors added a fifth to the four groups of Kölliker: ***Göndulea*** with fam. *Göndulidæ*, genus *Göndul* Kor. Dan. but has otherwise restricted himself to the inserting of the later established genera into the families of Kölliker (*Sciophyllum* Verr. in fam. *Pennatulidæ*, *Svava* Kor. Dan. in *Stylatulidæ*, *Gunneria* Kor. Dan. and *Distichoptilum* Verr. in *Protoptilidæ*). Later (Note prélim. etc. Camp. de l'Hirondelle 1890) he has inserted into the fam. *Pteroeididæ* the new genus *Gyrophyllum* Stud. Kükenthal (Diagnosen neuer Alcyonarien aus der Ausb. d. Deutschen Tiefseeexpedition. Zool. Anz. 25. Bd., 1902, p. 302) has added still another (the sixth) group: ***Verticilladeæ***: fam. *Chunellidæ*, genera *Chunella* Kükenth. and *Amphianthus* Kkth. Bourne (Anthozoa in the treatise on Zoology edited by Ray Lankester, part II, 1900) almost without any alteration — at all events, without any essential alteration — has followed Kölliker; it has to be remarked, however, that he regards the two families of Kölliker *Virgularidæ* and *Stylatulidæ* as subfamilies of one family *Virgularidæ*; *Pennatulidæ* and *Pteroeididæ* Köll. are regarded also as subfamilies; and the family *Göndulidæ* is placed beside, and in the same group with these families; finally also *Funiculinidæ* and *Bathyptilidæ* are degraded to subfamilies of one family, as are also the two families of Veretillinæ. The system has been more highly modified in Delage & Hérouard (Traité de Zoologie concrète T. 2, Partie 2, 1902); here there are five groups: 1) *Frondina* (*Renilla*), 2) *Umbellina* (*Umbellula*), 3) *Juncina* (*Spicatæ* + *Veretillæ* of Kölliker), 4) *Pennina* (= *Pennatulæ* of Kölliker), 5) *Acaulinæ* (*Göndul*). The extent of the families remains otherwise almost unaltered; the family *Protocaulidæ* of Kölliker, however, has been placed under the family *Kophobelemnoninæ* D. & H., and the genus *Deutocaulon* Marsh. & Fowler has been included in the same family; the genus *Cladiscus* Kor. Dan. has been removed to the family *Protoptilinæ*; the genus *Svava* Kor. Dan. to the family *Virgularinæ*; several genera of the same family, as *Lygus* Herkl., *Radicipes* Stearns, as also some of the genera established by Gray in the family *Pennatulinæ* are also enumerated.

[1]) Nye Alcyonider etc. 1884.

I cannot regard the grouping of Delage & Hérouard as an improvement on the system of Kölliker, and most of the genera, found in these authors but not in those before mentioned, will have to be abandoned.

Nor can I, for my part, regard the system of Kölliker as satisfactory; the characters, by which the division into groups has been made, hardly always make the line of separation in a natural way; when, for instance the first group *Pennatulæ* is made to contain the forms in which the individuals of the polyp-series are coalesced to form wings, this feature is seen not to be of absolute validity: in the genus *Virgularia*, species are found in which the wings are partly dissolved into free individuals, or, more properly, in which only some individuals are coalesced, and only to quite a slight extent (*Virgul. bromleyi* K. and *Virg. cladiscus* mihi); the same is found in the genus *Stylatula* (in the subgenus *Dübenia*). On the other hand, forms are found in the group *Spicatæ*, in which a coalescing of some individuals in an oblique series takes place, in which, accordingly, there is as distinct a beginning of wings as in the mentioned *Virgulariæ*; this is seen in *Anthoptilum grandiflorum* Verr., while in another species of the same genus, *A. murrayi* K. the polyps are quite separate, and partly even not arranged in regular oblique series. A one-sided prominence, given to this single character, will thus easily separate closely related forms into two groups; but when other structures are also taken into consideration, I think that the four groups of Kölliker may be kept — at least provisionally — but, to be sure, with altered contents. If we knew more of the development of the colony in a larger number of Pennatulids than is the case now, the mutual relations of the forms might certainly be seen more clearly, and then, perhaps, the grouping might be different. For the present, it is exceedingly difficult to reach a sure classification; difficulties occur on all points, especially in limiting off the species. Most of the features that have generally been used as specific characters prove to be more or less useless: the number, grouping, size of the polyps and zooids often change considerably during growth, as also all the relative sizes of the parts of the polyps and the stem, which are moreover exceedingly influenced by the degree of contraction. Nor does the anatomical structure give many holds for the classification, as it is upon the whole too uniform; the spicules also give but slight help: species of the same genus may quite lack spicules or be abundantly provided with them (for instance, within the genus *Umbellula*); nor is the form and size of the spicules often of much assistance; in specimens of the same species both the number and the size may be very varying (for instance, in *Funiculina quadrangularis*, *Kophobelemnon stelliferum*). Amongst the better characters, I reckon the presence or absence of a calyx on the polyps, and the form of the calyx. For the delimitation of genera and families, these features along with the grouping of the polyps and zooids in the developed colony will for the present be of most value.

I am not in a position to undertake a complete reformation of the system of the Pennatulids on the basis of the material I have hitherto had for examination, but on several points I shall be able to revise, with greater certainty than has before been possible, certain parts of the system of Kölliker and the later additions to, and alterations of, this system; on other points I shall have to be content with giving suggestions more or less positive. The more particular reasons for the position of the forms dealt with in the following section, will be given there; in this place I shall only give some conclusions with regard to these forms.

In the group *Pennatulæ*, the genus *Halisceptrum* Herkl. will have to be removed from the family *Pennatulidæ* to the family *Virgularidæ*; it is quite obvious that this genus is closely related to the genus *Virgularia* itself; perhaps it might even be embodied into it (see later under *Virgularia*); further the genera of the family *Stylatulidæ* show so close a resemblance to *Virgularia*, that they can scarcely be regarded as forming a separate family; they are certainly more closely related to the genus *Virgularia* than this genus is to the genera *Scytalium* Herkl. and *Pavonaria* Köll.; on the other hand, I should be inclined to separate these latter genera into a separate family (or, at all events, a subfamily) characterized — in contradistinction to *Virgularia* and the Stylatulids (with the exception of *Acanthoptilum*) — among other things by the fact that the sexual organs are only developed in the fully formed polyps of the older wings, and that new polyps, at any rate in the younger forms, bud out on the upper, older part of the rhachis; in this family *Pavonaridæ* mihi must further be included a member of the group *Spicatæ*, viz. the genus *Halipteris* Köll., although its polyps are not united into wings; but in most other features it shows the greatest resemblance to *Pavonaria* Köll., much more than to *Funiculina*, with which it has been placed by Kölliker. The genus *Svava* Kor. Dan., which Studer has referred to the Stylatulids, Delage & Hérouard to their *Virgularinæ*, will have to be dropped as a genus; it is only a species of the genus *Virgularia*; *Lygus*, which in Del. & Hér. is given as a separate genus, is synonymous with *Virgularia*; and *Radicipes* Stearns (Proc. U.S. Nat. Mus. Vol. 6, 1883, p. 96, Pl. VII) is no sea-pen at all, but a Gorgonid (a species of *Strophogorgia* Perc. Wr.); the genera of Gray: *Ptilella*, *Phosphorella*, *Crispella* (the family *Pennatulinæ* Del. & Hér.), and *Argentella* (of their *Pterocididinæ*) have already, and certainly rightly, been condemned by Kölliker in his monograph. Further, the genus *Stachyptilum* Köll., in my opinion, is to be included in the family *Pennatulidæ*.

In the group *Spicatæ* of Kölliker (= *Umbellina* + *Juncina* — the family *Veretillinæ* in Del. & Hér.) the greatest alterations will have to be made. In the first place the whole family *Protocaulidæ* must be done away with: two of its genera, *Protocaulon* Köll. and *Deutocaulon* Marsh. & Fowl., because they are young stages of *Virgularia*-species, *Cladiscus* Kor. Dan., because it is only a (wrongly interpreted) species of *Virgularia*, in reality identical with *Svava* Kor. Dan. (for further particulars see under *Virgularia mirabilis* and *V. cladiscus* mihi). Consequently, all inquiry may be omitted with regard to the question whether *Cladiscus* is to be included in *Protoptilidæ* or *Protocaulidæ*, and whether *Protocaulon* and *Deutocaulon*, as has been done by Del. & Hér., may be placed under the family *Kophobelemnoninæ*.

Again, most members of the family *Protoptilidæ* must be dropped as separate genera. *Lygomorpha* Kor. Dan. is a young form of *Halipteris* (for further particulars see under *H. christii*); *Microptilum* Köll. of *Pavonaria*; *Leptoptilum* Köll. and *Trichoptilum* Köll. are young forms of *Funiculina* (see under this latter); *Gunneria* Kor. Dan., which was inserted not only by the authors of the genus, but also by Studer and Delage & Hér., is a wrongly determined *Kophobelemnon* (see under *K. stelliferum*); further, the genus *Scleroptilum* Köll. must be separated from this family; its polyps, in spite of their dense provision of spicules, want a calyx, and it can only be by an oversight of Kölliker that it has been placed in a family especially characterized by him as provided with a calyx. Finally we have only left *Protoptilum* Köll. and the later added *Distichoptilum* Verrill. These two genera, at all

events, have the common feature that their polyps are provided with a well developed calyx, the abaxial part of which is fully formed, often with calyx-teeth, while its axial side is more or less connected with the stem; young stages of *Protoptilum*, or such simple species as *Prot. carpenteri* (if it is not only a young stage also) resemble *Distichoptilum* very closely; the arrangement of the zooids, however, is quite different, as *Protoptilum* is provided with numerous dorsal zooids, and moreover with zooids everywhere on the rhachis between the polyps, while *Distichoptilum* has only lateral zooids, two for each polyp.

The other forms of the group *Spicatæ* in which the polyp has developed a calyx: *Funiculina*, *Halipteris*, and *Stachyptilum*, seem to me to show no close relation, so that they certainly cannot — as has been done by Bourne — be placed in one family. On the contrary, the genus *Stachyptilum* Köll. seems to me to be altogether a stranger in this group; as far as I can see from the description and figures of Kölliker, I think it must be referred to the first group, *Pennatuleæ*, and be placed there in the family *Pennatulidæ*; the whole form of the colony and the arrangement of polyps and zooids is as in *Pennatula*: the polyps are placed quite regularly in oblique series, but the members of one series are not mutually coalesced; the dorsal surface of the stem is covered with zooids, as are also the lateral and ventral intervals between the polyps; apart from a slighter development of the points of the calyx it looks like a *Pennatula* with free polyps.

The genus *Funiculina* occupies a quite isolated position by wanting real zooids; only the quite young polyps appear temporarily as zooids; by and by they increase in size, get fully developed tentacles, form sexual organs, and become perfect polyps; the arrangement and growth of the individuals is not regular, although they, as it were, tend towards a regular arrangement in transverse series. From all these facts, *Funiculina* seems to me to occupy an especially primitive place below all known sea-pens, and, at all events, a sufficiently peculiar place for it to form a separate family in which no other genus can be included for the present. *Halipteris*, which has been placed as its nearest ally, since Kölliker in his monograph had made this arrangement, is in reality far removed from it; the resemblances found are common to most long and slender sea-pens. In *Halipteris*, there is as strong a contrast between zooids and polyps as in any other sea-pen; in the calyx of its polyps the abaxial side is far more developed than the axial one where teeth are quite wanting in the calyx. In reality, I think that the original reference of the typical species *H. christii* to «*Virgularia*» has more nearly approached the correct thing; it is, as stated above, a Pavonarid; as in *Pavonaria* the calyx of the polyp is provided with two abaxial teeth; the only essential difference is that the polyps do not coalesce to form real wings.

With regard to the genera with polyps without calyx, *Scleroptilum* Köll. shows the simplest form of colony; as it shows no immediate relation to the other known genera it must, I presume, form a separate family *Scleroptilidæ*[1]).

The genus *Anthoptilum* must still form the type of a family *Anthoptilidæ*; but in this family

[1]) The genus was established by Kölliker (Chall. Rep. Vol. I, p. 30, Pl. VII, fig. 29) for the species *S. grandiflorum* and *durissimum*, both from considerable depths in the Pacific off Japan; Verrill has later found another species *S. gracile*, of a length up to 1 foot, in the depths of the Atlantic to the east of North America (Cape Hatteras) (Rep. Comm. Fish and Fisheries for 1883 (1885) p. 510 [8], Pl. III, fig. 6, and Am. Journ. Sc. Vol. 28, 1884, p. 219); the description in the latter place speaks of «ventral» zooids, and such zooids, according to Kölliker, ought to be wanting.

the genus *Benthoptilum*[1]) of Verrill may probably also be included; further, I think that the two families *Kophobelemnonidæ* and *Umbellulidæ* are to be kept unaltered. *Umbellula* I regard — contrary to Delage and Hérouard — as a particularly specialized form, related to *Kophobelemnon*; an *Umbellula* might be thought to be derived from a *Kophobelemnon*-like form in which the polyps in the greater part of the rhachis were checked so as to be kept in the zooid-stage; the zooids in *Umbellula* are somewhat more developed than ordinary zooids, in so far as they are generally provided with one tentacle; and a certain resemblance to *Kophobelemnon* is undeniably seen in such *Umbellula*-species as *U. güntheri* K. in which the polyp-bearing part of the rhachis is lengthened in a club-shaped manner. The radial structure seen in certain *Umbellula*-species (for instance *U. encrinus*), is, at all events, a secondary development, having plainly arisen from an original bilateral formation, as is sufficiently shown by the younger stages. To *Umbellulidæ*, the *Chunellidæ* Kkth. are no doubt related; in these latter also the radial arrangement of the polyps is plainly a secondary one; the bilateral formation may unmistakably be traced in the arrangement of the zooids, but may also be seen in that of the polyps. I think it superfluous to form a separate main group for this family.

According to this, the section *Spicatæ* will have to be divided into two subsections:

A. The polyps with calyx.
  Fam. *Funiculidæ* (*Funiculina* Lam.).
  » *Protoptilidæ* (*Protoptilum, Distichoptilum*).

B. The polyps without calyx.
  Fam. *Scleroptilidæ* (*Scleroptilum*).
  » *Anthoptilidæ* (*Anthoptilum, Benthoptilum*).
  » *Kophobelemnonidæ* (*Kophobelemnon, Sclerobelemnon, Bathyptilum*).
  » *Umbellulidæ* (*Umbellula*).
  » *Chunellidæ* (*Chunella, Amphianthus*).

The sections *Renilleæ* and *Veretilleæ* must probably still remain. Even if *Renilla* in its development, shows a distinct connection with a common primitive Pennatulid, it is so peculiar when fully grown, that it does not agree with other groups. This holds good to a smaller degree with regard to *Veretilleæ*; the radial arrangement of polyps and zooids in these forms, however, is a peculiarity justifying a separation, at least provisionally. I think it probable that this radial arrangement will meantime prove to be of secondary origin, since a bilateral formation may be traced in the inner structure of the stem in *Veretillum* (comp. Kölliker Monogr. p. 430). It is rather remarkable that no young stage of this group is as yet known, although it is represented, in the Mediterranean for instance, by two rather common genera: *Veretillum* and *Stylobelemnon*. Both these groups: *Renilleæ* and *Veretilleæ*, I must regard as very specialized and anything but primitive Pennatulids.

With regard, finally, to the group *Gönduleæ* (*Acaulina* Del. & Hér.), it must be quite omitted; it has been established only on the «genus» *Göndul*, which is nothing but a mistaken fragment of *Pavonaria finmarchica* (see under this species).

1) *B. sertum* Verrill, from the depths of the Atlantic to the east of North America (Cape Hatteras). Rep. Comm. Fish etc. 1883, p. 510 [8], Pl. II, fig. 4, and Am. Journ. Sc. (3), Vol. 29, 1885, p. 149, note.

List of the northern Pennatulids.

By northern Pennatulids are here meant the species known from the Davis Straits and Baffins Bay, the Greenland Sea, and the part of the Atlantic north of 55° N. Lat. and east of the meridian of Cape Farewell.

The reduction made in the previous section of formerly established genera, will appear clearly in a list of the Pennatulids from this territory, which has been the special object of my investigations; to this is further to be added that I have found it necessary to unite together several of the earlier established species. Notwithstanding the fact that several forms have now been added from within this geographical territory, which were not hitherto known to occur there, and among these two new species, the total number of species will be seen to be diminished to about two thirds of the number which might be enumerated from previous publications.

The following list A contains the earlier established species, the list B the species as I now think they should be. In the latter list, the species marked with an asterisk have been brought home by the Ingolf-Expedition itself.

A.		B.
1. *Pennatula phosphorea* L.	=	1. *Pennatula phosphorea* L.
2. » *distorta* Kor. Dan.		
3. » *aculeata* Kor. Dan.		2. * » *aculeata* Kor. Dan.
4. » *grandis* Ehrenberg		3. » *grandis* Ehb.
		4. * » *prolifera* n. sp.
5. *Virgularia affinis* Kor. Dan.		5. *Virgularia affinis* Kor. Dan.
6. » *mirabilis* (L.)		6. » *mirabilis* (L.)
7. *Cladiscus gracilis* Kor. Dan.	=	7. **Virgularia cladiscus* nom. n.
8. » *loveni* »		
9. » *köllikeri* »		
10. *Svava glacialis*		
11. *Deutocaulon hystricis* Marsh. & Fowl.		
12. *Dübenia abyssicola* Kor. Dan.	=	8. *Stylatula (Dübenia) elegans* Kor. Dan.
13. » *elegans* »		
14. » *borealis* »		
15. *Pavonaria finmarchica* (M. Sars)	=	9. **Pavonaria finmarchica* (M. Sars)
16. *Göndul mirabilis* Kor. Dan.		
17. *Halipteris christii* (Kor. Dan.)	=	10. *Halipteris christii* (Kor. Dan.)
18. *Lygomorpha sarsii* »		
19. *Stichoptilum arcticum* Grieg		
20. *Protoptilum tortum* »		

21.	*Protoptilum lofotense* Kor. Dan.	=	11. *Protoptilum thomsoni* Köll.
22.	» *mohni* »		
23.	» *carinatum* »		
24.	» *armatum* »		
			12. **Protoptilum carpenteri* Köll.
			13. * » *denticulatum* n. sp.
			14. **Distichoptilum gracile* Verr.
25.	*Funiculina quadrangularis* (Pall.)		15. **Funiculina quadrangularis* (Pall.)
			16. **Anthoptilum grandiflorum* (Verr.)
			17. **Anthoptilum murrayi* Köll.
26.	*Kophobelemnon stelliferum* (O. F. M.)	=	18. **Kophobelemnon stelliferum* (O. F. M.)
27.	» *abyssorum* Kor. Dan.		
28.	» *moebii* »		
29.	» *leuckartii* Köll.		
30.	*Gunneria mirabilis* Kor. Dan.		
31.	*Bathyptilum carpenteri* Köll.		19. *Bathyptilum carpenteri* Köll.
32.	*Umbellula encrinus* (L.)		20. **Umbellula encrinus* (L.)
33.	» *gracilis* Marsh.		21. * » *lindahli* Köll.

Fam. *Pennatulidæ* Köll.

Pennatula Lam.

Pennatula aculeata Kor. & Dan.

Pl. I, fig. 1.

Pennatula aculeata Kor. Dan. 1858. Forhandl. i Vidensk. Selsk. i Christiania 1858, p. 25.
» » Kor. Dan. Fauna littor. Norvegiæ. III. 1877, p. 86. Tab. XI, figs. 8—9.
» *distorta* var. *aculeata* Kor. Dan. Nye Alcyon. Gorgon. etc. 1883, p. 24. Tab. XI, figs. 5—10.
» *phosphorea* var. *aculeata* Köll. Monogr. p. 134 and 366.
» » Marshall. Penn. Triton , 1883, p. 123. Tab. XXI, figs. 4, 5, 7; Tab. XXII.
» *americana* Moroff. Octoc. 1902, p. 381.

The «Ingolf» has brought home 2 specimens from Station 25 in the Davis Straits; the steamer «Thor , in 1903, has taken 10 specimens at its Station 167, one specimen at St. 166, to the south of the Vestman-Islands. Of the two Greenland specimens, the smaller one especially (Nr. 1) appears so peculiar from its violet colour and its long spines (dorsal zooids), that at the first glance it might be thought to be a new species; moreover, the wings of the pen are unfortunately highly contracted and broken by the hauling-in, so that the form of the pen has been somewhat distorted (comp. fig. 1). Only the calyx-teeth and the points of the zooids are red, and the peduncle is of a reddish violet colour quite down to the terminal bulb. The other, larger specimen (Nr. 2), which is excellently pre-

served, agrees completely, on the other hand, with *Penn. aculeata* as to outer appearance, has the same long, narrow wings etc.; but in this specimen also the red colour passes into the violet, even if the red is more conspicuous.

By closer comparison with our Museum's type-specimens of *Penn. aculeata* Kor. & Dan. from Christianssund, complete correspondance is found in such features as the number of polyps in the wings, the double row of lateral zooids at the base of each wing, the 4—6 rows of dorsal aculei; but in the length of these latter there is a conspicuous difference. Whilst the spines of the Norwegian specimens are 1—2^{mm} long (according to Koren and Danielssen they may grow to a length of 3·3^{mm}: Fauna litt. Norveg. 3, p. 87), in the two Greenland specimens they are fully 4^{mm} long. American specimens in our Museum (from the Atlantic: 36° 55′—58° N. Lat. 71° 13′—14′ W. Long., depths 207—214 fathoms, and 40° N. Lat. 70° W. Long., 260 fathoms), both by their strong colour, which is redder, however, and by their long and stout spines, resemble the Greenland specimens very closely; when to this is added, that the Iceland specimens brought home by the «Thor», stand as to colour between the two Greenland ones, and that specimens of *Penn. aculeata* are also enumerated from several other Atlantic localities with spines of more than 3 and up to 4^{mm} (Marshall, «Triton»-Penn. p. 124, Kölliker, Monogr., Appendix p. 366), there can be no doubt that the specimens from the Davis Straits are justly referred to this species. Both the colour and the size of the spines also, to judge from several statements in the literature of *Penn. aculeata*, would seem to vary according to the depth at which it is found; at great depths the ventral calyx-tooth of some of the large zooids is developed to a powerful spine, and the colour becomes more intense, deeply red or violet.

The following features refer to the two Ingolf specimens:

	Nr. 1.	Nr. 2.
Total length	105^{mm}	115^{mm}
Length of peduncle	50 »	48
Number of pinnulæ	19/17	22/22
Length of a well-developed pinnula	19^{mm}	24^{mm}—25^{mm}
Number of polyps in such a pinnula	8—9	7—9
Length of the largest aculei (zooids)	4^{mm}	4^{mm}

The specimen Nr. 1 (Pl. I, fig. 1) is provided with spicules differing somewhat from the form common to the species, being more slender, more spatulate at the end, and very strongly coloured; some of the polyp-spicules, moreover, reach a very considerable length; the largest ones measured are 3·120^{mm} long and 0·108^{mm} broad, whilst the smallest measured (from the tentacles) 0·080^{mm} in length and ca. 0·008^{mm} in breadth. The specimen Nr. 2 shows, both in the form of the spicules and their length, a tolerably close agreement with the American specimens of *P. aculeata* examined. The longest measured spicules from one of the aculei were 2·160^{mm} long and 0·096^{mm} broad.

In the specimen Nr. 1 the top of the rhachis is so much contracted and partly damaged, that its more particular structure cannot well be made out; in Nr. 2 the rhachis is terminated above by a rather large individual with three-toothed calyx; this may possibly be a somewhat uncommonly developed terminal zooid, possibly the transformed terminal polyp; in the latter case, the terminal zooid must have disappeared.

The 11 specimens brought home by the steamer «Thor» from the south of Iceland, are, as already indicated, of an intense, deep-red to violet colour; size and other proportions are given below:

	Nr. 1.	Nr. 2.	Nr. 3.	Nr. 4.	Nr. 5.	Nr. 6.	Nr. 7.	Nr. 8.	Nr. 9.	Nr. 10.	Nr. 11.
Total length	111 mm	105 mm	102 mm	100 mm	86 mm	85 mm	75 mm	65 mm	65 mm	.....	30 mm
Length of peduncle	58 »	53 »	46 »	45 »	38 »	38 »	40 »	30 »	35 »	. .	14 »
Number of wings	23/24	19 20	20/19	17/17	17/17	21/21	14/14	14/15	13/13	..	8/8
Length of a well-developed wing	20 mm	22 mm	19 mm	24 mm	24 mm	21 mm	14 mm	21 mm	15 mm	21 mm	8 mm
Breadth of such a wing above the base	3 »	3 »	ca. 3 »	3 »	3 »	2·5 »	2·2 »	2 »	2 »	2·6—3 »	1·5 »
Number of polyps in such a wing	8	10	10	9	9	9	7—8	7—8	7	9—11	3—4
Length of the largest spines (zooids)	3 mm	2 mm	3 mm	2·8 mm	3 mm	2 mm	3 mm	3 mm	2·2 mm	3—3·5 mm	c. 1 mm

None of the first ten specimens show any distinct terminal polyp; some (Nr. 1, 4, 5, and 7), on the other hand, have a distinct terminal zooid, in Nr. 1 with a spiniform, large, but distinctly two-pointed calyx; in some, rudimentary wings with reduced polyps are found at the apex; in some distinct top-zooids. Nr. 10 is a torn-off pen, not quite complete below. In the specimen Nr. 11 (from St. 166), on the contrary, the terminal polyp and terminal zooid are well developed; in spite of its slight size it may already be recognized quite distinctly as belonging to the species *aculeata*; a few of the zooids are not only larger than the others already, but have also the long calyx-tooth distinctly marked; moreover, the specimen is of the same dark, violet-red colour as the ten specimens from St. 167.

Pennatula aculeata is originally known from the western coast of Norway; it is here (see Grieg **30**, p. 9) said to go farther north than *P. phosphorea*, viz. to the Lofotens, and to greater depths (400 fathoms); it seems not to have been found farther south than Askevold (Söndfjord). Later it has been found by the English expeditions of the «Porcupine», «Triton», and «Knight Errant» at the following places in the Atlantic: west of Brittany (48° 26′ N. Lat. 9° 44′ W. Long., 358 fathoms); north-west of Rona (the Hebrides) (59° 40′ N. Lat. 7° 13′ W. Long., 556 fathoms, and 59° 37′ N. Lat. 7° 19′ W. Long., 520 fathoms); further, by the Prince of Monaco near the Azores (38° 34′ 30″ N. Lat. 30° 43′ 30″ W. Long., 1287 M.); by the French expedition of the «Caudan» in the Bay of Gascony (46° 28′ N. Lat. 7° W. Long.[1]), 1710 M.); by the «Travailleur», west of the Spanish peninsula (P. Fischer, **23**, p. 38). To these localities are to be added as new ones: south of the Vestman-Islands, 63° 5′ N. Lat. 20° 7′ W. Long., 557 M. (the «Thor», St. 167, 14/7 1903), and 52° 57′ N. Lat. 19° 58′ W. Long., depth 956 M. (the «Thor», St. 166, 14/7 1903). The species is not known from the North Sea nor the adjoining seas, the Skager Rak, Kattegat etc., nor from the Mediterranean. On the American side of the Atlantic it is very common, and is hitherto known from the Gulf of St. Lawrence as its northernmost locality (Whiteaves), to off Chesapeake Bay. To this occurrence on the American coast is to be added the new locality, St. 25 of the «Ingolf», Davis Straits, 63° 30′ N. Lat. 54° 25′ W. Long., 582 fathoms, by which observation its northern limit on the American side has been carried considerably farther north. According to the above, this species is assuredly to be regarded as a purely North-Atlantic one; it is not known south of the Azores, nor on the American side farther south than 33° N. Lat. (Agassiz: Three Cruises of the

[1]) Reckoned from the meridian of Paris.

Blake, vol. II, p. 142. Bull. Mus. Comp. Zool. vol. 15); it seems to be limited essentially to the margins of this part of the Atlantic and to the slope into great depths. As to its bathymetric range the lowest depth is 30 fathoms, at Norway, but upon the whole it occurs in greater depths; on the American side, where, as mentioned, it is very common, it is still found at 1255 fathoms (Verrill: Rep. U. S. Fish. Comm. 1883 (1885) p. 509), but it is most abundant between 150 and 300 fathoms.

Whilst the very closely allied *Penn. phosphorea* has not yet been found in America, a *Penn. americana* has been described by Moroff. According to the description, it is beyond all doubt, however, *P. aculeata*. M.'s specimen is also from Massachusetts (see Zool. Anz. 1902 and Zool. Jb. 17. Bd., 1902).

Pennatula phosphorea L. var. **candida** Marsh. & Fowl.

A. Milnes Marshall and G. H. Fowler: Report on the Pennatulida dredged by H. M. S. Porcupine». Trans. Roy. Soc. Edinb. vol. 23, part 2, 1887, p. 456, Pl. XXXI; Pl. XXXII, Fig. 3.

This form has been founded by Marshall and Fowler l. c. on three fragments taken by the «Porcupine» in 1869 at 62° 1′ N. Lat. 5° 19′ W. Long. Our Zoological Museum has obtained 17 specimens from the Vestman Islands, 7 from the physician Thorsteinn Jónsson, who, according to «Skýrsla um hid islenzka náttúrufræðisfélag árid 1897—98», p. 12, has also given a specimen to the Natural History collection at Reykjavik; 8 specimens from the cruise of the «Diana» in 1900 (A. C. Johansen); 1 specimen from 1901 (R. Horring), and 1 from the collection of the «Thor» in 1903. The species is peculiar by its being perfectly white in spirit, almost all the spicules being colourless; the animal, when living, may be of a slight reddish colour (according to Horring), and in a single specimen the red colour is still distinctly seen (see below). Otherwise it agrees in several features with *Penn. phosphorea* var. *augustifolia* Köll. (Monogr. p. 130). The pinnules are slender, and the calices of the polyps are long and conspicuous, provided with 8 long teeth formed by spicules; the number of pinnules on either side 17—24 (often differing somewhat on the two sides of the rhachis; comp. below). The tentacles of the polyps carry spicules along the dorsal side of the stem. The large spicules, as elsewhere in *P. phosphorea*, are fusiform, and thus only conspicuously triangular at the ends; in section, they are somewhat round; the smaller ones, on the other hand, are altogether triangular. The largest polyp-spicules measured are 1·072^{mm} long, and 0·072^{mm} thick; the smallest are 0·04—0·048^{mm} long, but the general length of the spicules of the tentacles is 0·096—0·128^{mm}.

The specimens in hand show the following particular features:

Nr.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Total length in mm.	37	65	65	65	66	72	72	75	75	80	80	80	83	85	90	...	78
Length of stalk »	15	27	30	30	32	30	35	32	34	35	35	40	40	41	42	...	36
Number of wings...	12/12	22/21	19/19	20/18	17/19	22/23	22/22	18/17	19/18	19/20	23/24	21/21	20/21	22/21	20/20	25/23	18/18
Number of polyps in one of the large wings	6	9—10	8—10	9	11	9	10	9	8	8—9	10—12	10	9—11	8—11	9	10	8—10
Length of a wing in mm.	10	15	11	13	14	12	11	16	14	17	16	11·5	19	12	15	12	13

The specimen Nr. 1 is distinguished by having rather a strong red tinge, so that it approaches somewhat the common *phosphorea*; both polyps and zooids contain red spicules in considerable numbers; the polyps are red, but with white calyx-teeth and white lateral edges; the edges of each wing are therefore white, and the red surface is streaked with narrow white lines marking the boundaries between the coalesced polyps. A quite similar distribution of the colours, only with a far deeper red, is not uncommon in typical *phosphorea* specimens from the Kattegat. Further, this specimen has kept both terminal polyp and terminal zooid, as is also the case with the specimens Nr. 4 and Nr. 9. In the specimens Nr. 3, 7, 12, 15, 16, and 17 the quite distinct terminal zooid is preserved in its full development, but the terminal polyp is transformed into a zooid, either of equal size with the terminal zooid (Nr. 15), somewhat smaller than this (Nr. 12), not much smaller (Nr. 3) — or quite atrophied (Nr. 7, 16, 17). Although the specimens in question, with the exception of Nr. 1, are large and must be considered as fully developed, the features mentioned are quite uncommonly distinct. The other specimens show much altered features at the upper end of the rhachis; some specimens (e. g. Nr. 6) show very beautifully a number (4) of large «top-zooids», amongst which, probably, both the terminal polyp and the terminal zooid are to be sought. In the specimens Nr. 2 and Nr. 7, the peculiarity is found that one of the dorsal zooids near the middle of the edge of the rhachis is developed as a solitary polyp, 7 and fully 4^{mm} long respectively. The specimen Nr. 14 approaches somewhat the «lancifoliate» form[1]). Most specimens contain ripe sexual organs, and some seem to contain larvæ.

Occurrence. This light-coloured form has been taken by the «Porcupine», as mentioned, on 62° 1′ N. Lat. 5° 19′ W. Long., accordingly E. of the Faeroe Isles, at a depth of 114 (English) fathoms. All the specimens here mentioned are from the Vestman-Islands; with regard to Nr. 2, 5, 8, 10, 11, 13, and 14 there is no information as to the depth or the bottom; but to judge from the attached particles it must have been black Basalt-mud; Nr. 9 has been taken at 50—60 fathoms, E. of the Vestman-Islands, $2^1/_2$ miles E.N.E. of Storhöfdi; the others have been taken (the «Diana», 1900, St. 41) on «clay-bottom», at a depth of 68—70 fathoms; Nr. 17, the «Thor», 1903, St. 169, 63° 24·5′ N. Lat. 20° 1′ W. Long., depth 120—158 m., ooze. All the specimens have been taken during the summer months (July, August).

This pale or white variety probably occurs on restricted localities within the wide extended area of the species, but with regard to the more particular conditions under which it is produced and thrives, we have no information which could render any certain statement possible. The question can scarcely be of a casual albinism, as all the specimens known from the Vestman-Islands belong to the same pale variety, and in its red forms *Penn. phosphorea* is altogether unknown hitherto from any locality at or round Iceland or the Faeroe Isles. Other discoveries of white forms of *Penn. phosphorea* are, so far as I know, only referred to by two authors. Kölliker describes a white specimen in his Monograph, p. 133; it belongs to the Museum in Copenhagen, and I have thus been able to compare it with the form from the Vestman-Islands; it is very different from this latter, and Kölliker with good reason has determined it as a subvariety *alba* of *Penn. ph.* var. *lancifolia*. Unfortunately, we

[1]) When Marshall and Fowler give $4{\cdot}2^{cm}$ as the greatest length of a pinnula in their specimens, this is surely due to a misprint; such a length is scarcely found in any form of *P. phosphorea*, and the figures on Plates 31 and 32 give also a length of only ca. $14—15^{mm}$.

have no information at all as to the place where the specimen was found. Esper's *Pennatula alba* which Kölliker has referred to his var. *angustifolia*, closely resembles, to judge from the figure, **22**, pl. VI, the specimens in hand from the Vestman-Islands; their colour is said to pass almost imperceptibly into a reddish one; but we have no information as to the place where these specimens of Esper were found.

Verrill mentions a white specimen of *Pennatula aculeata* (Amer. Journ. Sc., vol. 23, p. 310, and Report... «Blake» p. 3) taken by the «Fish-Hawk» at st. 1025, depths 216 fathoms; he says of it: «This is doubtless only an albino»; it appears to have been taken together with numerous specimens of the common red form of *Penn. aculeata* (comp. Am. J. Sc. 23, p. 315).

Remarks. According to what has hitherto been known, it must be regarded as hardly probable that *Pennatula phosphorea* should be found outside the Atlantic. Studer, however, in his preliminary report of the «Albatross» Expedition (p. 55) has given *Penn. phosphorea* as from the Pacific, from 0° 19′ N. Lat. 90° 34′ W. Long., 331 fathoms, and *Pennatula distorta*, Dan. Kor, var. *pacifica*, n. var.», from 1° 7′ N. Lat. 81° 4′ W. Long. Of the former, it is said that the (single) specimen was not to be distinguished from the Atlantic (i. e. the typical) *phosphorea* L. As to *Penn. distorta* Kor. and Dan., this species cannot be maintained, in my opinion; it is nothing but *Penn. phosphorea* with unusually narrow and (casually?) distorted wings; and the *Penn. distorta* var. *aculeata* described by the same authors, is obviously only «distorted» specimens of the species *Penn. aculeata*. And with regard to Studer's «*Penn. distorta, pacifica*», his remark that the colour is whitish yellow, and that the calyx-spicules appear to be longer and more conspicuous, seems to me to indicate that another species must be in question; from the Asiatic side of the Pacific several *Pennatula*-species are known, among others just such forms with narrow leaves in which yellow or reddish yellow is prevalent in the colour, and where the type of spicules, moreover, is different from that of *phosphorea*; also the depth, 1740 fathoms, must be regarded as somewhat great for the supposed species. Th. Moroff (Zool. Anzeiger 1902, p. 579, and Zool. Jahrb. Abth. Syst. 17 Bd., 1902, p. 380) has established a *P. phosphorea* var. *longispinosa* from Japan (1 specimen); unfortunately, his figures show only that the specimen is a *Pennatula*; but some remarks in the description would indicate that *phosphorea* is not in question (for instance the broad streak between the «ventral» zooids).

Pennatula grandis Ehrb.

Pennatula grandis Ehrenberg. Die Corallenthiere des rothen Meeres, 1834, S. 66.
borealis M. Sars. Fauna litt. Norvegiæ, I, 1846, p. 17, Pl. II.
Ptilella borealis Gray. Catalogue of Sea-Pens, 1870, p. 21.

This splendid species has not been taken by the «Ingolf» itself; but during one of our sojourns at Thorshavn I received from Mr. Finsen, apothecary, a specimen taken on «the bank south west of the Faeroe Isles at a depth of 90 fathoms»; later, 19 specimens from the Faeroe Isles have been sent to our Museum by the agent Mr. Müller, taken on the fishing bank east of Fuglø, ca. 150 fathoms. With the exception of one individual (Nr. 20) all the specimens are large and well-developed.

I can add nothing essentially new to the former descriptions (by Sars, Kölliker, Koren & Danielssen,

Verrill, a. o.) of this species which can scarcely be confounded with any other. I shall only make a few observations on the spicules, as these have not been described in particular by the earlier authors. The spicules are of a marked triangular type; in the larger types especially the polyp-spicules (i. e. of the calices, the upper part with the tentacles containing no spicules) the three ridges which constitute the spicule show their free edges to be distinctly thickened, whilst the sides are hollowed; in the red spicules, therefore, the colour is deeper at these thick edges. The polyp-spicules measure 0.144—0.897^{mm} long, and 0.016—0.048^{mm} broad. The colourless part of the peduncle is provided with short, coarse spicules 0.088—0.120^{mm} long, the thickest ones being 0.024^{mm} thick; these spicules are of a very slight reddish colour; the deep-red spicules from the band-shaped edge of the bulb are 0.096—0.200^{mm} long, and 0.016—0.032^{mm} broad.

The specimens in hand from the Faeroe Isles show the following particular features:

Nr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
Total length in mm.	445	445	435	435	433	430	430	425	420	420	410	400	398	395	390	380	370	315	210	107
Length of peduncle, to the edge of the bulb . . . . in mm.	125	110	90	130	124	120	110	108	110	125	110	82	92	101	80	90	105	. . .	. .	30
Diam. of bulb »	32	34	30	35	32	30	30	29	27	30	27	30	34	27	35	20	23	. . .	23	7
Number of polyps in a well-developed, arge wing	83	73	70	77	74	79	70	73	68	82	78	67	72	78	81	. . .	62	84	. .	25
Number of wings	39/40	42/44	44/41	37/37	44/43	39/39	37/35	37/38	36/35	37/40	39/39	41/41	42/41	39/39	37/37	34/34	39/39	(31/32)	30/31	18/17
Length of a large wing . . . in mm.	. .	.		45	44	. . .	.	35	. . .	41	23	38	43	45	47	. . .	. .	. . .	. . .	22
Greatest breadth of do. . . . . in mm.	. .		. .	23	30	. . .	. . .	26	.	25	23	22	27	24	17	. . .	. .	. .	.	8
Length of polyp-calyx . in mm.	. .		.	4—5	4—5	.	. .	3—5	. .	3—5	3—4	5	5	4 6	5	. .	.	. . .	. . .	4

The specimens Nr. 18 and 19 are defective; in Nr. 18 the lowermost wings are wanting, the tissues of the bulb and the peduncle having been rubbed away; Nr. 19 is broken off below the bulb; the rhachis, which is complete, is ca. 70^{mm} long. Nr. 20 is the smallest specimen of this species I have ever seen amongst the large number I have had the opportunity to examine in our Museum and in Bergen and Christiania; Verrill mentions that he has had several young specimens and one very young, but he gives no measurements nor any further information. For the sake of comparison, I may just mention that the two specimens of M. Sars, upon which the species *P. borealis* was established, were of a respective length of 420 (16″) and ca. 810^{mm} (31″), with 37 and 57 pairs of wings; in other Norwegian specimens measured by Koren and Danielssen, the length is given as 250—780^{mm} with 30—70 pairs of wings and 48—100 polyps, whilst Verrill mentions a specimen of 530^{mm} in length with 36 pairs of wings, as one of the largest American specimens.

The colour in some specimens is brownish or dark brownish-red (especially so in Nr. 20, partly in Nr. 18 and 19), but most frequently of a beautiful red or reddish yellow.

Occurrence. The species was only known hitherto from the fjords and coast-regions of Norway, the eastern coast of North America where it is common on the fishing banks off New

Foundland, Nova Scotia, and the northernmost of the United states (as far as off Nantucket Island and Martha's Vineyard). To these localities are now to be added the banks round the Faeroe Isles. It has been taken at depths from 50—1255 fathoms[1]).

Pennatula prolifera n. sp.

Pl. II, figs. 15—24.

From two stations in Davis Straits, 24 and 36, we have obtained a *Pennatula*-species in very large numbers, from the former station about 40 specimens, from the latter upwards of a hundred; but all the specimens are young ones, several of them as small and apparently as young as the youngest known stages of *Pennatula phosphorea*[2]); even the largest and most developed specimen is still little developed, as will be shown more particularly below, so far as the pen's provision of polyps is concerned. It is a very difficult thing therefore to characterize the species; or, to speak more correctly, it is impossible to diagnose it briefly by such features, as are elsewhere used in distinguishing species within the genus *Pennatula*. That the species is a new one not hitherto described, will be obvious, I think, from the following description, in which I shall give an account of the peculiar mode of propagation in this species which has led me to give it the specific name *prolifera*.

All the specimens were white, with the exception of two from St. 36, which were light-red; but these also have now turned as white as the others in spirit.

The largest specimen (from St. 24) has to some degree the penniform appearance (figs. 15, 16). The total length is 35^{mm}, in which the rhachis accounts for 18^{mm}, measured from the terminal zooid (see below) to the lowermost polyp-bud, the peduncle $15^1/_2{}^{mm}$; the breadth of the pen is 4.5^{mm} (the polyps being pressed in against the stem); the rhachis itself is ca. 1.5^{mm} broad, the terminal bulb of the peduncle is 2.5^{mm} long and ca. 1.5^{mm} broad. On either side of the rhachis are eight distinct wings and below these four rudimentary wings.

The calyx-mouth of the polyps is provided with 8 long and strong spines supported by long spicules. The form of the calyx, as is ordinarily the case in the genus, is somewhat different according to the degree of retraction; when the polyps are quite retracted, the calyx-teeth are closed and the whole calyx has a lengthened oval form reminding one of a narrow grain of barley. The longest calices are 5^{mm} long and ca. 1^{mm} broad. The tentacles are on the aboral side provided with longitudinally arranged spicules, both on the stem and the lateral branches.

With regard to the arrangement of the polyps it has first to be pointed out that no terminal polyp is present: the pen ends above in two polyps placed (almost) side by side and equally developed; between their bases the upper end of the rhachis itself is found, formed by a large zooid (with two calyx-points). Each of these two uppermost polyps forms a wing (I). This uppermost pair of wings is separated from the next pair (II) by a somewhat long part of the rhachis, this latter pair again by a somewhat shorter distance from the third pair (III), whilst the following pairs (IV—VIII) follow one another more closely.

[1]) Verrill: Rep. U S. Fish. Comm. 1883, p. 509.
[2]) Figured by Jungersen, 1888, Pl. V, figs. 1—2.

Apart from the uppermost wing the other wings contain more than one polyp, as at all events a rudiment of one or two polyps more is found in each wing to the ventral side of the oldest one. In the uppermost pair of wings but one (II) the polyp of the left side (1) carries a small protuberance (*), which I take to be the first trace of individual Nr. 2; the right wing has a distinct individual 2, but still in the zooid-stage; in wing III, polyp 2 is large and well-developed on either side of the colony, but nothing is seen of 3; in wing IV, polyp 2 is still larger, and 3 is present as a zooid; in wings V—VII there are also 3 individuals, but 2 is smaller than in the preceding wings, and decreases in development below, while 3 is still only a zooid in all of them; in wing VIII there are only two polyps, of which Nr. 2 is only a zooid. The four rudimentary wings (IX—XII) consist, each of them — more or less distinctly — of two individuals, both still zooids.

Of zooids, there are 2 longitudinal rows dorsally, one on either side, separated by a bare streak (i. e. devoid of individuals), about 0.5^{mm} broad below, narrowing above (a similar naked streak runs along the rhachis between the polyps of the ventral side); in each row an indication of a grouping into 3—4 zooids for each wing may be traced. The series is already indicated below at the smallest rudiments of wings. — Between the uppermost wing and the next the series is very open, and only one zooid is found at each of the uppermost polyps (1). The zooids look like small scales supported by spicules. At the upper end of the rhachis the rows are completed by a median, considerably larger, single top-zooid, Z, provided with two distinct calyx-points[1]). Of lateral zooids, one seems to be begun immediately above each wing, with the exception of the two uppermost pairs of wings. These rudiments, however, are very small, and difficult to determine with certainty.

The spiculation is copious and dense; the longest spicules are found on the polyps, the next on the zooids and rhachis where they are mostly arranged longitudinally; there are also many transverse, rather long and thin, spicules on the peduncle, intermingled lower down with longitudinal, short, oval ones; towards the terminal bulb the spiculation diminishes to open, longitudinal rows of short, oval spicules, and the bulb itself has no spicules, and is therefore transparent, so that the interior longitudinal septum is seen (but no terminal pore; I think upon the whole that the existence of such a pore in *Pennatula* normally is very doubtful[2]).

The spicules (especially with regard to the long ones) are of quite a different type from that predominant in *Penn. phosphorea*. The fact is that all the spicules (excepting the oval ones in the peduncle) are distinctly and sharply triangular, recalling mostly those of *Penn. grandis*. The longest measured are 0.784^{mm} long, 0.04^{mm} broad; the short and thick ones are respectively 0.160^{mm} and 0.04—0.112^{mm}, and 0.032^{mm}; the small oval spicules of the peduncle are 0.064—0.088^{mm} long, and 0.016^{mm} broad.

The calcareous axis terminates above, bent to the right, opposite to the third uppermost wing, and below, also curved, just above the terminal bulb.

The sexual organs are fully developed; they may be seen shining through the polyps without any further preparation, but still more distinctly by clearing with oil of cloves; in

[1]) In this specimen the top-zooid has by chance been wedged in between the two uppermost polyps, so that it is only partly seen in the figure, but both from the dorsal and the ventral side.

[2]) Comp. Jungersen, 1888, p. 161.

all the more developed polyps, from the uppermost to the two lowest, large eggs (or larvæ) are seen; in the rhachis, on the other hand, no sexual products are found.

In the other specimens, about 150, that I have been able to examine, there is found, a so to speak continuous series of stages, from the one just described down to a stage where the colony is provided with only one pair of wings (I). Representatives of these stages may be found figured on Pl. II, figs. 17—24.

One specimen (St. 24) of a total length of 29^{mm}, is provided with six distinct pairs of wings, and below these with tiny rudiments of two pairs more. Each wing of the uppermost pair (I) consist of three individuals: one fully developed polyp, one somewhat smaller, and one still a zooid; the next wing (II) shows the same development. The wings III—V still consist of three individuals, but two are in the zooid-stage, and the most ventral, youngest one, is already very small in IV, in V both are very small; VI consists of only two individuals, a small polyp, and a small zooid; both the rudiments (VII, VIII) consist of a larger and a quite small zooid.

Another specimen (St. 24), of 25^{mm}, shows 5 pairs of wings and 2 pairs of rudiments; all the wings consist of two individuals, the two uppermost of a developed polyp and one little developed, (wing I on the right, however, has three individuals, being provided with a small zooid), the others of a polyp and a zooid, both decreasing in size from above downwards; the rudiments consist of two zooids. Other smaller specimens of 21^{mm}, also show 5 pairs of wings and 2 or 3 pairs of rudiments; others again (25—16^{mm}) 4 pairs of wings, 3 pairs of rudiments, others (17—13^{mm}) 3 pairs of wings, 3 pairs of rudiments; others again 2 pairs of wings and 2 pairs of rudiments, Pl. II, figs. 17, 18; in all these specimens each wing consists of two individuals, a polyp and a zooid. Finally, we have several specimens with only one pair of wings, and below one or two pairs of rudiments, and some specimens with only one pairs of wings and no rudiments below (Pl. II, figs. 19, 20). Each wing in these latter, however, consists also of two individuals, a developed polyp and a small zooid.

The proportion between the rhachis and the peduncle as to length is somewhat varying; sometimes the former, sometimes the latter is the longer, but often they are about equal in length. Developed sexual organs (sometimes larvæ) are seen in most polyps, at all events in the developed ones; in quite small (10^{mm} long) specimens indeed with only one pair of wings and 2 pairs of rudiments, I have seen large and developed sexual organs in one or both of the large polyps. Even the smallest specimen, of 6^{mm}, represented in figs. 19, 20, shows (by clearing with glycerine) the sexual organs, though not yet ripe. All the specimens have the two rows of zooids (z), but their number in each row is very varying, increasing with the number of wings; in the specimens with only one pair of wings only one or two zooids are found in each row. The small lateral zooid above each wing is only seen in the tolerably well developed colonies. A common feature in all the specimens is further, that the stem contains a calcareous axis, and that the rhachis terminates above in a large zooid (Z). This series of stages therefore is evidently a developmental series, in which the last-mentioned specimens with only one pair of wings are the youngest. That this developmental series belongs to a species of the genus *Pennatula* is undoubtedly a fact; but the rather obvious supposition that the young stages of the pale variety of *Penn. phosphorea* var. *candida* before mentioned might be in question, is inadmissible on account of the difference in the type of the spicules, and a closer comparison with

the developmental stages known of *P. phosphorea* renders it quite untenable. *Penn. phosphorea* always shows more numerous and more advanced polyps in the single wings, at stages where the number of wings is as in specimens of the present new species, and the colony is upon the whole more developed at corresponding sizes; on the other hand, the young colonies of *P. phosphorea* show no ripe sexual organs. These features, however, might be thought to be influenced by the conditions of life at such great depths as the one from which the new form has been obtained. The most conclusive thing to my mind, however, is the great difference in the construction of the upper end of the rhachis. In young colonies of *Penn. phosphorea* the rhachis always terminates above in a terminal polyp, and on the dorsal calyx-base of this there is a large terminal zooid which completes the rows of dorsal zooids[1]). Both terminal polyp and terminal zooid are found even in well-developed colonies with complete pen-form (for instance, in specimens of more than 35^{mm}, with 12 pairs of wings, the largest of which are provided with 5—6 polyps; but more rarely in still larger specimens); in the new species however, no stage not even the youngest, shows the least indication of a terminal polyp: the rhachis ends as stated in a large zooid, and the two nearest polyps (or wings) are equally developed and placed at almost the same height; thus the younger stages especially have a dichotomous appearance, markedly different from that of *Penn. phosphorea*.

According to what has been known hitherto, the primary individual, developing directly from the larva which arises from the egg, is in all Pennatulids a polyp with tentacles (see my treatise pp. 162, 173); as this polyp grows greatly in length, its lowermost part below the calyx forms the stem (rhachis + peduncle); on this lengthened part the other individuals, polyps and zooids, appear gradually (in some genera zooids are also formed on the polyps). During the growth of the colony the terminal polyp may later disappear; this is probably the case in most of the genera of sea-pens, and it is the rule in *Penn. phosphorea*. Where the disappearance of the terminal polyp is not due to a mere displacement (as in *Kophobelemnon*), it may be due either to an abortion or a transformation into a zooid. In the genus *Pterocides* the latter seems to be the case; when the colony has grown to a certain size, the end of the axis, at all events, carries a very large zooid instead of a terminal polyp, (see Kölliker, Monograph, p. 356, my previous treatise, p. 172, and v. Koch 2, p. 398). In *Penn. phosphorea*, the end of the rhachis of large colonies carries generally several very large zooids «top-zooids»; amongst these presumably, are both the original terminal zooid and — by a retrograde transformation — the terminal polyp and some of the uppermost wing-polyps (comp. Jungersen p. 168, and v. Koch). With these facts in view we return to our new *Pennatula*-species. It may be maintained with a probability, bordering on certainty, that this species like *P. phosphorea*, has also had a stage not only with a terminal polyp, but also with a terminal zooid on its calyx-base. — I shall only recall the fact that such a distant form as *Renilla* agrees completely in this respect with *P. phosphorea*. How, then, has the terminal polyp disappeared here?

1) If a displacement had been the cause, one of the two uppermost polyps would have to be regarded as the terminal polyp, and the large zooid of the end of the axis would represent the terminal zooid. This supposition, however, is inadmissible, partly because this large zooid is not placed in the same way as the real terminal zooid in *P. phosphorea* and *Renilla*, on the dorsal calyx-base of either

[1]) Comp. my previous treatise p. 168, and Marshall & Fowler, Penn. «Porcupine», Pl. XXXII, figs. 5 and 7.

of the polyps in question, partly because both the upper polyps (I) always (or, at all events, with very rare exceptions) distinctly appear as lateral polyps, i. e. wing-polyps, a polyp Nr. 2 sometimes even a Nr. 3 being found at their base on the ventral side of the colony (whether these latter ever grow to their full size is of no consequence in this connection); in *Penn. phosphorea* (and *Renilla*) the terminal polyp is always single, and continues to be so.

2) The large zooid on the end of the rhachis might be interpreted as the terminal zooid, the terminal polyp itself being aborted. This hypothesis would require so early an abortion of the terminal polyp, that we know of no parallel in any other Pennatulid whatever.

3) The terminal polyp might be transformed into the large zooid, which ought, in this case, to be denoted as the »top-zooid». This interpretation would be met by a difficulty quite similar to the one in supposition Nr. 2, and further by the fact that the original terminal zooid must have disappeared at the same time — that is to say, at a very early stage. This seems little probable, when it is remembered that v. Koch has in one case found the real terminal zooid to be preserved in a specimen of *P. phosphorea*, in which the terminal polyp seemed to have disappeared, a full grown specimen with 38 pairs of wings (comp. v. Koch, 2, p. 397, fig. V).

Although, in spite of the difficulties indicated, the possibility is scarcely quite rejected that one of the two latter suppositions, or both, may apply to this species, I believe I have observations which show quite a different interpretation to be the correct one, and make the others superfluous.

The fact is that amongst the many specimens from St. 36 no less than 18 individuals, and 3 individuals amongst those from St. 24, show that this species is capable of transverse fission. By this fission only the upper end of the rhachis with the uppermost pair of wings (I) is separated. The separation always take place close above the second uppermost pair of wings (II), and before it is quite accomplished the part of the rhachis situated between the two uppermost pairs of wings evidently stretches longitudinally; by this means, the part prepared for separation becomes similar to the the youngest known stages of development described above; compare figs. 19, 20 with the top of figs. 21 and 22. A clearing with glycerine or oil of cloves shows, however, that all the specimens in hand which are in the act of transverse fission, contain no calcareous axis in the top-part destined for separation; this part contains only the continuation of the longitudinal partition which farther down in the rhachis contains the calcareous axis. This axis itself terminates always immediately below the point of separation, generally with a hook turned to the right but this may also assume a somewhat different form (comp. fig. 22). This want of an interior calcareous axis is literally the only difference that can be pointed out between the top and one of the youngest independent colonies. The specimens showing the transverse fission belong to the large and middle-sized; the total length is between ca. 17 and 25^{mm}; the number of wings is 4 pairs with 2 or 3 pairs of rudiments, and up to 7 pairs and 3 pairs of rudiments; each wing is generally provided with two individuals, of which Nr. 2 is almost always a zooid; yet the largest specimen, with 7 pairs of wings, shows three individuals in wings II and III: a large polyp, a quite small polyp and a zooid. Developed sexual organs are found in some of the specimens, but in several others, e. g. the one represented in fig. 21, I have not been able to find them. The process of transverse fission itself is seen in somewhat different stages; where the constriction of the rhachis is not deep, the top is least lengthened (comp. fig. 23); where the constriction

is so deep, that the top is only connected with the other part of the colony by a quite thin string, the top (on the dead specimen) is hanging down like a broken flower along the stem of the colony, and then its rhachis is always prolonged stalk-fashion, most often bent into the shape of an S, so that the top gets a still more independent appearance (comp. fig. 21). Unfortunately, I have had no opportunity of observing the separation itself, the further fate of the separated top, nor that of the remaining part of the colony.

That I am not here guilty of a misinterpretation of chance mutilation is certain; to be sure, casual injuries are not wanting in many of the specimens in hand, but they have quite a different appearance; here the spicules on both sides of the constriction are placed quite regularly and in such a way as to be evidently arranged for the purpose; broken spicules are never seen as in injuries; moreover, the facts that the constriction always takes place at the same spot, that it is found in different stages and in a somewhat large number of specimens, and further that the top grows in length and emancipates itself, as it were, tend without a doubt to show that this species really is able to separate off the top. Of course it may be doubted whether this is a normal process; but I think it an obvious conclusion to take it to be normal, and to regard the phenomenon as a kind of propagation. The whole individualized character of the top, ready for separation, seems to me to indicate that this part will later live independently as a small colony, develop an interior calcareous axis[1]), continue to grow and increase its number of individuals. The rest of the colony, the mother-colony, will then probably form the large zooid at the place of constriction. One single specimen (fig. 24), without any constriction, seems to me of some interest in this connection; in that place of the rhachis where the constriction is seen in the other specimens, we have here a large, single and median zooid (Z') projecting in a polyp-like manner and interrupting the two rows of smaller dorsal zooids; it is provided with two lateral calyx-points in quite the same manner as the zooid which terminates the rhachis above between the two wings I (Z). The interpretation of this feature might be that the large top-zooid had been formed exceptionally before the constriction, this having not taken place or having been delayed for some reason or other. The specimen in question is otherwise of a good size (27^{mm}), has 7 pairs of wings and 3 pairs of rudiments and contains developed sexual organs (even larvæ); the calcareous axis reaches only to the height of the pair of wings III, that is to say, to a tolerably great distance from the spot where the large zooid is formed.

My conclusion is accordingly, that all the mentioned features of the transverse fission observed, tend to show that this species may justly be called *Pennatula prolifera*. We should then have found a mode of propagation within the Octactinia somewhat reminding one of that known in the Polyactinia, for instance in *Goniactinia prolifera* (M. Sars), and the *Fungiæ*; but the question, with regard to this sea-pen, is of a transverse fission of a colony.

Several facts will be more intelligible viewed in this light. In the first place, the circumstance will now be readily understood why the species was taken in great numbers at both places where it was found, and that, in spite of this, it is only represented by colonies of a youthful character. It is obvious that the colonies need only a slight degree of development to be capable of transverse fission

[1]) It might, however, be possible that an interior calcareous axis might come up, before the separation took place; the contrary cannot be said to be proved by the specimens in hand.

(as in *Goniactinia*, it is only young individuals that divide); the new colonies separated off by the division will soon get so far as also to divide; even the mother-colony itself will soon again be able to throw off the top part, and so on. Secondly, the fact will be explained that in the whole series of development found, no specimen, however small, is provided with terminal polyp and terminal zooid; the smallest colonies may possibly simply be tops of somewhat older colonies recently divided, which older colonies had before divided — perhaps more than once. Accordingly, we do not yet know the real primary polyp of this species, nor do we know the appearance of the species in its full-grown state. Whether the finished *Pennatula*-shape is ever reached must remain doubtful; I think, however, that the largest specimen in hand indicates that some individuals attain this form. This would not be necessary for the sake of the sexual generation, as a great number of the imperfect colonies have proved to be sexually ripe.

Occurrence. The Davis Straits; St. 24, 63° 6′ N. Lat. 56° W. Long., (ca. 40 specimens), and St. 36, 61° 50′ N. Lat. 56° 21′ W. Long. (upwards of 100 specimens).

The depths are 1199 fathoms and 1435 fathoms; accordingly, the species seems to be a marked deep-sea form; it has been found together with numerous other deep-sea forms; other Pennatulids found there, were specimens of *Distichoptilum gracile*, a series of young stages of *Kophobelemnon stelliferum*, and a young stage of *Umbellula lindahli*.

Fam. *Virgularidæ* Köll., emend.

Virgularia Lam.

Among the peculiar characters of this genus, I shall point out a few which have either not been noticed or only imperfectly:

1) The polyps are provided with a calyx, the edge of which may be simply circular or furnished with 8 more or less distinct small teeth without spicules; in the former case (for instance *Virg. mirabilis*), the edge of the calyx is not seen at all, when the polyps are most extended. I need only mention that the calyx here, as elsewhere, means that the hinder part of the polyp-body is rather stiff, so that the fore part with the tentacles may be retracted into it; thus the necessary stiffness is found here in spite of complete want of spicules.

2) The shaft (the rhachis) may be divided into three regions; (a) that of the developed wings, (b) that of the rudimentary wings, and (c) that of the stalk-zooids. (a) is the longest, upper part of the shaft; the polyps are fully formed, with tentacles etc., but generally contain no sexual products[1]); (b) may be rather long, and is on either side provided with close-set wings with undeveloped polyps which still want tentacles, but contain sexual organs and ripe sexual products; these wings become smaller below and gradually mere rudiments looking like low transverse ridges, and finally pass into (c); this last region is provided on either side with a single row of small zooids, which I shall call stalk-zooids. Close below these the peduncle or stalk begins; the boundary is generally indicated

[1]) An exception is found in *Virg. affinis* Kor. & Dan. (see Kölliker, Monogr. p. 198).

by a slight constriction. Unless the examination is thorough, however, the peduncle seems to begin where the rudimentary wings cease. The stalk-zooids are never developed to polyps, but keep the zooid-form [1]).

3) New polyps are never seen in the act of formation at the ventral edge of the wings (as in *Pennatula* and many other genera); this holds good not only of the whole region (a), but also far down in (b); only in the smallest rudimentary wings are polyps seen to arise as elsewhere in the Pennatulids; that is to say in such a way, that the most dorsal polyp in each rudiment is the oldest, the most ventral one the youngest. One gets the notion indeed, that all the polyps belonging to a wing are begun contemporaneously [2]); certainly every wing, as soon as it has the character of a wing, whether its polyps are fully formed or not, is provided with the number of polyps that it has altogether. Nevertheless the polyp forming the dorsal edge of the wing continues always to be the largest, the one terminating the ventral edge the smallest, even if the difference is often very slight.

4) The calcareous axis has always a b r o k e n end above; it generally projects even with a more or less long n a k e d end from the sarcosoma. This is a well-known and often mentioned fact; but it has been interpreted as due to injury, whilst I think it is caused by the mode of growth of the colony (for further particulars see under *V. mirabilis*).

5) All the species of the genus are provided with the regular radiate canals in the rhachis, pointed out by Kölliker.

In all these features, and in several more, *Halisceptrum* agrees with *Virgularia*; it is quite certain therefore, that the genus *H.* is to be referred to the same family as *Virgularia*; and it may be doubted whether it ought to be maintained as a separate genus distinct from the latter.

Virgularia mirabilis (O. F. Müller).

Pennatula mirabilis O. F. Müller. Zool. Dan. Prodrom. 1776. 3074.
» » Zool. Danica. The Danish edition 1781 (Straa-Sofjæren), p. 43; the Latin edition. 1788, p. 11, Tab. XI.
Virgularia mirabilis Lamarck. Anim. s. vertèbres. 1816. T. II, p. 430.
Kölliker. Monogr. 1872, p. 190.
» *Ljungmanni* Köll. Monogr. p. 196.
» *multiflora* Kner. Verhdl. k.-k. zool.-bot. Ges. Wien. 1858, p. 295.

[1]) K ö l l i k e r has first seen these facts in *Halisceptrum* and in *Virgularia*; but in the description of what he calls lateraler Zooidstreifen , he does not distinguish between the zooids that become partly the wing-polyps, partly the lateral zooids placed under the wings, and those that continue to be zooids and to be arranged in a long single series; these latter are the stalk-zooids.

[2]) In this way the fact has been interpreted by M a r s h a l l; but everybody may, by careful examination of the most rudimentary wings, see that this interpretation is not correct. M., however, was scarcely in possession of any specimen with this part of the rhachis fully preserved. Otherwise he seems to be the only author, who has especially observed the unvarying nature of the number of polyps in the wings. See: Report on the Oban Pennatulida, 1882, p. 63. This little treatise, which amongst many well-known things, contains several new interesting facts, is not found in our libraries, so that, when in 1898 I communicated my conception of the mode of growth and development in *Virg. mirabilis* to the Natural History Society here, I did not know that anyone had before observed the want of increase in the wings of Virgularia. The interpretation of M. of the mode of growth, however, is essentially different from mine (see later).

Of this species, I have had the opportunity to examine a very large number[1]), partly from Danish seas, partly from various Scandinavian regions and from Iceland (the Vestman Islands). I have been able to examine both well-developed and large specimens, to a length of 530[mm][2]), and also young stages down to a size of 10[mm], i. e. smaller than those hitherto mentioned in the literature.

In larger specimens I find the number of polyps in the developed wings very varying, from 12 to 4; specimens with three polyps in the wings or fewer are young stages which will be more particularly mentioned later on. Kölliker, it is true, in his diagnosis of the species, states the number of polyps to be 6—9, but in the more particular description, specimens occur with 10, with 11—12, and with 3; O. F. Müller gives the number as 8, Dalyell 8—10. The lateral zooids placed under each wing occur, in a corresponding manner, in varying numbers; where they are most numerous they are grouped in two transverse rows, in the young stages in a single row and in a number almost similar to that of the polyps. The pedunele is always shorter than the pen, but otherwise of very varying relative length. When Kölliker says: »Feder ungefähr $2^1/_2$—3 mal länger als der Stiel», his statement is by no means always correct. The peduncle, here as in many other Pennatulids, may obviously be stretched very much in the living state of the colony, and in a few preserved specimens it may also be found much longer; in a specimen 350[mm] long from the Kattegat I thus find it to be 250[mm] long (measured from the real boundary towards the rhachis at the cessation of the stalk-zooids).

Of the numerous young stages examined, most, and especially all the youngest ones, belong to the museum in Stockholm. They form together a rather close series, elucidating, I think, the essential facts of development and growth in the Virgularia. There is still, however, a regrettable break between my youngest stage and the single primary polyp, the »oozoite», which we know hitherto only from Dalyell (l. c. pp. 188—189). In the month of June, Dalyell succeeded in hatching some »planulæ» which swam about very actively (l. c. Pl. XLVIII, fig. 11); later, in July, he succeeded in developing other planulæ into the »hydra» form, i. e. into a solitary, tentacled, lengthy polyp (figs. 12—14) without any interior calcareous axis. Apart from the fact that the tentacles developed several lateral branches, these polyps did not change during the period of more than a month, in which it was possible to keep them living. As to the size, unfortunately, no more particular information is given[3]).

In conformity with what is known of (*Renilla* and) *Pennatula phosphorea*, it is to be supposed that this primary polyp grows in length, gains an interior calcareous axis, and develops on either side a row of solitary polyp-buds following each other, as to age, from above downwards, so that a small colony of the simplest penniform type is formed. Such a stage might be called the »Protocaulon»-stage[4]). My youngest stages are of a form approaching very near to this supposed one, the only difference being that they are all wanting in a terminal polyp as the upper termination of the stem.

[1]) Amongst these also, the specimens from our Museum mentioned by Kölliker in his Monograph.

[2]) Kölliker, in his diagnosis, says: »bis zu 345[mm] lang». Dalyell, (l. c. p. 182) however, had already stated a length of 23 inches, or about 585[mm].

[3]) Dalyell evidently — although with a cautious reservation — thinks these young polyps to be, not the beginning of the stem which they really are, but a first wing-polyp. His words are: »Indulging conjectures regarding the incidents of futurity is perilous; however, the survivance of a nascent animal might shew it to be the first of an originating lobe, that the flesh is carried up in a solid mass beyond the bone, and that in this manner both ends of Virgularia are fleshy».

[4]) After a genus established by Kölliker in Chall. Rep., but being really only a *Virgularia*; see p. 30.

Together with some of the more developed stages they have been obtained by Lovén in 1832, partly at Kullen (Mölle), partly at Bohuslän.

The youngest stages measure 10, 10·5, and 11·5^{mm}. One specimen 10·5^{mm} long, is figured on Pl. II, fig. 25, seen from the dorsal side. The upper, polyp-bearing part of the rhachis measures ca. 4^{mm}, the part with the zooids 3·5^{mm}, so that the length of the peduncle proper is 3^{mm}. On either side of the rhachis there is a row of five distinct polyps decreasing in size and stage of development from above; the polyps of one side alternate with those of the opposite side; only in the row on the right is there at the lowermost polyp but one, on the ventral side of the colony, a small rudiment of a wing-polyp No. 2. Below each polyp one lateral zooid is found. In addition, the lower part of the shaft, which is devoid of polyps, carries on either side a longitudinal row of four distinct and large stalk-zooids. The uppermost is placed about 1^{mm} below the lowermost polyp-bud, and the zooids of the two sides are somewhat alternating in position. At the first glance, the upper end of the stem seems quite intact, and no naked part of the calcareous axis projects; but on a more thorough examination the calcareous axis is seen to end quite abruptly, as if cut off, in the thin sarcosoma; accordingly, its upper end does not taper to the fine thread, usually found in Pennatulids. Further, the top of the stem is not occupied by a developed polyp which might be regarded as the terminal polyp, but there are at the top two somewhat alternating and quite rudimentary polyps, without tentacles; below each of them is a lateral zooid, so that they prove to be wing-polyps. Thus the features at the top are already highly changed; at all events, the terminal polyp and the upper end of the calcareous axis have disappeared, and the two wing-polyps that are now the uppermost ones are about to atrophy, or — what I think less probable — to regenerate. The specimen is excellently preserved, so that the radiate canals in the rhachis are easily recognised, and there are no traces of generative organs. The two other specimens agree in essential features with the one described, the only difference being that all the wing-polyps are solitary. The specimen 11·5^{mm} long[1]) is provided with 6/6 solitary polyps, each with a lateral zooid below, and four stalk-zooids. At the upper end of the axis a rudimentary polyp is found only on the left side; but this polyp has to an important degree a distinctly atrophied appearance, and is very little similar to the young imperfect polyp-buds at the lower end of the shaft.

A number (8—9) of small colonies, 11—22^{mm} long, appear somewhat more developed, in that some of the wings are provided with two polyps. A specimen is figured on Pl. II, fig. 26, seen from the ventral side; it is 22^{mm} long, with a peduncle of 4·5^{mm}. Each of the wings of the upper part of the rhachis consists of only one polyp (on the left side there are 4 such, on the right side only 2), each of the following wings lower down have two polyps, likewise the distinct rudimentary wings under these show two polyp-buds with perceptible difference in age. Under each of the wings with two polyps and rudimentary wings two lateral zooids are found, under the upper solitary polyps only one such zooid. The number of stalk-zooids is doubled (8 on the right side, 9 on the left), and the lowermost indistinct rudimentary wings[2]) almost reach the uppermost of them. To judge by the size, each of the new stalk-zooids seems to have arisen in the interspace between two of the older

[1]) In this specimen two parasites are present in the rhachis; on account of the transparent sarcosoma the lower one may distinctly be recognized as a *Distoma*.

[2]) These are not given in the figure, as they are only seen under rather high magnifying powers.

ones. At the top of the shaft a short portion of the calcareous axis projects nakedly, and the uppermost wing-polyp is somewhat rudimentary. Quite similar features are found in the other specimens; in some, the ventral polyp of the two-polyp wings is quite small, but a bud, and among the two-polyp wings there may be a wing with only one polyp, but it, like the wings with two polyps, is provided with two lateral zooids. At the apex of the stem one or two rudimentary polyps are found, and above the uppermost there is generally a lateral zooid, which, together with the broken end of the calcareous axis shows that the original apex must be wanting.

Other specimens again, up to a length of 40^{mm}, show two-polyp wings quite to the apex with two lateral zooids, and likewise in the rudiment-region, which in the larger specimens is long, and reaches to the numerous stalk-zooids; a specimen of a length of 40^{mm} numbers on either side 11—12 wings with developed polyps.

A somewhat more advanced stage is represented by the specimen 45^{mm} in length (from Bohuslän) figured on Pl. II, fig. 27. At the apex a naked end of the calcareous axis projects; uppermost are two single, rudimentary polyps; then follow two-polyp wings, of which the two uppermost are rudimentary, whilst the others (5/6) are provided with two fully developed polyps; next follow wings with three polyps the most ventral of which is the smallest, and the farther we get down, the smaller it becomes; but so long as the polyp-buds of the smallest wings in the rudiment-region may be discerned, the number continues to be three. Of lateral zooids three are found under all the wings. The stalk-zooids are numerous (upwards of 16), and close-set, especially below. Similar features are seen in several specimens, partly Swedish, partly from the Vestman Islands. Finally, we have a great number of young colonies, 60^{mm} in length and others (Swedish, Icelandic specimens, one Danish fragment) in which the developed wings and the rudiments, whose polyp-buds are distinct, contain three individuals; at the apex, however, (if not damaged) a few two-polyp wings are regularly found, but with rudimentary polyps. The number of lateral zooids is three or four; in the latter case one of them may be placed in a second row. In the rudimentary wings where the most ventral polyp-bud is very small, the corresponding lateral zooid is also indistinct. The rudiment zone is long and joins onto the line of stalk-zooids; in a specimen (from Kristineberg) 60^{mm} long, with 15/15 fully developed wings I have counted ca. 36 stalk-zooids in a closely packed series.

The larger colonies with four, five, and more polyps in the wings, which are generally found in collections, although most frequently in fragments, connect directly with such stages as the last-mentioned.

The young stages described accordingly show: 1) that the number of polyps in the wings is gradually increased by one individual in the rudiment-zone, 2) that by the longitudinal growth of this zone the new wings advance farther upward, as also the older wings above with fewer polyps, 3) that contemporaneously with this growth, transformations take place at the apex, as the oldest wings, and upon the whole the older parts of the colony, here atrophy and finally drop off; for, the fact that all the well-preserved young stages, even the smallest, are provided at the apex with indisputable rudimentary polyps, without tentacles and often much diminished, seems to me to be most naturally interpreted as an atrophy. A new light is thrown on the condition found also in the older colonies by this interpretation: it is evident that the same processes continue, as long as the *Virgularia* is living.

It is well-known that most of the specimens found in collections are fragments; generally the peduncle is wanting, often also the upper end. This, of course, is often owing to the fact that the long and thin colonies with the fragile calcareous axis, are easily broken by the fishing gear, and especially easily at the spot where they rise up from the bottom. But when Kölliker says that he has seen no single specimen undamaged at the upper end, this statement is most likely due to a very common misconception. The fact that a naked end of the calcareous axis, which moreover is abruptly broken, projects from the sarcosoma, is generally taken to be due either to a contraction in spirit of the soft parts of the colony, or to chance mutilation. That the former cannot hold good as a general cause is easily seen: in many cases, the sarcosoma beneath the naked part of the axis is not contracted at all or drawn away from its part of the axis, but wraps this part as firmly as in any other part of the colony, and moreover specimens just caught and still living show the same feature. If the condition was due to damage, the first thought occurring to one would be of such as might be caused by the fishing gear. But the same kind of fishing gear may bring up other forms as long and fragile, for instance *Funiculina*, in a quite undamaged condition, sometimes even together with Virgulariæ; and again, there are several signs tending to show that *Virgularia* and allied forms, while they are still growing undisturbed in their natural element, are already possessed of the naked end of the axis; it is well-known that other organisms, for instance Serpulæ, have been found attached to this part[1]); besides, certain Virgulariæ and Stylatulæ have been observed in places where it was possible to wade out at low water, and draw them up with the hands, or where divers might easily see and take them[2]); these forms showed the naked axis-stump. Here the mutilation cannot be due to the fishing apparatus. Marshall[3]) has also been of opinion that the mutilation might be due to the fact that other sea-animals, especially fishes, had browsed on the tops. To support this supposition, he refers to the fact that fragments, and especially often tops, of *Virgularia* have frequently been found in the stomachs of haddock and cod. From the description Marshall gives of the fragments he takes to be entire tops, it is clearly seen however that the calcareous axis was broken, and that it even projected from the sarcosoma with a small naked part (Oban Penn. p. 56). Kölliker has perhaps also had before him specimens with tops that were „perfect", in the signification in which Marshall uses the word. In the Museum of Copenhagen however, we have a great number of fragments with such „perfect" tops, and also a by no means small number of colonies, also with „perfect" i. e. normal apices, from various collections after 1870. When the apex does not show some quite indisputable mark of mutilation of the sarcosoma and the soft parts upon the whole, I regard it as normal; and among the characters of a normal apex is an abruptly cut calcareous axis, whether it ends near the soft parts or projects with a more or less long, naked part. On closer examination such a normal

[1]) Dalyell l. c. p. 182; Koren and Danielssen, Fauna litt. Norv. III, p. 19. Pl. IV, fig. 3 d (*Virg. affinis*). In our Museum are specimens of *Virg. mirabilis* from Danish seas (Samsö Belt, Great Belt, collected by G. Winther; the Kattegat, Dr. Joh. Petersen), where the top of the rhachis immediately above the soft parts continues in a long, round prolongation, formed by closely entangled threads of algæ intermingled with bristles of Annelids, sponge-spicules, vegetable detritus, and particles of mud; and the lower part of this enwraps the top of the calcareous axis of the Virgularia. One of these specimens is 80mm long, the extraneous prolongation 35mm, a second is 72mm, the prolongation 56mm, a third 67mm, the prolongation 48mm; the specimens mentioned are young stages with wings with three to four polyps.

[2]) Darwin, Journal of Researches p. 99 (*Stylatula Darwinii* Köll.). Bell (Thurston), Proc. Zool. Soc. Lond. 1890, p. 463 (*Virgularia juncea* Pall.).

[3]) Oban Penn. p. 59; Rep. Penn. „Triton", p. 133.

apex will always show that the upper wings are quite rudimentary in a more or less large number; not only are they smaller than those farther down, although, if their polyps can be counted, they may show the same number as these; but their polyps are quite degenerated, without tentacles, or with reduced tentacles. The degree of degeneration increases upwards; where a somewhat large number of reduced wings occur, the polyps of the lower ones may still be counted, then follow some in which only a single polyp seems to be preserved, and finally, instead of wings we find but low and narrow transverse ridges just as indistinct as those far down in the rudiment-zone. All these features I interpret as indicating atrophy. As the atrophied part gradually dies the upper part of the calcareous axis is quite naturally denuded; and this denuded part decays and is broken off, like the top of the shell of certain snails with truncate shells — or is perhaps thrown off, after the lapse of some time, as a stag throws off its dead antler.

This process begins very early, as shown by the young stages described (in so small colonies, that fishes cannot be suspected of having any share in the phenomenon), and it goes on normally hand in hand with the growth and increase of polyps in the rudiment region[1]).

This interpretation of the mode of growth in the Virgulariæ is certainly not quite new, as I thought at the time when I gave my first communication upon it[2]); it has in reality been set forth, contemporaneously with the first real description of *Virg. mirabilis*, by O. F. Müller. In the Danish edition of Zoologia Danica (1781) it is said of Straa-Sofjæren p. 45: When it has grown to a certain height, the outermost polyp-hooks by and by die and wither away from above downwards at the outer end of the stalk, and only the shrunken skin remains some time. Finally this also drops away, and the end of the stalk is denuded. Accordingly, the polyps perish at one end as they are generated at the other, which shows the second resemblance to the mode of growth of the tape-worm; yet the stalk (i. e. the calcareous axis) remains entire and undamaged. Marshall has also had the same idea (Oban Penn. p. 58), but he immediately rejects it, as he does not think that the facts sufficiently support it. I think, however, such facts have been advanced here; and especially by pointing out the features in the small young stages, I think I have placed this interpretation on a better footing at all events than has hitherto been done.

The young stages described are also of interest in another respect, as proving that two Pennatulid-genera (together with their family) will have to disappear from the system. One is the genus *Protocaulon* of Kölliker (Rep. Challenger Penn. p. 26), with the species *P. mollc*, from a depth of 700 fathoms near New Zealand. My previous supposition, which was well-founded, that this species was only a young *Virgularia* at a similar stage to that of *V. mirabilis* figured on Pl. II, fig. 25, has been fully corroborated by examination of the original specimen in the British Museum. The upper end of the colony is not — as might be thought from the figure l. c. Pl. VII, fig. 23 — provided with a terminal polyp, but is imperfect after the manner of *Virgulariæ*; a small broken end of the calcareous axis projects distinctly. The polyps are solitary, in two alternating series as stated by Kölliker;

[1]) If this explanation was not correct, and the condition of the top was a result of violence, it would be a strange thing if specimens were never found showing that the colony has managed to repair the damage. Dalyell has proved that *Virg. mirabilis* is possessed of no slight power of regeneration. On a living specimen D. cut off both ends, and hung up the middle part on a thread; in three weeks both ends were repaired by regeneration (l. c. p. 186).

[2]) In the meeting of Naturhist. Forening on Nov. 11th 1898. See Vid. Medd. 1898, p. 1.

but they are furnished with a clearly marked, although short calyx with distinct edge which may even by longitudinal folds seem to be provided with 8 slight teeth ; under each polyp one lateral zooid is found (seen by K. indeed, but he has not ventured to state it as a certainty); by clearing in a suitable mixture of oil of cloves and alcohol it is seen quite distinctly, as also the long line of stalk-zooids characteristic of Virgulariæ; here, these zooids reach almost to the lower end of the colony; the peduncle proper is damaged. Thus, there is full conformity between this species and my youngest specimens of *V. mirabilis*; *Protocaulon molle* can only be a young stage of a *Virgularia*-species, and probably of *Virg. gracillima* Köll.[1]).

The other genus that must be rejected is Marshall and Fowler's *Deutocaulon* founded on the species *D. hystricis* (Rep. Penn. Porcupine , p. 461, Pl. XXXII, figs. 8, 9). I have not had the opportunity of examining the type specimens, but the descriptions and the figures make it quite certain that the five specimens (30—48^{mm} long, badly preserved) are a *Virgularia* in stages corresponding to my young stages on Pl. II, figs. 26 and 27, and the ones slightly more advanced. Marshall and Fowler have seen themselves and very correctly that the family *Protocaulidæ* of Kölliker, to which they refer their *Deutocaulon*, must be placed nearer to the Virgulariæ than in the system of Kölliker, where it is far from these latter; they even hint as a possibility that *Deutocaulon* might prove to be identical with *Virgularia gracillima* of Kölliker (from New Zealand), but they think that in this case a new genus would have to be established for it. This is now superfluous; *Deutocaulon* is either simply *V. mirabilis* or possibly *V. cladiscus* mihi. The locality and depth (south west of Ireland and west of the Hebrides, 109 and 110 fathoms) might very well speak in favour of the former, but do not, however, exclude the latter, which was taken at one of the places together with *Deutocaulon* , and is referred to by M. & F. as a *Syava glacialis* Kor. & Dan .

Among the great number of specimens of *Virg. mirabilis* I have examined, some show certain differences from the normal which I think worthy of mention.

In a complete specimen from the Kattegat, 530^{mm} long, with wings with 12 polyps, small wings with few (3—4) polyps are found, inserted here and there among the normal wings; in a few places, a long solitary polyp is found between two normal wings, and under this a group of three lateral zooids; in two places the uppermost, most dorsal zooid of a common group of lateral zooids is transformed into a complete polyp (similar features, however, are known from *Pennatula phosphorea*; comp. p. 15 under var. *candida*). Further, this specimen is provided with two calcareous axes, of which however, only one projects from the top with a naked end. In the middle of the rhachis both axes are very thick; the one retains a considerable thickness, until it suddenly ends, but little rounded, in the upper part of the peduncle, whilst the other, as is the normal case tapers downward and ends in a bent hook, about 2^{cm} below the termination of the stalk-zooids. From the Great Belt and from Samsö Belt, we have further two other small specimens each with two calcareous axes. One is 50^{mm} long, with wings with five polyps; both the calcareous axes project with naked ends over the top; here also, only one of these forms the bent hook in the peduncle. The other specimen is a young

[1]) This species has been found again at New Zealand, where it is apparently of frequent occurrence. Deudy: Trans. and Proc. N. Zeal. Inst. 1896, vol. 29 (N. S. vol. 12) p. 256. When Verrill (Am. J. Sc. 23, p. 312, note) thinks that *Protocaulon* may prove to be the young of *Anthoptilum* , this supposition is no better founded than the one that *Protoptilum* Köll. is the young stage of *Virgularia* (!).

stage, 30mm long, with wings with 3 polyps, a quite short pen with developed polyps, but a long rudiment-region; here also two naked axial ends project from the sarcosoma at the top, one quite short broken off, the other rather long (5—6mm) and evidently in process of decay, being plainly divided into a series of short, loosely connected pieces, like joints [1]).

In a complete specimen, 423mm long (the peduncle 80mm), with wings with six polyps, from the Norwegian coast off Arendal, the wings of the left side are normal, whilst those of the right side, even quite down in the rudiment-region are placed in an inverted position, so that the calyx-openings and the tentacles of the polyps are turned towards the peduncle. It is well-known that the wings have a considerable power of motion, and I have often seen that they may also be turned in such a way as to make the polyps point downwards, but here the question is somewhat different; in the present specimen, the group of lateral zooids belonging to the inverted wings is placed above the wing instead of below it, and by serial sections I have convinced myself that both zooids and polyps here turn the ventral side upward, pointing towards the top of the colony, whilst the zooids and polyps of the correctly situated wings of the left side are placed normally with the dorsal side turned upwards. The same abnormality is seen in two fragments of the upper part of the pen in a specimen with four polyps in the wings, from Bohuslän, Flatholmen, and in another fragment from the same locality, with three polyps in the wings, in which latter the abnormal side is distinguishable as the right one, the end of the stalk being preserved. The last-mentioned specimens belong to the Museum in Stockholm. An abnormality, probably of a somewhat similar kind, is mentioned by Kölliker in a specimen of *Halipteris christii* (Mongr. p. 244); I have found no statement elsewhere of such features having been observed before.

As to the synonymy of *V. mirabilis*, I have without any hesitation referred the *V. Ljungmanni* of Kölliker to this species. He has established his species on a fragment (in the Museum in Stockholm) from the Azores, and he himself expresses (Monogr. p. 197) a strong doubt as to its specific difference from *V. mirabilis*; after all, I think that its geographical occurrence, so far distant from what is otherwise known for *mirabilis*, has been the special reason of its being established as a separate species. Later, the correctness of this species has hardly been carefully examined; it has, so far as I know, only been mentioned later by Studer as having been obtained in fragments by «l'Hirondelle» in the Bay of Gascony, without, however, any further information as to its structure, and by Whiteaves from the Gulf of St. Lawrence (Catal. Mar. Inv. East. Canada, 1901, p. 33). So far as I can discern from the careful description of this species by Kölliker, there is no sufficient reason for retaining it. The same can also be said for the *V. multiflora* Kner of the Adriatic, which Kölliker himself seems to be most inclined to regard as a local variety. Only the fact that the specimen in our Museum, in spite of its size, is provided with remarkably small polyps, could raise some doubt in my mind; the polyps, however, are just as small in a large fragment of *V. mirabilis* from the Vestman Islands (Th. Jónsson); but this specimen has evidently been somewhat dried. No doubt also the *Virgularia sp.* mentioned by P. Fischer, from the west coast of France (Loire-Inférieure, at Croizic),

[1]) A double calcareous axis in *Virg. mirabilis* has been observed before in a single specimen by Dalyell (l. c. p. 187) Pl. XLIII, fig. 8. «The bones were unequal, a longer and a shorter, the longer extending so regularly, that the shorter might have been almost considered a fragment accidentally or supernaturally introduced along with it amidst the fleshy substance».

is identical with *V. mirabilis*. It is said to resemble *V. multiflora* Kner, and to have its, «calicles aussi profondément séparés que ceux des *V. mirabilis* Müll.» (Bull. Soc. Zool. de France, vol. 14, pp. 36, 37); but a more particular description of it is wanting.

With regard to the distribution, I have to add here a new locality of no small interest, viz. the Vestman Islands off Iceland. During the summer of 1900, about fifty large and small fragments of specimens with wings with 4—9 polyps were taken here, also 14 young stages, most of them with 3 polyps in the wings (the «Diana», A. C. Johansen), and in the summer of 1901 the Museum has received from Th. Jónsson, physician in the Vestman Islands, a large fragment (145^{mm} long) with (8—9) polyps in the wings. Hitherto *V. mirabilis* was only mentioned from the coasts of Scandinavia, Denmark and Great Britain. On the west coast of Norway it reaches as far north as Lofoten (Grieg, l. c. p. 11), on the British coasts it does not seem to have been found farther north than Scotland; in the Danish seas its southern boundary is given as the Great Belt and the Sound down to south of Hveen (Levinsen, Hauchs Togter, p. 399); for England, in the Channel (Falmouth and Eddystone, Marshall: Oban Penn. p. 75, W. P. Marshall (sen.): Journ. Mar. Biol. Ass., vol. III. p. 335). The fact of this species having now been found at the Vestman Islands not only removes its northern boundary and considerably extends its western territory, but, when we consider that in recent years we have been able, just at the Vestman Islands, to point out several Atlantic animals known as belonging to the fauna, partly of the south-west of Europe, partly of the Azores, the probability that the «*V. Ljungmanni*» taken at the Azores and in the Bay of Gascony is identical with *V. mirabilis* rises almost to a certainty. If my supposition that *V. multiflora* is also to be referred to *mirabilis*, be correct, the Mediterranean will also belong to the territory of the species, the Adriatic at all events where *V. multiflora* has been taken in the Bay of Fiume (at the island of Veglia)[1]); also at Naples (Nisida) has a *Virgularia* been found (Kölliker, Monogr. p. 369), but of its more particular determination nothing is as yet known; also at southern France, Cap Béarn (Lacaze Duthiers, Comptes rend. Acad. Sc. 1891, and Corallaires du Golfe du Lion, p. 359). On the American side of the Atlantic the species has not hitherto been found, according to existing statements; but according to what has been said above of *V. Ljungmanni* Köll. it no doubt occurs there also, since 15 specimens of *V.* «*Ljungmanni*» were taken already in 1872 at a depth of 200 fathoms in the Gulf of St. Lawrence north east of Cap des Rosiers (Whiteaves l. c. p. 34).

The depths at which *V. mirabilis* has hitherto been found seem not to exceed 150—200 fathoms. At the Vestman Islands it has been taken at 98 fathoms (the «Diana» St. 41) and at 49 fathoms (the «Diana» St. 18).

Virgularia cladiscus nom. nov.

Cladiscus gracilis Kor. & Dan. Fauna litt. Norv. III, 1877, S. 101, Tab. IX, Fig. 13—15.
Loveni Berg. Mus. Nye Alcyonider etc. 1883, S. 23, Tab. XI, Fig. 1—4.
Virgularia tuberculata Marshall. Rep. Penn. H. M. S. «Triton» 1883, S. 129, Tab. XXXI, Fig. 1—3.
Cladiscus Köllikeri Kor. & Dan. Norske Nordhavs Expedition, Pennat., 1884, S. 57, Tab. II, Fig. 8—13.
Svava glacialis Kor. & Dan. Norske Nordh. Exp. 1884, S. 4, 5, Tab. I, Fig. 1—16.

[1]) From Trieste it is not known; at all events, it is not mentioned by Graeffe in Übers. der Seethiere des Golfes v. Triest, III. Coelenteraten. Arb. Zool. Inst. Wien, T. 5, 1884.

The calyx of the polyp distinct, with 8 small papillæ or wart-shaped calyx-teeth (sometimes, however, they may be indistinct and seem to be wanting), often with 8 slight longitudinal ridges; the wings formed of groups of 3—4, up to 6 polyps, somewhat coalesced only at the base; more frequently one of the outermost polyps is quite, or almost quite, free; below each wing a series sometimes double, of 3—4 lateral zooids. The wings of the two sides are, in the younger part of the rhachis, placed almost opposite to each other, farther up they are distinctly alternating, with a distance of up to 2—3^{mm} between each set of wings. The dorsal radiate canals on each set of wings grouped more or less distinctly in a fan-shaped manner. Spicules are quite wanting (as in *V. mirabilis*). The colour of the living animal yellowish white.

Of this beautiful Pennatulid the «Ingolf» has obtained four specimens at three different stations; a fifth specimen (a fragment) has been taken by the «Diana» at the Vestman Islands. Only in one specimen (Nr. 4) has the peduncle been preserved complete with its terminal bulb, in the three largest (Nr.. 1—3) the lower part of the peduncle is wanting, but the corresponding end of the calcareous axis with its fine, bent hook is preserved; as in other Virgulariæ, a denuded part of the axis projects above from the sarcosoma.

Nr.	1.	2.	3.	4.	5.
Total length ..... in mm.	94	85	71	32	40
The rudiment-region + the stalk-zooids in mm.	25	20	20	10	»
Number of polyps in each developed wing	4	3	4	3	3
Length of a polyp ..... in mm.	2	2—2,5	2	2	2
Number of lateral zooids under each wing	3—4	3	3—4	3	»

In the upper part of the rhachis irregularities and variations are found with regard to the wings and their number of polyps, which is probably, at least to some extent, connected with a normal atrophy of the top part. At the top of the larger specimens, for instance, some of the upper wings are quite wanting on one side, so that only something like a «scar» is left; towards the top there may be wings with two polyps or even with one, or 3- to 4-polyp wings with one or two quite small, probably atrophied, polyps. As mentioned above, the polyps are provided with a distinct calyx, about 1^{mm} long, with eight small soft calyx-teeth; these teeth, however, may be very indistinct or even imperceptible in some individuals of the same colony; the forepart of the polyp with extended tentacles is generally of the same length as, or a little longer than, the calyx; whether the fully developed polyps are able to retract this part completely into the calyx as in *V. mirabilis*, I must leave undecided; in the specimens before me all the fully developed polyps, at all events, are stretched out. As in other Virgulariæ the rudiment-region contains the sexual organs, whilst the developed polyps are sterile. The longest colony I have been able to measure myself, is 105^{mm} long (a specimen taken north of Norway by the Barents-Expedition); Grieg (Norges Penn. p. 20) gives a size of even 486^{mm} (a specimen from Fotlandsvaagen north of Bergen).

As is seen from the synonyms this form has been described before, but as constituting a separate genus, or even two genera, and several species. The reason why I have given it a new specific name within the genus *Virgularia*, and not retained its oldest specific name «*gracilis*» is that the

name «*Virgularia gracilis*» has long ago been used by Gabb and Verrill for another, Californian, species[1]). I have therefore used as specific name, Koren and Danielssen's oldest name for the genus which, I think, is quite descriptive in itself.

Koren and Danielssen originally established the genus *Cladiscus* with the species *Cl. gracilis* on a single, fragmentary specimen (Fauna litt. III. p. 102); the genus was referred to the subfamily *Funiculinæ* of the family of the Virgulariæ in the (old) system of Kölliker; later, Kölliker (Chall. Rep. p. 35) placed this genus far from the Virgulariæ in his family *Protocaulidæ*[2]). This erroneous position — far from the Virgulariæ — is, I think, essentially due to the misinterpretation of certain features in the structure of the colony by Koren and Danielssen, which misinterpretation, among other things, led them to establish the genus *Cladiscus*. The fact is that in the original diagnosis of this genus, only the following essential features are mentioned viz. that the cells are situated separately, and «the zooids ventral». (Lateral zooids are not mentioned). In the description of the single specimen of the species *Cl. gracilis* upon which the genus has been established, it is said of these zooids: «On the ventral surface ..... there appears a series of scattered zooids which, in the spaces between the groups of cells are more agglomerated, become larger, and form strong ventral protuberances of a very peculiar, as it were, crenulated appearance; the zooids, which are very much elongated, lying in the protuberances nearly in fan-like arrangement (fig. 15 a). In each protuberance there are from 20 to 25 zooids». Later (Bergens Mus. Nye Alcyonider etc. p. 23) with the help of a new species *Cl. Loveni* the generic characters have been supplemented with a remark that the lower end of the axis is knob-shaped (which is not correct); on the other hand, nothing whatever is said in the altered diagnosis as to zooids. According to the description, the new species is not provided with the above mentioned «ventral zooids», but on the contrary with a single series of 3—4 lateral zooids below each wing. At the same time, the authors protest against Kölliker's transferring the genus *Cladiscus* to the family *Protocaulidæ*, in which the calyx of the polyps is said to be wanting[3]), justly drawing attention to the fact that the polyps are here provided with distinct «cells»; but when they then place their genus in the family *Protoptilidæ* Köll., they are still farther in the wrong. Finally, the same authors again find in a third species *Cl. Köllikeri* (Norwegian North-Atlantic Expedition p. 57) the «ventral zooids», arranged upon the whole as in *Cl. gracilis*, but bell-shaped and containing sexual organs(!) (comp. l. c. Pl. II, figs. 8—13); further, two transverse rows (each of three individuals) of lateral zooids below the wings. From a close examination of the type-specimens of these three *Cladiscus*-species in the Bergen Museum (where I have also examined the later added specimens of *Cl. Loveni*, mentioned by Grieg (l. c. p. 20)) it was easy for me to see: 1) that the specimen described as *Cl. gracilis* has also lateral zooids, 2) that in *Cl. Loveni* the same «ventral zooids» are found as in the two other «species», and 3) that the lateral zooids in all three species may occur in a single row, or some may be placed in such a way that the row seems double. As the number of polyps in the wings, three or four, which number varies with growth, cannot be used here as a distinguishing specific character there can be no doubt

1) This species is hardly caracterized in such a way, that one would recognize it from the original description only. Comp. Kölliker, Monogr. p. 215.

2) This family (under the section *Spicatæ*, subsection *Junciformes*) consists in Kölliker of the genera *Protocaulon* Köll., and *Cladiscus* Kor. Dan.; as both the genera must be abandoned, the family must also be dropped. Marshall & Fowler (Rep. Penn. «Porcupine» p. 462) had seen already that its place was unnatural.

3) In «*Protocaulon*», however, a calyx is found. See above p. 31.

whatever that their three species will have to be united into one. Further from an examination of the type-specimens of the genus *Svava* of Danielssen and Koren (North-Atlantic Exp. Penn. p. 45) — the species *Sv. glacialis* with the var. *alba* — I have convinced myself that this genus agrees in every respect with the «*Cladiscus*-species»[1]); here also «ventral-zooids» of the same kind and the same arrangement as in these species may easily be detected; they may always be seen — even under a magnifying glass — when the specimen is cleared in oil of cloves, or, what is often better, in bergamot. But if the same method is used with regard to any tolerably well-preserved specimen of *Virgularia mirabilis*, the very same «ventral zooids» will also be found there, arranged in the same way, only in far greater numbers and in several layers. The fact is that these so-called «ventral zooids», which in some specimens of «*Cladiscus*» are seen so easily, in others only with difficulty unless in a clearing medium, are not at all zooids, but on the contrary the «radiate canals» described by Kölliker in *Halisceptrum* and *Virgularia*. There can be no question therefore of maintaining genera like *Cladiscus* and *Svava*; they are one and the same species, and this species must belong to the old genus *Virgularia*; it is even very closely allied to the species *mirabilis*; indeed, young specimens of this latter species with the same number of polyps in the wings can with difficulty be distinguished from *Virg. cladiscus* mihi; on clearing, the young *V. mirabilis* also show radiate canals in smaller numbers and in a single layer; the polyps, however — whose degree of coalesence in *V. mirabilis* is somewhat varying, — are never so slightly coalesced as in *V. cladiscus*, and distinct calyx-teeth, at all events, are not found. That the species *V. cladiscus* may be provided with more than four polyps in the wings is seen in a couple of specimens from the Dutch Barents-Expedition (1881) now before me, which have five polyps in the wings (whilst others specimens from the same expedition have four or three polyps in the wings), as also in a specimen from Finmark, Grölsund, and one from the Skager Rak (both belonging to the Stockholm Museum): and Grieg (l. c. p. 11, under *Svava glacialis*) mentions a specimen from Trondhjem Fjord with up to six polyps. A young stage, with two polyps in the wings, two lateral zooids, 52^{mm} long, from the Skager Rak, is found in the Stockholm Museum. This species may also vary in the way in which the polyps of the separate wings are connected, and partly also in the degree of their coalescence (comp. Grieg l. c. p. 19).

That I have also enumerated *Virg. tuberculata* Marshall among the synonyms will require no long explanation. From the description in Rep. Penn. «Triton» pp. 129—133 and from the figures, every one will easily recognize its identity; and moreover, this specific name has been withdrawn in the later work by Marshall and Fowler (Rep. Penn. «Porcupine», p. 464), on account of its identity with *Cladiscus gracilis* Kor. & Dan., and it is added that these authors find «the generic characters as given by the Norwegian authors too slight to justify a separation of the form from *Virgularia*»[2]) one must certainly allow that they are right here, although they pay no regard to the false «ventral zooids» whose nature was unknown to them. Strange to say, the same authors have retained *Svava glacialis*,

[1]) The description by Danielssen and Koren of the genus *Svava*, agrees so well with the one given earlier of the genus *Cladiscus*, that it is astonishing they have not themselves seen the identity. And when it is stated for *Svava* that the generative organs are only developed in the lower, imperfect polyps, whilst the upper, perfect ones are sterile, it is also strange that their attention was not immediately drawn to the genus *Virgularia*, with regard to which Kölliker had long ago pointed out the same fact.

[2]) Marshall figures no lateral zooids in his *V. tuberculata*; from his remarks on p. 132 it is seen, however, that he has noticed them, but does not venture to state them as certain.

although they had a specimen before them; but they have referred it to the right place, in the family of the Virgulariæ [1]).

Distribution. The «Ingolf» has taken the species at the following localities: St. 6: 63° 43′ N. Lat., 14° 34′ W. Long., 90 fathoms, bottom temp. + 7° (Nr. 4); St. 59, 65° N. Lat., 11° 16′ W. Long., 310 fathoms, temp. ÷ 0.1° (Nr. 2), both these stations near Iceland; St. 138, 63° 26′ N. Lat., 7° 56′ W. Long., 471 fathoms, temp. ÷ 0.6° (Nr. 1, 3), near the Faeroes to the north. The «Diana» has taken Nr. 5 at the Vestman Islands at 68 fathoms. To judge from the hitherto known places, the species occurs in different fjords along the Scandinavian coast from Finmark through the Skager Rak to Bohuslän; in the deep channel of the Skager Rak it is evidently of frequent occurrence, to judge from the numerous specimens from this place in the Stockholm Museum (taken by the «Gunhild»); north of Norway it has been taken (by the North-Atlantic Expedition and by «Barents») up to 75° 31′ N. Lat. (between Bear Island and Spitzbergen); north of Asia, west of Taimyr by the «Vega»-Expedition; by the English expeditions («Triton», «Porcupine») it has been taken north of the Hebrides and southwest of Ireland (51° 51′ N. L., 51° 51′ W. L.), its most southerly occurrence hitherto known, while the Vestman Islands, about 20° W. Long., is the most westerly. It is remarkable that it may occur both in the warm and the cold area; its proper territory, however, seems to be within the warm area; within the cold area, it has only been taken at the two stations of the «Ingolf» enumerated above, and at four stations of the North-Atlantic Expedition (18, 31, 124 and 251); but all these stations are near the boundaries to the warm area, the Norwegian ones (according to the chart) even at the very border. At all events, it has not hitherto been taken in the deep and cold polar basin, properly so called.

The bottom is commonly soft, clay or mud, sometimes sand (e. g. St. 6). The depth rather varying, from 40—555 fathoms, most frequently, however, over 100 fathoms.

This species is not known from the American side of the Atlantic. On the other hand, a «*Cladiscus*»-species is described from the Pacific, *Cl. Agassizii* Studer (Note prélim. sur les Alcyon. «Albatross» Exp.; Bull. Mus. Comp. Zool. Vol. 25, Nr. 5, 1894, p. 58) [under the family *Protocaulidæ*], of considerable size, 280^{mm}, with three polyps in the wings («Albatross», St. 3424, 20° 15′ N. Lat. 106° 23′ W. Long., depth 676 fathoms). That *Virgularia*-species of «*Cladiscus*»-form are also known from other places in the Pacific, is seen from the *Virg. bromlei* Köll. of the Challenger-Expedition, from Japan (565 fathoms, temp. + 3°.3 C., provided with spicules), and *V. gracillima* Köll. from New-Zealand (at small depths, 10 fathoms or thereabout).

Stylatula Verrill.

In Fauna litt. Norv. III, p. 92, Koren and Danielssen separated the genus *Dübenia* from the genus *Stylatula* for two Norwegian species, which at the same time they figured and described in detail, later a third species was added. These three species cannot be maintained; they are only one species, and I think the justification of the genus *Dübenia* to be doubtful. To the best of my belief, *Dübenia* is related to the other *Stylatula*-forms (with *St. gracilis* Verr. as type) in quite the same manner as the «genus» *Cladiscus* is to the typical *Virgularia*; here as there, the most conspicuous difference from the nearest

[1]) Danielssen and Koren had said nothing at all of the more particular relationships of *Svava*.

allies is that the polyps are almost free and only few in each wing; further, the polyps in *Dübenia* are said to want calyces; generally, they are only contracted — in very different degrees — and not with the circle of tentacles fully retracted; but that this circle may be completely retracted, is seen from Kor. & Dan.'s fig. 3, l. c. Pl. X[1]), and it is also mentioned l. c. p. 95; when the circle of tentacles is retracted the other part of the body of the polyp then forms a «calyx»; I find this feature to be quite similar in *Stylatula gracilis*, in which, however, it is the rule that the individuals of the wing are retracted. Finally, the lateral zooids are arranged in a group above each wing with numerous individuals, whilst in the other *Stylatula*-forms they seem to be arranged in a single transverse row. Altogether, these features seem to be too insignificant to justify a separation from *Stylatula* as an independent genus; but, as my material of typical forms of *Stylatula* has been limited to one specimen of *St. gracilis*, I think it better to leave the matter for future determination.

Stylatula (Dübenia) elegans Dan. Kor.

Virgularia elegans Dan. Videnskabsselsk. Forhdl. i Christiania 1859, S. 251.
Stylatula elegans Richiardi. Monografia etc., 1869, S. 73.
» » Köll. Monogr., 1872, S. 225, Tab. XVI, Fig. 137—38.
Dübenia elegans Dan. Kor. Fauna litt. Norv. III, 1877, S. 97, T. III, Fig. 1—7.
» *abyssicola* » » Ibid. S. 94, Tab. X og XII, Fig. 1—3.
» *borealis* » » N. Nordh. Exp. Penn., 1884, S. 97, T. III, Fig. 1—7.
abyssicola Marshall. Rep. Triton Exp., 1883, T. XXIII, Fig. 17—21.

From the Vestman-Islands we have two fragments (17 and 20^{mm}, probably of the same colony) of a «*Dübenia*» with four polyps in the wings, above each of which is a group of zooids consisting of several rows; the large needles of the calcareous plate are 2.4^{mm} long, and at the thick end up to 0.240^{mm} broad; the smaller needles are 0.544—0.768^{mm} long, up to 0.048^{mm} broad. The large needles of the calcareous plate seem to grow in thickness at the proximal end in such a way that the original long spicule is united with several of the smaller neighbouring spicules. The spicules along the aboral side of the tentacle-stem are of a length of 0.064—0.160^{mm}. The body of the polyps is without spicules, or only provided with a few. The polyps measure up to 3^{mm} (but the size is here, as is so often the case, very varying according to the degree of extension).

I have stated above that I cannot acknowledge the three established species as separate. Neither from the descriptions, the figures, nor the specimens I have had the opportunity of examining, can I discern any other difference than in the number of polyps in the wings and the number of lateral zooids; and here where the number of polyps varies within the limits 2—6, this difference means no more than in *Virgularia*, the mode of growth of the colony being the same as in that genus (even Koren and Danielssen have given up laying absolute weight on the number of polyps by making the form «*smaragdina*» a variety of *abyssicola*). Only in appearance are the specimens of

[1]) I find the feature to be the same in a great number of polyps in a specimen in our Museum; it is determined as *D. abyssicola* by Koren and Danielssen, and has been sent from Bergen Museum.

«elegans» and of abyssicola rather different; but this is due, partly to the colour, partly to the different degree of retraction of the polyps and their tentacles, partly also, to the distance between the consecutive pairs of wings. All such features are individually varying, e. g. compare Kölliker's figures of *St. elegans* with those of Koren and Danielssen; both are true to life as I can certify from the respective original specimens. As to *D. borealis*», its right as a separate species rests on one single spicule! That a separate species cannot be maintained on such a character will be admitted by all who have compared, for instance, a number of specimens of *Funiculina quadrangularis*.

Distribution. This form is known from the coast and fjord-regions of Norway, from Lofoten and down through the Skager Rak, in the deep channel of which it seems to be common (found by the German North-Sea Expedition of 1872 and by the Gunhild); further, it is known from a locality north west of the Hebrides (west of Rona) (Triton); to these localities must now be added the Vestman Islands, and thus its territory to the west is considerably extended, and it is quite probable that it will also be found elsewhere. Its bathymetric range is between 30 and 550 fathoms; at the Vestman Islands it has been found at 68 fathoms together with *Virg. mirabilis* and *V. cladiscus*.

On the American side of the Atlantic, and only in the south, are as yet only *Stylatula*-species having true wings with many polyps known (further particulars are wanting of the *Stylatula*-species taken by the «Albatross» on the eastern coast of North America, off Chesapeake Bay, at a depth of 444 fathoms; Verrill: Am. J. Sc. Vol. 29, p. 150, 1885).

Fam. *Pavonaridæ* Jungersen.

Pavonaria Köll.

Pavonaria finmarchica (M. Sars).

Pl. II, Figs. 28, 29; Pl. III, Figs. 33—36.

Virgularia finmarchica M. Sars. Nyt Mag. for Naturvidensk. 1851, S. 139; Fauna litt. Norv., II, 1856, S. 68, Tab. XI.

Balticina finmarchica Gray. Catal. Sea-Pens, 1870, S. 13.

Pavonaria » Köll. Monogr., 1872, S. 243, Tab. XVII, Fig. 144.

Göndul mirabilis Kor. & Dan. Berg. Mus. Nye Alc. etc., 1883, S. 19, Tab. X.

This Pennatulid is said to have been taken at Iceland and brought to the Paris Museum by Gaimard 1839 (Köll. Monogr. p. 243). According to its known distribution, its occurrence at Iceland was very probable, though up to the present we have had no other authority for it than the above. From the results of the Ingolf, however, I am able to confirm the correctness of this occurrence. At one of the stations south of Iceland (St. 47) the «Ingolf» has taken four specimens of a Pennatulid which, after a thorough examination, I can state positively to be young stages of a *Pavonaria*, and to belong without doubt to the species *P. finmarchica*.

These four specimens show the following proportions:

Nr.	1.	2.	3.	4.
Total length ..... in mm.	167	140	136	87
Length of the peduncle ..... »	20	20		15
Greatest thickness of the peduncle »	2	2		1
Length of the polyp-calyx ..... »	1—2	1—2	1—2	

The specimens Nr. 1 and 4 are unfortunately rather badly preserved; Nr. 3, which is figured on Pl. III, fig. 33, twice the natural size, has been broken just above the peduncle (which has been added after one of the other specimens); in the three specimens (2, 3, 4) the upper part of the rhachis is bent with the concavity towards the ventral, polyp-bearing side; in the specimen figured in fig. 33, moreover, a rather abrupt bending is found, ca. 15^{mm} from the point, possibly a healed up fracture. The upper part of the peduncle is dilated in the form of an ellipse; the calcareous axis is also enlarged here and reaches its greatest thickness; the calcareous axis is round, and ends both below and above without being bent into a hook. There is no terminal polyp, but the rhachis ends as a naked process containing the end of the calcareous axis. The polyps are placed along the ventral side of the rhachis in two rows, each really belonging to one side; two polyps are often placed almost opposite to each other, making, as it were, a pair; they then touch each other at the base, so that no naked ventral streak is left between them; now and then, especially at the upper end of the colony, groups of three polyps are found (comp. fig. 34); in this case one of these polyps is always distinctly younger than the two others, and at its base is partly coalesced with the one belonging to the same side as itself, and always placed obliquely immediately below; two such polyps form the first beginning of a wing. In some part of the rhachis, especially in its lower half, large polyps alternate tolerably regularly with smaller ones; several polyps (not only farthest down towards the peduncle) have evidently appeared quite recently. The zooids are small and only found on the ventral side, placed between the polyps, often but one or two above each polyp.

The polyps are provided with a very marked, conical calyx, the ventral edge of which projects into two strong points; sometimes these points are very long. They are close together on the side turned away from the stem, but on the side towards the rhachis they are separated by a broader and much deeper indentation, from which projects the fore part of the polyp with the circle of tentacles. The largest calyces measure 2.5—3^{mm} to the end of the points. The calyx is abundantly provided with spicules, especially dense in the long points; the other part of the polyps shows spicules only along the aboral side of the tentacle-stem. The longest spicules of the calyx I have measured, are 1.024^{mm} long and fully 0.048—0.064^{mm} broad; the average size of the long calyx-spicules is 0.8—0.96^{mm} in length and 0.040—0.048^{mm} in breadth; the smallest calyx-spicules are 0.08—0.128^{mm} long and 0.007—0.016^{mm} broad; the tentacle-spicules have been measured to a length of 0.122—0.144^{mm}, and a breadth of ca. 0.0014^{mm}.

The whole stem is provided with lengthy parallel spicules, of a length of 0.096^{mm}, a few rougher ones 0.144^{mm} long and ca. 0.032^{mm} broad. The lower end of the peduncle is sparingly provided, and the spicules here become quite small, oval or round, 0.008—0.016^{mm} long; here and there a few longer ones, up to 0.064^{mm}. All the spicules — apart from the quite small ones — are of a marked

triangular form being composed of three ridges. As to the colour, it can now (i. e. for spirit specimens) only be said that the part of the polyps projecting outside the calyx, as also the stomach, is chocolate-coloured, or deep reddish-brown.

These four specimens show so much correspondence with the *Microptilum* of Kölliker, established on a specimen of the species *M. villemoësii* from Japanese seas (Rep. Chall. Penn. p. 26, Pl. VII, fig. 27) that they may undoubtedly be referred to this genus. This I have done originally; but on a visit to the Bergen Museum in 1897 I had the opportunity of examining the type-specimens in that collection of *Lygomorpha Sarsii* Kor. & Dan., and I very soon recognized this genus and species to be young stages of *Halipteris christii*; now these Ingolf-Microptiles show no slight resemblance to »*Lygomorpha*», as will also be seen from figs. 29 and 31 on Pl. II. The arrangement of the polyps is the same in both, as also the structure of the calyx etc. I therefore referred them to *Halipteris*, being of opinion that both *Microptilum* Köll. and *Lygomorpha* Kor. and Dan. were to be referred to *Halipteris* as young stages of this genus. Later, when I had the opportunity of studying the genus *Pavonaria* more thoroughly, I came more and more to the conviction that the Ingolf-Microptiles would have to be referred to *Pavonaria*; I wished therefore to test their resemblance to *Lygomorpha* by a direct comparison of the specimens. The Bergen Museum, with the greatest friendliness, met my wish and sent me the type-specimens of *Lygomorpha*. With regard to *Lygomorpha* the result was the same; it is decidedly a *Halipteris*, but it is as decidedly different from the Microptiles of the Ingolf». To mention only a single case: the long calyx-spicules of the latter are on an average twice the length of those in *Lygomorpha*, whilst the spicules of this latter agree with those in *Halipteris*.

That I am right in referring these Ingolf-Pennatulids to the *Microptilum* of Kölliker will, I think, be evident, when one compares Kölliker's figure of *M. villemoësii* with the fragment of the Ingolf-specimen Nr. 2 shown in fig. 36, and also the descriptions. The most essential difference is that the genus *Microptilum* is said to have only one ventral calyx-point. This one point, however, is really two points fused together. At the British Museum I had the opportunity of examining the type-specimen of *M. villemoësii*, and thereby to verify, not only the resemblance to especially the smallest of the Ingolf-specimens (Nr. 4) already seen in the figure of Kölliker, but also just the feature mentioned of the double nature of the calyx points. The Challenger-specimen, however, which is only 65^{mm} long, has a terminal polyp in which the calcareous axis ends; this polyp seems to be provided with eight calyx-teeth, but in the others the calyx-teeth are arranged into two ventro-lateral points with an indentation between them on the side turned towards the stem, where the circle of tentacles of the polyps etc. may be seen; in most, the two teeth are joined close together ventrally but the arrangement of the spicules distinctly shows the double nature. Except in the four uppermost polyps a small, younger polyp is placed at each of the others, immediately above the larger one. The form of the calyx, the arrangement of the polyps etc. leave no doubt that *Micr. villemoësii* and our Ingolf-specimens belong to one genus; but it is beforehand little probable that they should belong to one species; I shall, however, return to this question later.

Verrill has already said that the genus *Microptilum* of Kölliker is a young stage of *Pavonaria*; he has set forth the opinion (Am. Journ. Sc. (3) Vol. 23, p. 311) that most, if not all, the members of the families *Protocaulidæ* and *Protoptilidæ* of Kölliker are young stages of other Pennatulids; and though

his supposition that *Protocaulon* belongs to *Anthoptilum*, and *Protoptilum* to *Virgularia*, is quite erroneous, he is assuredly right with regard to *Microptilum*. He has had young forms of *Pavonaria finmarchica* in which he finds «the polyps isolated, thus forming two simple alternate rows, along the rhachis» as in *Microptilum*; and later (Bull. Mus. Comp. Zool., vol. XI, p. 4), he has described a young specimen of *Pavonaria finmarchica* of a length of 70^{mm}, in the following manner: «When most developed, there are two polyps in each oblique row, supported by two-lobed spiculose calicles; between the wings there are four to six scattered zooids. Toward the upper part of the peduncle there is but one well-developed polyp, with or without an additional young bud, in the oblique rows; and here the calicles have the apex bilobed slightly, or not at all, and terminating in a single pointed group of spicula. This part agrees essentially in structure with the genus *Microptilum* Kölliker». The — somewhat imperfect — figure that he gives (l. c. Pl. I, fig. 3) of part of a young *Pav. finmarchica* is presumably of this described specimen. By a comparison of this figure with those on Pl. II of the Ingolf's specimens, there will be scarcely any doubt left as to the identity of the form. That the question is really of *Pavonaria finmarchica* — this species being the only *Pavonaria* known from the northern Atlantic — is made further certain for the American specimens, by the fact that Verrill has evidently had sufficient material for comparison and sufficient intermediate stages. But without such intermediate stages, I am equally certain with regard to the Ingolf specimens; a direct comparison even with specimens of two feet or more will show the essential agreement in the features not dependent on the growth. In the developed form of *P. finmarchica* the polyps are present in large numbers, arranged in oblique rows and united in these by coalescing into wings; the single calyces are completely coalesced almost to the very edge; the oblique transverse ridge thus formed shows, however, in well-preserved specimens a series of long points supported by spicules on its abaxial surface, apparently one such point for each polyp. A more thorough examination will show that to each polyp-calyx belong really two long points, but the two adjoining each other in neighbouring calyces are either coalesced, or one, the inner one, atrophied. Often, however, the oldest polyp of each wing, the one at the dorsal edge of the wing, shows both its calyx-points; and when, as is frequently the case, even in specimens of two feet or more, a solitary polyp is placed between the wings, the calyx of this polyp has two ventral or ventro-lateral points. Here, as in the solitary young polyps at the lower border of the rhachis towards the peduncle — the edge of the calyx on the side turned towards the stem is seen to be deeply hollowed; this may partly be seen also in the wings, when the attention is drawn to it. The polyps have evidently some difficulty in retracting completely; at all events they are generally somewhat expanded; their fore-part and tentacles (in spirit) are chocolate-coloured or deep reddish brown. I have measured the largest of the spicules of the calyx to a length of 1.280^{mm} and a breadth of 0.080^{mm}; on an average they are 1.024^{mm} long and 0.048^{mm} broad, (Kölliker, however, gives their length to 1.8—2.1^{mm}, their breadth to 0.06—0.08^{mm}); these dimensions, as will be seen, agree very well with those of the Ingolf specimens, and I may add that the form of the spicules is the same. Both the form and especially the considerable size of the calyx-spicules exclude *Halipteris* absolutely; this holds good also with regard to the long calyx-points; and the question could only be of referring these young stages to the genera *Halipteris* and *Pavonaria*; of northern Pennatulids they are the only ones in which the calyx is provided with two points.

I have also included amongst the synonyms *Göndul mirabilis* Koren & Danielssen, and I am able to do so with perfect surety, as I have had the opportunity of examining the only existing specimen of this form, the type-specimen in the Bergen Museum. It is not difficult to see that this specimen is nothing but a mutilated fragment of *Pavonaria finmarchica* from which the calcareous axis has been extracted; and thus originated the free edges of the four «longitudinal valves». A similar mutilation of fragments of other Pennatulids, for instance of *Virgularia mirabilis*, may also give results which, on superficial examination, have a very striking semblance to being a distinct organism. This «*Göndul*» is either the upper end of a colony or a part near the top casually torn from the axis, and attached to an *Oculina* (*Lophohelia*) by the secreted slime; the basal surface or «attaching disc» mentioned and figured loc. cit., does not exist at all on the fragment, which on the part in question, shows only the surface of a wound; the «axial polyp» is no terminal polyp at all, but (by the mutilation perhaps?) an isolated polyp etc. When the long description of Koren and Danielssen is read with the reservation, that in many things they have let themselves be deceived by preconceived ideas, it will then be found that such features, as have not been quite disfigured by the mutilation, agree very well with *Pavonaria finmarchica*, among other things for instance, the colour; but nobody, who has not seen the original, would be able to suspect from the description the real state of the case; now, however, every one who sees the specimen with the information given here, will certainly recognize it. Obviously, all the comments made by these authors and others on this *Göndul mirabilis* with regard to its relation to other Pennatulids or Alcyonariæ, its being an intermediate form between Pennatulids and Alcyonids etc., are now quite superfluous. «*Göndul*» and the systematic group based upon it will have to disappear and be forgotten as soon as possible!

Distribution. *Pavonaria finmarchica* has been found in the fjord-regions of Norway, from Finmark (Öxfjord) to the neighbourhood of Bergen; it seems also to extend farther south, into the Skager Rak, to Bohuslän (at Koster, Grieg, l. c. p. 11); it has further been found at Iceland (Gaimard), and south of Iceland, St. 47 of the «Ingolf», 61° 32′ N. Lat., 13° 40′ W. Long., 950 fathoms; next it has been found, frequently and in specimens more than one yard long[1]), on the east coast of North America, especially on the fishing banks. It has been taken at depths from 60 to 980 fathoms. According to the localities where it has hitherto been found, its territory seems to be the whole northern part of the Atlantic, and there is every possible reason to expect that it will be found again in several places at Iceland (i. e. at the south coast and especially at the Vestman-Islands), and on the fishing banks round the Færoe Isles.

From the Atlantic another species has been described: *P. africana* Studer (Übers. Anth. Alc. «Gazelle». Berl. Monatsber. 1878, p. 672), 4 specimens of which were obtained on the west coast of Africa at 10° 12.9′ N. Lat., 17° 25.5′ W. Long, depth 360 fathoms. The possibility is not excluded that we have here really the same species which has so wide a distribution farther north; the very low wings and the small number of polyps in these (4, or 5 to 6), specially pointed out by Studer, can scarcely — the number of polyps at all events cannot — be regarded as reliable specific differences from *P. finmarchica*; at the top, the wings become higher and the polyp-calyx more distinct; the teeth of the polyp-calyx are not very distinct, but this is often the case in northern specimens also, and here also

[1]) In the rich collection of *P. finmarchica* of the Christiania Museum is a specimen from Öxfjord, 5 feet long.

the wings may be quite low. Whether the want of an enlargement of the calcareous axis at the thickest part of the peduncle, is of any importance I must leave undecided, but I think it doubtful. The colour, to be sure, is not in exact agreement with the statements of Sars with regard to living *P. finmarchica*, but the difference is not so great as to make an identity of the species impossible.

The genus Pavonaria also occurs, but as other species, in the Pacific. In our Museum we have representatives of two undescribed species from Japanese seas[1]) and the Gulf of Korea. To these must be added a young stage from the coast of Korea (depth 80 fathoms); it is 305^{mm} long, but very slender. In spite of this considerable length it is still nearest to the *Microptilum*-stage; the calyx-teeth are long as in the Ingolf specimens, and in many of the polyps also fused together so as to appear as one tooth. The polyps are arranged in two rows, one belonging to either side, larger (older) polyps and smaller (younger) alternating somewhat regularly, and where two polyps are placed opposite to each other their bases touch; one zooid or only a few between each two polyps on the same side, etc. Most probably it is the same species described at a still younger stage by Kölliker as *Microptilum willemoësii* (Rep. Chall. Penn. Pl. VII, fig. 27) taken south of Yedo, 34° 7′ N. Lat. 138° E. Long., depth 565 fathoms.

In the Riksmuseum of Stockholm is a *Pavonaria* (1075, $^{14}/_{8}$ 79) taken by the Vega-Expedition at Bering-Island (depth 65 fathoms); and Moroff (l. c. pp. 390, 393) describes a *Pavonaria dofleini* from Monterey in California, and a *P. californica*. Finally, we have several older notices of large Pennatulids from the American side of the Pacific (originally by Gray called »*Osteocella*«, but he, to be sure, established the genus on the naked calcareous axes); they have been described by Stearns and Moss, and belong doubtless either to *Pavonaria* or *Halipteris*; the descriptions, however, are so imperfect, that it cannot be decided with certainty which of these closely allied genera are in question (comp. below under *Halipteris*).

Halipteris Kölliker.

The genus *Halipteris* is very closely allied to *Pavonaria* Köll. This may be seen, apart from the anatomical structure of the colony, its polyps and zooids (with regard to which I may refer to the monograph of Kölliker), especially in the polyp-calyx, the form of which is the same in both genera, viz. a truncate, oblique cone whose abaxial side is the longer and whose abaxial edge is provided with two calyx-points supported by spicules. The most essential difference between the two genera is only that in *Halipteris*, the oblique polyp-rows are not coalesced to real wings; the young stages therefore show so great a resemblance to one another as to be easily confused. To separate these two genera into two different families, as done by Kölliker, must be regarded as quite erroneous.

[1]) The remarkable »genus» *Echinoptilum* described by *Hubrecht* (Proc. Zool. Soc. Lond. 1885, p. 512, Pls. 30, 31) is, I think, one of the Japanese species, viz. a multilated fragment, from which, as is the case with *Göndul*, the calcareous axis has been torn out. As I have not, however, had the opportunity of seeing *Echinoptilum* itself, I can only advance this as a supposition, and leave it to a more particular test.

Halipteris christii (Kor. & Dan.).

Pl. II, Figs. 30, 31, 32.

Virgularia Christii Kor. Dan. Nyt Mag. for Naturvidensk. 5 Bd. 1848, S. 269; Faun. litt. Norv. II. 1856, S. 91, Tab. XII, Fig. 7—12.

Norticina Christii Gray. Catal. Sea-Pens, 1870, S. 13.

Halipteris Kölliker. Monogr., S. 241, Fig. 146, 147.

Lygomorpha Sarsii Kor. Dan. Faun. litt. Norv. III, 1877, S. 99, Tab. IX, Fig. 7—12.

Protoptilum tortum Grieg. Bergens Mus. Aarbog 1886, S. 13, Tab. VII, Fig. 19, 20, Tab. VIII, Fig. 1—3.

Stichoptilum arcticum Grieg. Ibid. S. 15, Tab. VIII, Fig. 4, 5, Tab. IX.

From a fishing bank ca. 20 miles east of Fuglö, the Færoe Isles, the Copenhagen Museum received through Agent Müller in 1899 a fine and complete specimen, 1040^{mm} long, of which the peduncle makes only 80^{mm}, and again in 1902 from the same donor an excellent, smaller specimen from the Færoe Isles, 400^{mm} long (the peduncle 56^{mm}).

Young stages of this species differ so much from the grown form, that they have been described as independent genera and referred to quite a different family. On some of them Koren and Danielssen have formed the genus *Lygomorpha*, on others Grieg has formed the genus *Stichoptilum*, whilst some specimens have been referred by the same author as a new species to the genus *Protoptilum* Köll.; all these »genera» were again gathered into the family *Protoptilidæ* of Kölliker. That I can now with perfect surety refer them to their right place as *Halipteris christii*, is due to the circumstance that I have been able to examine the respective type-specimens, and to compare them with one another, and with a large and good material of larger and full-grown specimens; upon the whole I have had before me a tolerably entire series from a length of ca. 73^{mm} up to about four feet.

The most important aid to recognizing the younger stage as *Halipteris christii* is the form of the calyx. The arrangement of the polyps will naturally vary; in the youngest specimens one must expect a more or less distinct arrangement in two rows, in the somewhat older ones we must expect to find new polyps on the inner side of the original rows (i. e. somewhat nearer to the ventral median line).

In large specimens of *Halipteris christii* the polyp-calyx has a somewhat different appearance, according as the polyps are stretched out or more or less retracted, and to this is to be added that the two abaxial calyx-points may vary somewhat in size; generally they are short, one (the inner one) is often quite indistinct, which may also hold good with regard to the outer one; this however, will scarcely ever be found in all the polyps of one and the same specimen. When the polyps are much expanded the mouth of the calyx is distended, and then the two teeth may be widely separated and are easily overlooked; when, on the other hand, the polyps are quite retracted, the mouth of the calyx is drawn together; then the calyx is very similar to a grain of wheat, and in well-preserved specimens the calyx-points are always seen distinctly. They are supported by layers of spicules continuing down the calyx. The longest of these spicules I have found to be of fairly constant length — having measured them in several specimens, both large and small; on an average they are some 0.480^{mm} long, 0.032^{mm} broad; the very longest I have found to be 0.496^{mm} long, 0.040^{mm}

broad (with these measurements those of Kölliker: 0.4—0.7, agree very well); the spicules are often, as it were, divided longitudinally into, or composed of, several incomplete individuals; this holds good also with regard to the shorter forms, as also for the tentacles.

Passing now to the hitherto wrongly understood young stages we shall begin with the smallest specimen. It is only 73^{mm} long (of which the peduncle makes ca. 15^{mm}), and belongs to the Bergen Museum, where it was found, together with two other larger specimens, in a glass labelled: «*Protoptilum tortum* Grieg; Vadsö, G. O. Sars». It is figured on Pl. II, fig. 30, three times the natural size; if this figure is compared with fig. 32, which represents the top of a fully formed *Halipteris christii* (viz. the above mentioned specimen from the Færoe Isles of a length of 400^{mm}) magnified to the same degree, the agreement in the form of the calyx will be so apparent that any further account will be unnecessary; it may be remarked, however, that the calyx-points are upon the whole somewhat more marked in the very young specimen.

It is evident that Grieg has founded the description of his *Protoptilum tortum* upon the largest specimen in the same glass (143^{mm} long), and this is the specimen figured l. c. Pl. VII, figs. 19—20, Pl. VIII, figs. 1—3; he does not even mention that he had two more specimens. In «Bidr. til de norske Alcyonarier» (1886) p. 13 it is said of the calyx: The edge of the cell is smooth; on the free side, however, is found a small tooth very richly provided with spicules»[1]). To this I shall only add that in this as in the other specimens I find two teeth, one of which is in most polyp-individuals somewhat larger than the other.

The next smallest specimen I have seen is 86^{mm} long (the peduncle only 7^{mm}). It deviates rom the former by the fact that the part of the rhachis where the polyps are developed, is much longer, whilst on the other hand the lower part with the rudiments is extraordinarily short; the new, inner polyps are upon the whole also larger. Together with a fragment 146^{mm} long[2]) it was labelled: «*Lygomorpha Sarsii*, Kristiansund, 80—100 fathoms. G. O. Sars coll.»

Next come two specimens, respectively 106 and 125^{mm} long, the peduncle respectively 20 and 25^{mm}, labelled: «*Lygomorpha Sarsii*, Lofoten, Risvær. G. O. Sars coll.» These are the type-specimens of Koren and Danielssen of the genus and species stated on the label[3]). Here all the polyps are fairly well expanded, and the calyx consequently is distended; nevertheless, the calyx-points seem to be comparatively long and are considerably more conspicuous than is commonly the case in adult specimens with expanded polyps; they seem also to be somewhat richer in spicules, but an examination of the spicules shows the form and size characteristic of *Halipteris*. Nor have Koren and Danielssen quite overlooked the resemblance; in Fauna litt. III, p. 100, they say: «The genus *L.* comes nearest to the *Halipteris*, Kölliker», but in the same breath they mention a series of features which

[1]) p. 20: «the free margin is furnished with an extremely minute papilla».

[2]) In this specimen the lower part of the rhachis together with the peduncle is wanting; in the upper part of the rhachis the appearance is already *Halipteris*-like on account of the increase in the number of polyps, whilst the lower part resembles more that of the small specimen; on either side of the rhachis two polyp-individuals are inverted (comp. *Virgul. mirabilis* above p. 32)'; here, the abnormal position is especially conspicuous, the long side of the calyx-cone and the two points of the calyx-edge being turned towards the peduncle instead of towards the top, as in the other individuals.

[3]) That my measuresments are a little different from those in Fauna litt. Norv. p. 100, is owing to the fact that Koren and Danielssen have paid no regard to the curves, and as to the peduncle, have not seen its real limit; the quite small polyp-rudiments at the lower part of the rhachis have presumably been overlooked. In *Halipteris* the peduncle in reality is always very short.

in their opinion, justifies the establishement of the new genus, which is placed between *Halipteris* and *Funiculina*. From a cursory examination of the large specimens of *Halipteris* of a meter or more, the resemblance, to be sure, is not very conspicuous; in most polyps of large specimens the edge of the calyx seems often but little formed, as for instance is shown in the figure of Kölliker (Monogr. Pl. XVII, 146—147). A closer examination, however, of any tolerably well-preserved specimen will always show a larger or smaller number of polyps, especially among the younger ones, for instance in the lower end of the rhachis, in which the two calyx-teeth so conspicuous in *Lygomorpha* are quite distinctly seen, and even rather long; and when once seen they may be traced in almost all the polyp-calyxes. In the figures of Koren and Danielssen of the adult *Halipteris* in Fauna litt. Norveg. 2[d] part, Pl. XII (figs. 7—10) they are also given very distinctly, and in the text it is said that the calyces are of a «conical form and end upward in two points». Kölliker says (Monogr. p. 244): «Mündung ganzrandig mit einem kurzen Zahn und einer demselben entsprechenden schwachen Leiste an der unteren ventralen Seite, und swacher Andeutung eines ähnlichen Vorsprunges am gegenüberliegenden Rande». Of the two ventral teeth also, the one which the polyp turns toward the naked dorsal surface of the rhachis is generally the most developed. It is evidently this tooth that Grieg has remarked upon in his description of «*Protoptilum tortum*», whilst he has overlooked the other. All other features, in which *Lygomorpha Sarsii* might seem to deviate from *Halipteris christii*, are only such as are a consequence of its being a young stage: the arrangement and smaller number of the polyps, the small size of the colony etc.

Next we come to some (3) specimens of lengths from 234—310[mm 1]); they were labelled «*Stichoptilum arcticum*» Grieg. Vadsö. 30—40 fathoms. G. O. Sars». Grieg has described them in Bergens Mus. Aarb. 1886, p. 15 and p. 21, and given figures l. c. Pl. VIII and IX; of the calyx he says p. 16: «The edge is provided with eight small, little prominent spines. The spicules are numerous in the cell, being especially found in large numbers in one side of the spines, whilst the other side is without spicules (Pl. IX, fig. 6). The spicules never project over the edge, they are mostly placed longitudinally, and are narrow, pointed, 0.210[mm] long». I must suppose that the statement here should be «in the spines of one (the ventral) side»; and the fig. 6 quoted above shows the two ventral calyx-teeth which I find in the polyps of all these specimens; as in the grown specimens, one of the calyx-teeth is even the stronger one in most individuals. What has given Grieg the notion of the other six teeth is only slight undulations of the edge of the calyx; they may also often be seen in large *Halipteris*, and I take them to be the last traces of the equipment that must be said to be typical of the Pennatulids. Also with regard to the arrangement and number of polyps, these «*Stichoptilum*», in accordance with their greater size, are nearer to the «*Halipteris*»-character than is «*Lygomorpha*». For the rest, Grieg has himself later observed the resemblance with the latter; in Ovs. Norg. Penn. (Berg. Mus. Aarb. 1891) p. 22 he says: «When I enumerate these two species (viz. *Protoptilum tortum* and *Stichoptilum articum*), it is not without some hesitation; they ought perhaps, to be enumerated as varieties of *Lygomorpha Sarsii*, which they resemble very closely». (The succeeding observations on the varia-

[1]) Between these and the preceeding, the above mentioned type-specimen of *Protoptilum tortum*, 143[mm] long, and the «*Lygomorpha*»-fragment, 136[mm] long, from Kristianssund, fit in with regard to development and size.

tions of the calyx are partly incorrect; the calyx, when it is correctly understood, will always give good characters).

Stages such as the last mentioned are immediately followed by others as for instance, the specimen 400^{mm} long from the Færoe Isles. If we are first persuaded that the difference between «*Lygomorpha*» and *Halipteris* with regard to the teeth of the polyp-calyx, is only a difference in degree dependent on the growth, and that all other features of the polyps are the same, it will easily be seen that the other, apparently great, difference in the appearance of the colonies, the number and grouping of the polyps and the zooids, is due only to age: at the same time that the colony — as is commonly the case in the Pennatulids — grows in the lower part of the rhachis, at the boundary towards the peduncle, and adds here new polyps and zooids, a constant increase in the number of the polyps also takes place in *Halipteris* in the older, upper part of the rhachis; as is indicated in the young stages, new individuals grow up in the interspaces between the older ones. In this way arise the short and little regular, oblique rows peculiar to *Halipteris*. The irregular arrangement seen in the younger stages is for the rest constant, solitary polyps or irregular little groups being always found between the more regular oblique rows; and apart from the lower part of the rhachis, the boundary line between the polyps of the two sides on the ventral side of the colony is, as in the young stages, only seen with some difficulty; in some places towards the top it seems to be quite wanting. The increase in the number of the zooids follows that of the polyps; Kölliker has carefully traced the mode of development of both these kinds of individuals in the lowermost part of the rhachis (Mongr. p. 245).

Distribution. Hitherto, the species has been known from various Norwegian fjords, from the Varanger fjord (Hjælmö) to the Jäder; also, the young stages were found within the same territory; away from Norway it is only noted as having been found on the east coast of North England (Northumberland, Tynemouth; Alder: Ann. Mag. Nat. Hist.; (3) vol. IX, p. 316). To these localities I may add the Dogger Bank in the North Sea [1]), and as a new locality also the Færoe Isles, the fishing bank 20 miles east of Fuglö (agent Müller). Hitherto it has only been found at depths to about 200 fathoms. From the American side of the Atlantic it is not hitherto known with full certainty. Verrill, to be sure, (Proc. U. S. Nat. Mus. vol. 2, 1879, p. 199, and later in Americ. Journ. Sc. and Arts vol. 23, 1882, p. 309) mentions a *Halipteris* (*christii*) as taken on the east coast of America on a fishing bank (Grand Bank), but nothing more definite has appeared concerning it later; if the genus be correctly determined, it is most probable that the species is also *H. christii*. It has probably a similar distribution to *Pavonaria finmarchica* and *Pennatula grandis* etc. [2]).

We have various indications that the genus *Halipteris* is not restricted to the Atlantic. In San Francisco Mining and Scientific Press August 9th 1873, and Proceed. Calif. Acad. of Sciences 1873, as also in Am. J. Sc. (3) vol. 7, p. 68, Stearns refers a Pennatulid (up to 66 inches = ca. 168^{cm} long) to the *Pavonaria* of Cuvier, as subgenus *Verrillia*, the species *V. Blakei*. In a note added (in the last named place, p. 70) Verrill declares the form to be most closely allied to *Halipteris christii* (Kor. & Dan.), and accordingly Stearns has later (Americ. Naturalist vol. 16, 1882, pp. 55—56), called the

[1]) Four specimens in the British Museum labelled: «*Funiculina quadrangularis*. Dogger Bank. 94. 6. 24. 1—4».

[2]) It is possible, however, that this *Halipteris* has later been tacitly withdrawn and placed by Verrill under *Pavonaria finmarchica*.

form *Halipteris blakei*. The place of discovery was the Gulf of Georgia, Burrard's Inlet (comp. also Proc. Calif. Acad. Sc. Vol. V, 1873, pl. I, pp. 7—12). From the description given I would not maintain as a certainty, however, that this species is not a *Pavonaria* Köll., and at all events nothing more particular can be said as to its specific difference from *Halipteris christii*. The description of the calcareous axis with its lower enlargement agrees with both genera. The specimen from the same locality, described and figured by Moss (Proc. Zool. Soc. Lond., 1873, p. 730), undeniably reminds one most of a *Pavonaria*; but neither the description nor the figure yields any reliable basis for a determination. Naked calcareous axes of the same forms have been described by Gray (Catal. Sea-Pens, p. 40; Ann. Mag. Nat. Hist. (4), IX, p. 405, X, pp. 77, 406) as «*Osteocella septentrionalis*» from the west coast of America, and others similar as «*Osteoc. cliftoni*», possibly from West-Australia. Thus the genera *Halipteris* and *Pavonaria* are probably rather widely distributed in the Indo-Pacific Ocean.

Fam. *Funiculinidæ* Köll., emend.

Funiculina Lam.

Funiculina quadrangularis (Pall.).

Pennatula quadrangularis Pallas[1]). Elenchus Zoophyt. 1766, p. 372.
Pavonaria antennina Cuvier. Règne animal. 1817, Vol. IV, p. 85.
Funiculina tetragona Lamarck. Anim. s. vert. Vol. II, 1816, p. 423.
» *quadrangularis* Köll. Monogr. 1872, p. 256.
Leptoptilum gracile Köll. (Rep. Chall. Penn. 1880, p. 27, Pl. VII, Fig. 28).
» var. *norvegicum* Kor. & Dan. Bergens Mus. Nye Alcyonider. 1883, p. 29, Pl. XIII.
Funiculina armata Verrill. Am. J. Sc. (3) Vol. 17, 1879, p. 240 and Bull. Mus. Comp. Zool. Vol. XI, 1883, p. 6, Pl. 1, Fig. 4.

South of Iceland the Ingolf» has obtained a young specimen of a length of 225^{mm}; the length of the peduncle cannot be decided with certainty, as the soft parts of the lower part of the rhachis have been scraped off; otherwise the specimen is very well-preserved; the polyp-calyxes up to 3.5^{mm} long. In appearance it is strikingly similar to the *Trichoptilum brunneum* of Kölliker (Rep. Chall. Penn. Pl. VIII, fig. 31), and agrees also with the *Leptoptilum gracile* var. *norvegicum* of Koren and Danielssen l. c. Pl. XIII. The polyp-calyxes are richly provided with spicules, the arrangement of which quite agrees with fig. 3 of Pl. XIII of the last-mentioned work; again, the tentacles are also

[1]) Bohadsch is stated by Kölliker to be the author who has given the earliest description of the species in: De quisbusdam Animalibus Marinis, etc. Dresdæ 1761. Here it is mentioned, chap. VI, p. 101 under «*Penna*», as no. 3, *P. rubescens* («pinnis carens, tentaculis in corporis trunco positis») and p. 112 as a species neglected by science, but known to fishermen who called it «Penna del pesce pavone». His specimen which was incomplete, was of a length of 2 feet 10 inches («multo vero longiorem eam fuisse non dubito»), and has probably been from the Mediterranean (Naples? from which locality he has several things). However, I have found this species mentioned as early as 1655 in Museum Wormianum p. 235: «Pennæ marinæ nomine ad me transmissum ex Norvegia corpus gracile, oblongum, cartilagineum, quadrangulum, interior substantia albicante, quodammodo extremitatem pennæ anserinæ plumis denudatæ referens, exterius membrana sublutea tectum. Tenuis licet sit hæc penna, crassitie extremitatem pennæ anserinæ non superans, longitudine tamen æqvat tres pedes Romanos. Nullam video habere affinitatem cum Penna marina a Gesnero, Rondeletio, Aldrovando & aliis descripta, ut quo referam vix habeam; hic interim locum obtineat, donec comodior detur».

provided with spicules along the aboral side of the stem. The polyps contain well-developed sexual products (eggs). The polyps are arranged in two alternating rows each corresponding to one edge of the quadrangular calcareous axis; between the developed polyps smaller ones are found, and between these again numerous small ones more or less in the zooid stage; in the very smallest, however, tentacles may be traced as small papillæ, and their calyxes are provided with 8 points; true zooids that remain as such, are not found. In all these features this specimen agrees with the «genus» *Leptoptilum* of Kölliker. At station 18, south west of Iceland, about midway between Greenland and Iceland, the «Ingolf» has obtained one more specimen, also a *Leptoptilum*-stage, but only about 70^{mm} long. Unfortunately, it is little but a naked calcareous axis, the soft parts having been scraped away except in a few places where some polyps are saved. They show the differences in size characteristic for these young stages; although they are only badly preserved the determination is quite certain; moreover, the axis is quadrangular. A very young and slender *Leptoptilum* stage, 28^{mm} long (the top, however, is broken off, and the specimen is upon the whole very badly preserved) has been taken by the steamer «Thor» in 1903, near the Vestman Islands (St. 167). It has been shown by Grieg that *Leptoptilum* is only a young stage of *Funiculina*, and further that *Leptoptilum gracile* — the Norwegian specimen (var. *norvegicum* Kor. & Dan.) as well as the pieces of the many specimens of the Challenger Expedition (from the seas near New Zealand) which have been given to the Bergen Museum — belongs to the species *F. quadrangularis* (Berg. Mus. Aarb. 1896, Nr. 9).

The genus *Leptoptilum* must accordingly be rejected, which assuredly, must also be the case with regard to the genus *Trichoptilum* of Kölliker. It has been established on a single specimen — *Tr. brunneum* — obtained between Ceram and New Guinea; in all essential features, also, as mentioned above, in outward appearance and very nearly in size[1]), it agrees exactly with the first named specimen of *Funiculina* of the «Ingolf». One difference, however, still remains: *Trichoptilum brunneum* is provided with zooids, without spicules, which do not look like future polyps. As, however, the specimen is somewhat damaged, their different appearance may possibly be due to maceration or the like, or the question may be of a separate species of *Funiculina*. But I am quite convinced that the genus «*Trichoptilum*» is a young form of some *Funiculina* or other. The same conviction has already been expressed by Verrill (Am. J. Sc. (3) vol. 23, p. 312, note), and he proposes the name of *Funicul. brunnea*[2]) for the species of Kölliker. The fact is that Verrill has observed its similarity to young stages of his *Funic. armata*.

As to this species of Verrill, which is described in Am. J. Sc. (3) vol. 17, p. 240, and later ibid. vol. 23, p. 312 and Bull. Mus. Comp. Zool. vol. 11, p. 6, Pl. I, fig. 4, it must, so far as I can see, be regarded as identical with *F. quadrangularis*, since in the description I can indicate no feature really separating these two species. The strong spiculation, which has evidently given rise to the specific name *armata*, may very well be found in *F. quadrangularis*, which is very variable

[1]) Kölliker gives 34.3^{mm}; but the figure, which is said to be natural size, measures ca. 300^{mm}; after having seen the type-specimen in Brit. Museum I am able to decide that the mm. of the text must be a misprint for cm.

[2]) The opinion of Verrill is followed by Roule (Camp. du «Caudan» p. 307); but when he thinks his «*Trichoptilum sp*». to be either a young *Anthoptilum* or a young *Funiculina*, he seems less clear about the matter (*Anthoptilum*, as is well known, having no calyx and no spicules, apart from the microscopic small spicules of the peduncle, etc.); the question can only be of *Funicul. quadrangularis*, which was before known from the coast off Arcachon.

with regard to spiculation; the want of spicules in the tentacles of this species, stated by Kölliker, is for instance in no way a constant feature, and will rarely, I think, hold good for young colonies.

Distribution. The species has been found on the Norwegian coast, at least from Trondhjem Fjord to into the Christiania-Fjord; also in the Skager Rak, in the deep channel of which it is evidently numerous (many specimens, both large and small, have been taken in 1897 by Dr. Joh. Petersen; comp. Vid. Medd. Nath. For. Kbhvn. 1898, p. 1; many specimens have later been taken at the same locality by the steamer «Thor»); at Bohuslän; the west coast of Scotland, the Hebrides; midway between the Hebrides and Suderö; the Færoe Channel, in the «warm area» (among others by the «Michael Sars», 1902); the Atlantic, west of Brittany (48° 26′ N. Lat. 9° 44′ W. Long., Köll. Monogr. p. 369), and nearer the coast of Brittany, as also off Arcachon (P. Fischer, Bull. Soc. Zool. Fr., vol. 14, p. 34); also in the northern part of the Bay of Gascony («*Trichoptilum* sp.» Roule, Camp. du «Caudan», p. 307); the Mediterranean (Golfe du Lion, Naples, Adriatic Sea). To these localities is to be added the American side of the Atlantic («*F. armata*» Verr.) from Sable Island to in the Carribbean Sea (Verrill).

The new localities, the stations of the «Ingolf» Nr. 40, 62° N. Lat., 21° 36′ W. Long., and Nr. 18, 61° 44′ N. Lat., 30° 29′ W. Long., and the station of the «Thor» Nr. 167, 63° 5′ N. Lat., 20° 7′ W. Long., accordingly extend the European distribution of the species in a way that can only serve to bear out my supposition of the identity of *armata* with *quadrangularis*.

In the Atlantic the species is thus known so far, only north of the equator and inside the territory of the positive bottom temperatures[1]). The depths are given as from 10—30 fathoms up to 769 fathoms; the above mentioned stations of the «Ingolf» exceed the greatest depth hitherto known, one being 845 fathoms, the other 1135 fathoms. According to what is stated above, the species, outside the Atlantic, may occur at New-Zealand, at a depth of 700 fathoms; but at all events it is certain that the genus *Funiculina* belongs also to the Indo-Pacific Ocean, the young stages of *Leptoptilum* and *Trichoptilum* having been taken there by the «Challenger» in two widely separated localities, both south of the equator.

Fam. *Protoptilidæ* Köll.

Protoptilum Köll.

Protoptilum carpenteri Köll.

Pl. I, Figs. 2, 3.

Protoptilum Carpenterii Köll. Monogr. 1872, p. 374, Pl. XXIV, Figs. 223, 224.
aberrans Köll. Chall. Penn. 1880, p. 28, Pl. VIII, Fig. 30.

In one locality, south of Iceland, the «Ingolf» has taken one complete and five more or less incomplete specimens of a *Protoptilum* which is to be referred to the form *P. carpenteri* Köll.

[1]) On Pl. II, figs. 3, 3a of the Chall. Report on the Alcyonaria (vol. 31, 1889) Wright and Studer — among the Strophogorgiæ, however — have figured a fragment of a «*Trichoptilum*», which, in their opinion, is perhaps a new species of this «genus». The very incomplete specimen has been taken at Station 143 of the «Challenger», off the Cape of Good Hope. The figure shows only three developed polyp-calyxes, and no incomplete polyps or zooids whatever, and just as little the form of the calcareous axis; neither is anything said of the latter in the explanation. To judge from the figure the question may be of a *Funiculina*, but it is impossible to decide whether it is *F. quadrangularis*.

To the south of Iceland also (St. 164) the steamer «Thor» has taken an incomplete specimen. As a rule there is only one row of polyps on each side of the rhachis. The polyps are arranged, partly alternating, partly in pairs almost opposite to each other; the zooids are upon the whole also arranged in a ventral and a dorsal row on either side; the rhachis is narrow and thin, ca. 1—2^{mm} broad, provided on the dorsal side only, throughout its whole length, with a narrrow streak bare of individuals (fig. 3, u); as is generally the case this streak becomes broader down towards the peduncle; on the ventral side also, there is a corresponding naked streak on the lower part of the rhachis, but it soon disappears, and the opposite polyps of the two sides join, so that the separation is only marked by the ventral zooids (fig. 2). The polyp-calyx is formed like a horn or (straight) «cornucopia» abundantly provided with long, red spicules; the edge of the calyx has very slightly marked teeth on the abaxial side, none of them distinct as a rule, and in no definite number anywhere; the axial side, as is commonly the case in the genus *Protoptilum*, passes into the cœnenchyma; the length of the calyx is 2—3^{mm}, the breadth 1—1.1^{mm}. The polyps are only provided with spicules along the aboral side of the tentacle-stem. The zooids have a calyx of similar form and appearance as that of the polyps, only much smaller. They are more numerous than the polyps; on the dorsal surface, there is generally 2—3 zooids opposite to each polyp on each side of the median streak, and one zooid between every two polyps on the same side; on the ventral side there are considerably fewer, about half the number.

The colour of the peduncle was yellowish white (in spirit, colourless), the calyxes of the polyps and the zooids were a splendid bright red on account of the coloured spicules (till now the colour has remained unaltered in spirit); the whole rhachis gets the same splendid colour due to the individuals being placed close together. The polyps themselves, like the zooids, were yellowish-white, apart from the red streak on the tentacle-stem, due to the spicules; towards the point of the tentacle, however, the red colour becomes faint or disappears, partly because the spicules decrease in size, partly because they lose the colour themselves. The naked streak on the rhachis is yellowish white.

The calcareous axis is round, ca. 0.4^{mm} in diameter.

In three of the specimens where the whole peduncle is preserved, it ends in a bulb; in a fourth (Nr. 1 of the table below) there is no indication whatever of any enlargement, a proof that a terminal bulb is here, just as little as in other sea-pens, of no importance whatever as a specific character.

The spicules (triangular) are on the polyp-calyxes 0.240—0.480^{mm} long, 0.016—0.032^{mm} broad; on the tentacle 0.064^{mm} long and up to 0.0112^{mm} broad.

Of the specimens in hand the six, as mentioned before, have all been taken at one locality: St. 40, south of Iceland, 62° N. Lat. 21° 36′ W. Long., 845 fathoms, bottom temp. + 3°.3 C.; the bottom dark gray mud with numerous shells of Foraminifera and Pteropods (*Limacina*). The seventh specimen has been taken (by the «Thor») at 62° 10.8′ N. Lat. 19° 36′ W. Long., $^{13}/_{7}$ 1903, depth 2150 metres. The measurements are as follows:

Nr.	1.	2.	3.	4.	5.	6.	7.
Total length ..... in mm.	128	100	75	115	50	35	190
Length of peduncle..... »	45	45	35	55	...	...	87
Breadth of terminal bulb .	..	4	2,8	2,8	...	...	4
Greatest breadth of rhachis	2	2	2	...	2,2	2	2

Nr. 1 is entire and shows no terminal bulb; Nr. 5 and 6 are fragments of the rhachis; in the latter, the upper end of the rhachis is undamaged; half of Nr. 4 is a naked calcareous axis, and only in the lower part of the pen are some polyps preserved; Nr. 7 is rather damaged, broken, and the uppermost 32^{mm} only a naked calcareous axis. By clearing of Nr. 1 and 6 in oil of cloves, quite whole, undigested shells of *Limacina* are observed partly in the œsophagus, and partly in the gastric sac of several polyps; at the locality in question, *Limacina* was especially numerous in the plankton. This fact, I suppose, indicates that these sea-pens, although bottom animals, get part of their food from the animal life of the surface, individuals from this part sinking to the bottom; in a similar way I have seen larvæ of lamellibranchs forming a prominent part of the food of *Virgularia mirabilis* from the Sound. Sexual organs were not seen on clearing; nor did an examination by serial sections show any such organs. Closer examination, on the other hand, has shown the following interesting features with regard to the inner structure. From the dorsal longitudinal canal of the rhachis, transverse canals issue at quite regular and somewhat short interspaces towards the periphery, where they open partly directly into the gastric sac of the dorsal zooids, partly — in the interspaces between the zooids — into a system of canals which is, otherwise, again connected with the zooids. These transverse canals evidently correspond to the «radiate canals» of the Virgularia (and also of other Pennatulids); here they are characterized by being in the form of a long funnel, narrow at the dorsal main canal and widening at the peripherial end; their epithelium stains very intensely, so that they are seen with unusually sharp outlines. In each transverse section only one or two such dorsal radiate canals are generally seen. Into the ventral principal canal open radiate canals situated in the middle of the rhachis; they are much larger and wider than the dorsal ones, but run also towards the periphery; their epithelium also stains very intensely. These wide «collecting canals» connect the polyps and the other (ventral) zooids with the ventral main canal of the stem either directly, or indirectly through a network of canals with less intensely staining epithelium. The «collecting canals» are much less numerous, but much longer than the first-mentioned dorsal radiate canals, and their course is a much less horizontal one; they go upwards or downwards, and only rarely are more than two seen along-side each other. The small number of these «collecting canals», I suppose to be connected with the small number of the polyps; both features — to which may also be added that no sexual organs were observed — might favour the belief that *Prot. carpenteri* is only a young stage.

The features given above of the «Ingolf» specimens of this *Protoptilum* show the very greatest correspondence with the *Pr. aberrans* of Kölliker; there is no doubt that these specimens might justly be referred to this form (or the unnamed ones which Kölliker in the Chall. Report has added afterwards as Nr. 2 and Nr. 3, which, however, no doubt belong to the same form). I have had the opportunity of seeing the originals in the British Museum, and I find no other differences between the specimens of the «Ingolf» and the type-specimens of the «Challenger» than the fact that the enlargement of the lower part of the rhachis in which the sexual organs were found, mentioned by Kölliker as characteristic of *Pr. aberrans*, is wanting (as in the unnamed Nr. 2), and further that the colour of our specimens is much more intensely red. The first feature: the presence or absence of an enlargement is certainly quite a casual one, and the presence or absence of distinct sexual organs in this place is certainly

quite special; as to the red colour, great stress is hardly to be put on it, as it probably is very widely varying in intensity, for example in *Pennatula phosphorea* where the red colour may quite disappear (comp. also *Protoptilum thomsoni*); and the unnamed Challenger-specimen Nr. 2 is of the same intense red colour as our specimens.

If I have, nevertheless, designated these specimens not as *P. aberrans* but as *P. carpenteri*, I have done so because I think these two «species» to be synonymous, and the name *carpenteri* is the older one. To be sure Kölliker says of *Pr. carpenteri* that the polyps are placed in two rows on either side of the pen; but it is very difficult to get a clear view of these double rows as the ventral median line is not distinctly marked, and at all events they are not found throughout the whole length of the rhachis. The figures given by Kölliker (Monogr. Pl. XXIV, 223, 224) show an arrangement, essentially agreeing with that of some of the specimens of the «Ingolf» (comp. the figured fragment, in which a two-rowed arrangement is quite distinctly beginning); and of *Pr. aberrans* Kölliker himself says that in some places the polyps show a tendency towards the arrangement seen in *P. carpenteri*. The whole difference in the arrangement of the polyps is certainly only a difference in individual development, and cannot consequently be made the base of a separation into different species of the forms *aberrans* and *carpenteri*, which agree so exactly in all other features. But if it is a fact that the «one-rowed» arrangement of the polyps may here pass into a «two-rowed» one, the question arises, if *Prot. carpenteri-aberrans* is not upon the whole only a young stage of a *Protoptilum* with more longitudinal series of polyps and a correspondingly larger number of zooids. This, perhaps, will turn out to be the case, and I think I may point out *Pr. thomsoni* as the further developed form in question; there is really in the calyx-form, the polyps and zooids, the spicules etc. of this species a tolerably close agreement with those of *Pr. carpenteri*, and all the differences are more particularly such as might be due to differences in age and growth. As there is, however, a recognizable difference in outward appearance from the least developed stages of the forms I refer to *Pr. thomsoni* — the whole colony of the latter is especially much more robust — I have thought it best for the present to keep the species *Pr. carpenteri*.

Occurrence. *Pr. carpenteri* has been found before in the Atlantic by the «Porcupine» Expedition, at 48° 31′ N. Lat., 10° 03′ W. Long., 690 fathoms (the type-specimen of Kölliker); 48° 50′ N. Lat., 11° 9′ W. Long., 725 fathoms, 2 specimens (Marsh. & Fowl.); by the «Challenger» Expedition (*Pr. aberrans*) south of New York, 37° 25′ N. Lat., 71° 40′ W. Long., 1700 fathoms; 31° 34′ N. Lat., 72° 10′ W. Long., 1240 fathoms; 40° 17′ N. Lat., 66° 48′ W. Long., 1350 fathoms. In addition, Verrill (Am. J. Sc. (3) vol. 23, p. 312, note) states that he has found the same species (as *aberrans*) in shallower waters, and adds that in some of the larger specimens the polyps are arranged in groups of two or three individuals. (When Verrill on this account thinks the genus *Protoptilum* to be «evidently the young of *Virgularia*», he is quite wrong, which need not be shown more particularly [1]).

By the discoveries of the «Ingolf» and the «Thor», the territory of the species has accordingly been considerably extended towards the north; probably it comprises the whole northern part of the Atlantic inside the warm area, where the depth, bottom, etc. are suitable.

[1] Grieg has already and justly objected to this view (Norges Pennatulider pp. 15—16).

Protoptilum thomsoni Köll.

Pl. I, Figs. 4—8.

Protoptilum Thomsoni Köll. Monogr. 1872, p. 373, Pl. XXIV, Figs. 220—222.
» *lofotense* Dan. & Kor. N. North-Atlantic Exp. Penn. 1884, p. 61, Pl. II, Figs. 14—20.
» *mohni* » » » » » 63, » III, » 1—7.
» *carinatum* » » » » » » 65, » III, » 8—11.
» *armatum* » » » » » 68, » IV, » 1—7.

Of a *Protoptilum*-species which I refer to *P. thomsoni* of Kölliker, I have had for examination three considerable fragments taken by the Michael Sars in the summer of 1902; these fragments I have been able to compare with a specimen from the Skager Rak belonging to the Riksmuseum in Stockholm, and with the material of the Bergen Museum amongst which were the type-specimens of the above named four species of the North-Atlantic Expedition.

The description of Kölliker is based on four considerable fragments of the rhachis; both the upper and the lower end with the whole peduncle were wanting. Only the abaxial edge of the polyp-calyx is free, and this edge is most frequently provided with four small points or teeth (to judge from the figures 221—222, Pl. XXIV, these teeth are as often wanting or slightly marked); the axial side passes into the cœnenchyma, and downwards towards the peduncle the calyxes pass upon the whole so very gradually into the rhachis, that their length cannot be determined exactly; the projecting part itself, however, measures hardly more than 1.5—2^{mm}; the calyx is richly provided with calcareous spicules 0.36—1.05^{mm} long and 0.027—0.066^{mm} broad. The zooids have an «incomplete» calyx supported by calcareous needles which form a small point. The polyps are provided with a row of spicules on the aboral side of the stem of the tentacles (0.11—0.19^{mm} long, 0.01—0.04^{mm} broad). According to Kölliker the arrangement of the polyps is difficult to define precisely; it may evidently be described as two-rowed, i. e. two rows of polyps on either side of the median line of the colony (this line, however, is only to be determined with difficulty on the ventral side); but K. prefers to describe the arrangement as consisting of short oblique rows of three polyps on either side, being of opinion that each of the dorsal polyps forms a group with the two lower polyps placed more ventrally; these oblique rows would then have to be designated as ascending towards the dorsal side, whilst the oblique rows (or the individuals of the wings) in the Pennatulids generally ascend towards the ventral side. The zooids are found in large numbers, and everywhere on the rhachis between the polyp-calyxes, with the exception of a streak along the dorsal surface of the rhachis. The colour is pink, varying in intensity in the different specimens.

In the Scandinavian specimens before me the calyx of the polyps is rather varying with regard to the degree to which it projects from the rhachis; this holds good with regard to different specimens as well as to different places in one specimen; but the axial side to the very mouth is always incorporated into the cœnenchyma. Thus the measurement of the length and breadth of the calyx may give very different results; it is especially difficult to determine the lower end of the calyx. The edge of the calyx is also varying, being often quite without teeth, often with one large and several smaller and indistinct; the most frequent number seems to be three, and these variations

may be seen in the same colony, even in neighbouring polyps; the calyx-edge of the zooids is just as indistinctly furnished with projections; most frequently, it seems to me, without such. The tentacles are provided with a distinct streak of spicules; otherwise the retractile parts of the polyps are naked, whilst the calyx is furnished with long spicules, placed densely and numerously on the abaxial side. The size of the spicules agrees upon the whole fairly well with the measurements given by Kölliker.

The arrangement of the polyps presents some variation, but the differences are evidently connected with the different age and development of the colonies; also, the arrangement shown by Kölliker for the type-specimens of 'the species *Pr. thomsoni* is represented here. A common feature in all the specimens is, that along the dorsal median line of the pen runs a distinct, sometimes rather broad streak devoid of polyps and zooids (*n*, figs. 4, 5, 6); it is broadest in the lower part of the pen towards the peduncle; this streak is uncoloured (or yellowish white) like the peduncle. A similar streak, more or less distinct, also runs along the opposite, ventral surface (*n'* figs. 6, 7, 8); it begins below at the peduncle where it is almost as broad as the dorsal one, but it very soon becomes quite narrow, often only seen as a very fine line, in some specimens even interrupted in several places by polyps placed quite medianly. Otherwise the whole rhachis is covered with polyps and zooids; the latter occur in very large numbers and fill all the interspaces between the polyps. On the lowermost part of the pen (figs. 6, 8) undeveloped polyps together with zooids form a long, wedge-shaped streak on either side, between the two naked streaks mentioned above.

In the most developed specimens the polyps may be said to be arranged in three or four longitudinal rows on either side; but if we follow Kölliker, and take into consideration the oblique rows ascending towards the dorsal surface, each of these contains generally four, five (or in a single place six) polyps (comp. fig. 7); in reality, the arrangement on either side is nearest quincuncial. Less developed specimens show two longitudinal rows on either side with two or three polyps in each oblique rows; the least developed show something between one and two rows, i. e. they approach the arrangement that may be found in *P. carpenteri*; in these specimens there seem to be transverse groups of three polyps: one belongs to the right side, one to the left whilst the middle one is apparently placed in the ventral median line (*Pr. lofotense*). In places where the ventral median line is only indicated (it may be very difficult or in some places quite impossible to see it) the real condition is that a polyp has been added alternately on the right and the left side inside the one belonging to the original first row (the dorsal polyps) nearer to, or, as it were, in the ventral median line; oblique rows cannot be said to be marked here as in the others; or, if they are present, they must be growing in the opposite direction and alternating in such a way, that opposite to an oblique row of two polyps on one side there is a solitary polyp on the other side. In the table below, of all the specimens which have hiherto been described and which I think must be referred to the same species, some of these features have been indicated and some measurements given. The statement of the total length means here only the length of the specimen in question, as no specimen is complete. This species probably grows to as greath a length as such forms as *Halipteris*, *Pavonaria* or *Funiculina*.

Nr.	1. «*P. lofotense*»	2. *P. mohni*	3.	4. *Pr. armatum*	5. Kölliker's type of *P. thomsoni*	6. «*P. carinatum*	7.	8.	9.	10.	11. *P. Gunhildæ*»
Total length in mm.	90	150	380	290	145	215	230	140	230	320	505
Length of peduncle		75									157
Breadth »		2									5
Length of the spicules of the calyxes in mm.	0.560 —0.893	0.445 —0.625		0.142 —0.893	0.36 —1.05	0.222 —1.023		0.992		0.192 —0.992	0.592 —0.960
Breadth »	0.020 —0.035	0.027 —0.045		0.016 —0.046	0.027 —0.066	0.041 —0.055		0.032 —0.064		0.032 —0.056	0.032 —0.048
Length of the spicules of the tentacles in mm.	0.290 —0.318	0.268		[1]	0.11 —0.19	0.136		0.118 —0.128		0.192	0.128 —0.192
Breadth	0.020 —0.027	0.027		[1]	0.01 —0.04	0.014		0.0080		0.016	0.016 —0.032
Length of the polyp-calyx	3—5	2—4	4—5	3	1.5—2	3—5	3—4	3—4	4(2—5)	2—4	2—4
Breadth			2	1				2	1.5—2	1.8—2	1.8
Number of calyx-teeth	3	2—5	3	2—3	(most often) 4	3	3(0—2)	3	3(0—2)	3(0—5)	3(0—4)
Number of longitudinal series of polyps	1(—2)	2	2	2	2	3	3	3	3	3	3(—4)
Number of polyps in each oblique series	1(—2)[2]	2—3	2[2]	2—3	3	3(—4)	3	3—4	4	4—5	5

The most complete specimen is Nr. 11 from the Skager Rak, in which the whole peduncle is preserved; the upper end, however, is broken off[3]. The four specimens Nr. 3, 7, 8, and 10 are of especial interest because their upper end is intact; this shows that any supposition that the genus *Protoptilum* was constructed like the Virgulariæ, is unwarranted; when the top is so often wanting, and the calcareous axis appears naked for a greater or less distance, this in *Protoptilum* is with tolerable certainty only due to mutilation, generally caused by the fishing apparatus. In the four mentioned specimens the rhachis terminates above as a longer or shorter process (fig. 4 *f*), bent towards the ventral side in a more or less hook-like way; this process is covered with zooids to the point; the point itself may be occupied by a zooid, which, however, does not appear to be larger or upon the whole built differently from the others.

No stress can be put on the differences with regard to the size of the spicules; in the first place, I have by no means always measured exactly the largest and the smallest specimens, and secondly, the measurements of the specimens of the North-Atlantic Expedition and of the type-specimen of the species *P. thomsoni*, have been made by Danielssen and by Kölliker, and these measurements I have not been able to control; besides, spicules are upon the whole often very varying both in length and thickness in different individuals of the same species of Pennatulids.

As to the colour of polyps and zooids, and consequently of the rhachis as a whole, it is also

[1] Is said to be «as in the other species».

[2] The oblique series are here most easily seen to be such, when viewed in a direction opposite to that in the other specimens, viz. from the dorsal polyp upwards towards the ventral median line.

[3] This specimen was in the Riksmuseum in Stockholm labelled as «*Pr. gunhildæ*», but the name has never been published (comp. Grieg. Ovs. Norges Penn. p. 21).

rather variable, but is almost always different shades of red; only Nr. 6 «*Pr. carinatum*» is stated by Danielssen to have been straw-coloured, the calyxes almost white. For several specimens the colour of the calyxes of the polyps is stated to have been of a brick-colour; now, however, they are almost quite bleached or only pink; exceptions in this respect are formed by the Swedish specimen Nr. 11 and one of those taken by the «Michael Sars» (Nr. 10), both being still of an intense brick-red colour.

By a careful comparison of all the Scandinavian specimens I have not been able to find any difference that might justify a division into several species. The four species established by Danielssen on the material of the North-Atlantic Expedition: *Pr. lofotense*, *armatum*, *carinatum*, and *mohni*, are each based on only one single specimen; in other words, each specimen found has been made a separate species, although the localities might have advised some caution; scarcely anybody will be able to find reliable specific characters in the (otherwise very careful) descriptions of Danielssen, no more than in his figures, and the specific diagnoses he himself gives, must be rejected by all, who have had any experience with regard to the Pennatulids. The fact is that the differences really found in these four specimens are individual ones, either such as are due to different development and growth (as the number and particular arrangement of polyps and zooids), or such as owe their origin to a casual degree of retraction (for instance, the features that have evidently given rise to the specific name *carinatum*; further, that the polyp-calyxes may be narrower, more or less projecting and marked off from the rhachis etc.). That it is injudicious to seek characters for the division of species in such features is immediately seen, when new specimens are found. In this respect I may refer to the fact that the two specimens found by Dr. Appellöf (Nr. 3 and 7 of the table), when judged in the same way as has been done with those of the North-Atlantic Expedition, would of necessity have to be established as two new species, neither of them agreeing exactly with any of the species of Danielssen, but being more or less closely related to each of them and being, besides, provided with something new. Grieg, to be sure, has seen this (at all events with regard to one specimen, comp. Norges Penn. p. 21), but he has also seen that it would be dangerous to create new species; the more so since the Swedish specimen (Nr. 11 of the table), which Grieg has also had the opportunity of seeing, might as well lay claim to the same title, as it cannot be said absolutely that it «seems to be quite similar to the type-specimen of *Pr. mohni*»; only with the specimens of Appellöf in mind could there be from Grieg's standpoint any question of referring it to «*Pr. mohni*». But when it is understood that «*Pr. mohni*» may assume so many different shapes, the necessary consequence will be the incorporation of the three other forms of Danielssen into the same species. I am therefore quite persuaded that every one, who can now inspect and compare all the Scandinavian specimens I have had at my disposal, will arrive at the same view with regard to their specific identity. Strange to say, no comparison with the species *Pr. thomsoni* seems hitherto to have been attempted; at all events this species is not mentioned at all by Danielssen or Grieg; nevertheless, the agreement between the Sandinavian forms and this one is in all essential features so close, that I think myself fully justified in using the specific name of Kölliker. Also, the features of the inner structure mentioned by Kölliker (Monogr. p. 371), have been found by me in the Scandinavian specimens I have examined in this respect. Thus, I find the radiate canals, to which Kölliker especially calls our attention as

being found haufenweise an der Dorsalseite des dorsalen Kanales, developed very beautifully and in considerable numbers. I shall add that it was easy for me to ascertain that these canals, the connection of which with the polyps K. could not explain, open into a network of other canals which are again directly connected with the polyps and with the gastric sacs of the zooids placed between the polyps; similarly, the dorsal zooids are connected with the dorsal main canal; on the other hand, the narrow lateral canals do not here, any more than in most other Pennatulids that I have examined in this respect, show any connection with polyps or zooids.

After to what has been said above, it will now be possible to give the following altered diagnosis of the species *Pr. thomsoni* Köll.:

Rhachis long (longer than the peduncle), cylindrical or somewhat compressed; the dorsal median streak distinct, the ventral one forming a fine line often indistinct or interrupted; the polyp-calyxes with the whole axial side of the polyps embedded in the cœnenchyma, the abaxial side provided with slightly marked teeth, most frequently three; all the tentacles with a layer of spicules along the aboral side of the stem. The polyps of either side arranged in up to four longitudinal rows; in developed colonies the polyps further form oblique rows rising towards the dorsal surface, and containing up to six polyps. The colour of the calyxes of the polyps and zooids is red in different shades, sometimes bright red; the retractile part of the polyps, the corresponding part of the zooids, the dorsal median line on the rhachis, and the peduncle colourless or yellowish white.

Occurrence. This large species is only known from the warm area within the northern part of the Atlantic, viz. from 36° 37′ N. Lat., 7° 38′ W. Long., 322 fathoms (the «Porcupine» Expedition, the four type-specimens of Kölliker); from the fjord-regions of Norway and the adjoining region: the Vest Fjord (*P. «lofotense»*, *P. mohni*, *P. carinatum*) 160—341 fathoms; west of the mouth of the Sogne Fjord (*«P. armatum»*), 206 fathoms; the Bergen Fjord (Nr. 3 and 7 of the table, taken by Dr. Appellöf), 150—200 fathoms; mouth of the Sulen Fjord (Nr. 8, 9, 10, taken by the «Michael Sars»), 215—220 fathoms; finally from the Skager Rak (*Pr. Gunhildæ*, Nr. 11, taken by Bovallius and Théel), 440 fathoms.

This species therefore, does not seem to be a marked deep-sea form. It will probably — like other European Pennatulids from the same region — prove to be indigenous also on the American side of the Atlantic, on the slopes of the banks at the Færoe Isles and Iceland etc.

Protoptilum denticulatum n. sp.

Pl. I, Figs. 9—11.

(Rhachis short; the polyps arranged in one row on either side; dorsal zooids likewise, separated by a narrow, naked dorsal streak; ventral zooids also in one row on either side, but a ventral median streak is not distinct). Polyp-calyx with 8 (the terminal polyp) or 6 distinct and long teeth supported by spicules; the polyps with a strong layer of spicules on the tentacle-stem; the calyx of the zooids provided with two teeth (the terminal zooid with three teeth on the calyx); the spicule-formation very abundant; the colony colourless.

In the Atlantic, to the south-east of the southern point of Greenland, the «Ingolf» has taken a small *Protoptilum* differing so much from the hitherto described species, that it must be established

as a new species. The specimen is quite complete, but it is a young stage and even very little developed, so that it is impossible to give a complete diagnosis. The information given above as to the arrangement of polyps and zooids is such as is known to change with the growth, and it is therefore given in parentheses. The feature by which we are especially justified in supposing this specimen to represent a separate species is the form of the polyp-calyx. This indeed, is formed like a horn, as in the preceding *Protoptilum*-species, but its upper end projects to a far higher degree from the cœnenchyma of the rhachis, the axial edge being also distinctly marked and freely projecting; this edge however has no teeth — at all events in most of the polyps — whereas the other part of the edge runs out in six long, pointed and strongly spiculed teeth, of which the four middle ones are as well-developed as the calyx-teeth for instance in *Pennatula phosphorea*. The terminal polyp (and, I think, also the two upper lateral polyps nearest to it) is provided with a complete circle of eight developed, long calyx-teeth. The calyx is abundantly furnished with long, strong spicules; some of these form six slightly elevated lines continuing into the long calyx-teeth. The polyps are naked with the exception of the tentacle-stem, the aboral side of which shows a very strong formation of spicules. All the polyps, also the terminal one, contain large, developed sexual organs; even the lowest, still quite undeveloped polyps contain large sexual organs, so that the whole rhachis (by clearing in oil of cloves) conveys the impression of being quite filled with these products. The polyps decrease in size gradually from above downwards; the lowermost ones are still quite undeveloped, and form a rather short row of 4—5 individuals on either side.

In the zooids, the abaxial side is richly provided with spicules which form a calyx, generally with two lateral points; the terminal zooid referred to later has a more strongly marked calyx, provided with three calyx teeth.

The arrangement of the polyps and zooids shows quite distinctly that the colony is in an undeveloped state. At the top, the rhachis ends in a terminal polyp whose calyx, as mentioned above, is complete all round and provided with a circle of eight teeth. The other polyps generally form a single row on either side of the rhachis; in this row each polyp more or less distinctly forms a pair with that of the opposite side, but in reality the rows are a little alternating. On each side larger polyps (*a*) alternate with others a little smaller (*b*); further, the latter are placed a little more ventrally than the former. Each pair of opposite polyps consists of a larger, placed more dorsally (*a*), and a smaller, more ventral, e. g. of an *a*-polyp to the right and a *b*-polyp to the left; then the pairs above and below have a *b*-polyp belonging to the right side, and an *a*-polyp belonging to the left side and so on. At the upper end of the rhachis an arrangement in oblique rows of two polyps is indicated, the two uppermost *b*-polyps being placed much nearer to the ventral median line than the others of the same pairs farther down the rhachis. Otherwise, the polyps of the same side join each other at their calyxes. The dorsal zooids are arranged in a row on either side of a slight dorsal median streak; at the top the double row terminates in a somewhat larger, unpaired terminal zooid placed at the base of the calyx of the terminal polyp; as stated above, this zooid is provided with a more marked and three-pointed calyx. The ventral zooids are in a similar way arranged in two rows, but a ventral median streak is not distinctly seen, excepting at the lower end of the rhachis.

The spiculation is highly developed; spicules are only wanting on the terminal bulb of the

peduncle and the retractile part of the body of the polyps, as well as on the pinnulæ. The longest and strongest are found on the abaxial side of the calyxes of the polyps, the shortest and thickest (of almost oval contour) on the peduncle; on the lower part of this these spicules are arranged, partly somewhat irregularly, partly with the longer axis placed transversely: farther up they form longitudinal layers with finer and longer forms interspersed; still farther up elongated spicules longitudinally arranged predominate. The long spicules are of the common triangular form, sometimes the edges curve irregularly in and out. As I was not willing to sacrifice any part of this one specimen for a more thorough examination of the spicules, only such have been measured as could be seen distinctly in situ, or dropped off during the manipulation of the specimen. The longest and biggest may be given as ca. 0.960^{mm} long, and a greatest breadth of 0.064^{mm}; others (measured when isolated) are 0.464—0.804^{mm} long and 0.032^{mm} broad; the smallest tentacle-spicules measured are 0.400^{mm} long and 0.0240^{mm} broad; the short and thick spicules of the peduncle are generally 0.096—0.144^{mm} long, 0—032^{mm} broad.

The calcareous axis is round, ending below in a bent hook far from the lower end of the peduncle (at * in the figure); this feature, however, is due to the accidental, much stretched condition of this part of the body of the colony, and so it cannot here, any more than elsewhere, be regarded as being of any value as a specific character. I have not been able to find the upper end of the calcareous axis, but I have followed it to about the height of the terminal zooid.

The whole colony is white, all the spicules colourless.

Occurrence. St. 20, 58° 20′ N. Lat., 40° 48′ W. Long., 1695 fathoms. Bottom temp. 1°.5 C., the bottom light gray mud, 1 specimen.

The specimen in hand shows the following measurements:

Total length	75 mm.
Length of peduncle	40 »
Greatest thickness of peduncle (close below the rhachis)	1.8 »
Length of terminal bulb	3 »
Breadth »	1.5 »
Breadth of rhachis measured across the mouths of two opposite polyp-calyxes	3 »
Length of a polyp calyx, from the base to the point of a tooth	4—4.5 »
» » notch between two teeth	3 »
The calyx-teeth	1—1.5 »
Diameter of the mouth of the calyx	1.3 »

Since, according to the description by Kölliker of *Protoptilum smittii*, there might be reason to suppose that the specimen of the Ingolf was perhaps the same species, I have, by the kindness of Professor Théel, examined the type specimen of *Pr. smittii*. This specimen is also at a little developed stage, mainly with one row of polyps on either side; but the top is broken off (it is upon the whole rather damaged); some agreement is present in the outer appearance, but the teeth of the polyp-calyxes are broader and vary more irregularly in size and number (3—5), the zooids are

much more numerous, the retractile parts of the polyps very dark-coloured, the spicules more slender and fewer, especially on the peduncle. Although several of these differences are of such a nature, that in some other Pennatulid-genera they would not be regarded as specific differences, I dare not overlook them with regard to the genus *Protoptilum*, our knowledge of the variation and the change in growth of this genus being still very incomplete. Accordingly I take — for the present — *Pr. smittii* to be a young stage of another species than my *Pr. denticulatum*. They belong both of them to the Atlantic Ocean, and the great distance between the localities, respectively ca. 36° N. Lat., 14° W. Long. (the Josephine Bank), and ca. 58° N. Lat. 40° W. Long., need not in itself — any more than the difference in depth (228—1695 fathoms) — prove any specific difference, as may be seen from other cases (e. g. *Anthoptilum grandiflorum* a. o.).

Distichoptilum Verrill.

The genus has been established by Verrill on one specimen of the species mentioned below, and characterized in the following way: «Slender pennatulids, with an axis through the whole length. Polyps arranged alternately, in a simple row, on each side. Calicles bilobed, appressed. Zooids three to each polyp, one in front and one on each side of each cell. Spicula abundant in the calicles, rachis, and stalk; those in the stalk are small, oblong, triquetral, interwoven». In this diagnosis, however, the following alterations have to be made: the calyxes of the lateral polyps are provided with several (6) teeth on the abaxial edge; the axial edge is toothless, and the axial side of the calyx fuses with the rhachis. The number of zooids is two at each polyp; they are placed directly above the mouth of the calyx of the polyp, one on the dorsal side of the rhachis, and one on its ventral side. The peduncle increases evenly in thickness downwards. This genus is especially interesting in that it retains as a constant feature, an arrangement of the polyps which in other Pennatulids is only found as a transitory one in young stages, and which may really be more or less distinctly traced in all the Pennatulids of which we know sufficiently young stages; it is seen most distinctly in the «*Protocaulon*»-stage of the Virgulariæ and in *Protoptilum*. This simple arrangement in *Distichoptilum* is not only a constant feature, but persists throughout with the utmost regularity, which gives to the whole colony an exceedingly emphatic character of simplicity.

Distichoptilum gracile Verr.

(Pl. I, Figs. 12, 13, 14).

Distichoptilum gracile Verrill. Am. Journ. of Sc. 24, 1882, p. 362, Note.
» Bull. Mus. Comp. Zool. Harvard Coll. Vol. XI, Nr. 1, 1883, p. 8, Pl. I, Fig. 1.
Verrillii Studer. Ibid. Vol. 25, Nr. 5, 1894, p. 59.

At two stations, very far from each other, one in the Davis Straits, the other south of Iceland, the Ingolf has obtained several specimens of a *Distichoptilum* which, in spite of some

differences, will have to be referred, I think, to the species *D. gracile* of Verrill. The features in which all the specimens differ from this species are the following: the polyp-calyxes are only here and there seen with a two-lobed edge; and when this is the case it has only arisen by a closing of the mouth of the calyx round the completely retracted polyp[1]; in other cases — where the contraction of the retractile parts is not so complete — the abaxial edge of the mouth of the polyp-calyx shows six pointed teeth supported by spicules. Next, the polyps are not placed so close to each other, as given in the description of Verrill and in the figure l. c. 1 a; generally, the front edge of a polyp-calyx does not reach farther upward than to the lower end of the calyx placed next above it, and consequently it covers no part of this next calyx; often, especially in the upper part of the rhachis, one polyp is far from reaching to the base of the next. With regard to this point, however, it is to be remembered that the sarcosoma of the rhachis in all Pennatulids may be shortened by a contraction of its longitudinal musculature, so that the distance between the polyps may be altered; as in *Virgularia (mirabilis), Stylatula,* etc., the appearance of *Distichoptilum* may also be influenced by this fact. Further, there are found at each polyp, not three but only two zooids (each with a small calyx provided with spicules); they are placed close to the (axial) upper edge of the calyx, one on the dorsal, one on the ventral side of the rhachis, and (very nearly) of the same relative height. When Verrill states that one more zooid is placed »in front of« i. e. above the calyx, such a zooid is absolutely wanting in all the specimens of the »Ingolf«; in this respect as in all others these specimens agree with Studer's *D. verrillii*; in Verrill's figure also, this third zooid is not seen, and I think its existence quite problematical. Finally, a more or less distinct longitudinal stripe or furrow is found both on the dorsal and on the ventral side of the rhachis; the appearance of this furrow may however, I think, be quite dependent on the degree to which the longitudinal canals are filled, and to the casual contraction of the sarcosoma. The colour is stated by Verrill to be »bright orange red, due to the spicula; end of bulb yellowish«; in the specimens of the »Ingolf« the colour is only red in the upper, abaxial part of the polyp-calyxes, otherwise it is yellowish to yellowish-white; the red colour of the calyxes extends over two only of the lateral points, whilst the other teeth contain colourless spicules (a further reason for overlooking these teeth). In all the features stated, the *D. verrillii* of Studer agrees with the Ingolf-specimens, except that the calyx is said by Studer also to be provided with two teeth; he declares himself that his »species« is very closely allied to that of Verrill — the only differences being the greater distance between the polyps, and the greater size of his specimens — but these features are of no value as specific characters. So far as I can see, both Studer's specimens and ours will have to be referred to the species *D. gracile* first described.

The calcareous axis is round, in some specimens a little angular or compressed in part of the rhachis.

In the upper retractile part of the polyps, spicules seem to be wanting, but they are found in the tentacles on the aboral side of the stem, not, however, to the very point; pinnulæ are naked. The specimens taken by the »Ingolf« show the following proportions:

[1] Verrill's fig. 1 a, which, by the way, is not very detailed, shows only quite retracted polyps.

Nr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Total length . . . . . in mm.	289	227	106	104	101	98	83	75	70	47	36
Length of peduncle	74	70	32	25	35	47	40	33	25	22	15
Greatest breadth of peduncle .	1.3	1.3	1	1.3	1	1	1	0.8—1	1	1	1
Breadth of rhachis measured across a polyp-calyx . . . . . in mm.	1,5	1.7	1—1.3	1	1.3	1.8		1.8	1.8	1.8	1.5
Length of polyp-calyx . . . . . »	3	3	3	3	3	2.3	2	2.5	2.5	2	2.5
Breadth » across the mouth	1	1	1	1	1	0.8		1		0.8	0.8

As a matter of comparison I may note that Verrill's specimen is 456^{mm} long, the breadth in the middle 2^{mm}, the length of the peduncle 100^{mm}, whilst Studer says that his species probably reaches to a length of upwards of a metre; the single entire specimen, however, measured only 470^{mm}.

Of the specimens before me Nr. 6, 7, and 10 are damaged, more or less of the upper part of the calcareous axis having been denuded; the others look as if they were entire, but a more thorough examination of the upper part of the rhachis makes it doubtful whether the original upper end of the colony is preserved. With exception of the specimen Nr. 9, which I take to be abnormal, and which will be more particularly mentioned hereafter, the rhachis ends in a solitary polyp which, moreover, on its axial (dorsal) side carries a solitary and rather conspicuous large zooid (see Pl. I, fig. 13 z). It would be natural therefore to suppose these to be the terminal (i. e. the original) polyp and a terminal zooid, such as we know to occur in young *Pennatula*-colonies. But so far as I can see, only six calyx-teeth are found in this apparently terminal polyp, as in the other polyps, the lateral ones; now we might, with some probability, expect eight calyx-teeth and a fully developed calyx-edge in the real terminal polyp, but the calyx-edge does not appear to be developed on the side towards the apparently terminal zooid — which, however, is difficult to decide with perfect certainty, as the polyp in question is always strongly contracted, so that the calyx-teeth join each other. At all events, the terminal zooid is placed close to the calyx-teeth of the end-polyp, whilst in *Pennatula*, as is well known, it is placed below at the base of the calyx of the terminal polyp. In other words, it is placed exactly where the one zooid would be found, if the apparent end-polyp is a lateral polyp. I am most inclined to suppose therefore, that the «terminal polyp» is the uppermost lateral polyp present, and the terminal zooid one of the two zooids of this polyp together with an adjoining small part of the rhachis, so that the real upper termination of the colony is close to this zooid. But such a termination of the rhachis can scarcely be the original one; it is probable that in all these specimens an upper part of the colony has dropped off either as a consequence of earlier mutilation or perhaps through atrophy in a somewhat similar way as in the Virgulariæ. That at all events, the original features are not found at the upper end of the longest specimen but one (Nr. 2), although this end looks as in the others, may be concluded with certainty from the fact that the calcareous axis ends immediately at the terminal zooid, cut off quite abruptly, and is there of the same thickness as farther down. With regard to the others I have not been able — even by clearing (in oil of cloves and the like) — to get a clear notion of the upper end of the calcareous axis, but it seems to be tapering, and does not appear to be broken. On the other hand, the lower end may easily be observed; it is found in the outermost point of the peduncle, and forms here a curved hook.

The specimen Nr. 9 deviates from all the others in having the lateral polyps in the uppermost part of the rhachis arranged in (almost) opposite pairs; three such pairs are present (Pl. I, fig. 14); between the two polyps of the uppermost pair the rhachis ends as a little knob (k) containing the upper, fine end of the calcareous axis, and provided with one ventral zooid at all events for one of the two polyps.

The *spicules* on the calyx have a length of 0.528—0.800^{mm} and a breadth of 0.032—0.048^{mm}; on the tentacles, the spicules are 0.096—0.176^{mm} long and 0.008^{mm} broad.

Occurrence. The specimens of the Ingolf have been taken at the following places: St. 24, 63° 06′ N. Lat., 56° W. Long., 1199 fathoms, bottom-temp. + 2° 4 C. (10 specimens, Nr. 1—7, 9—11, and some fragments of the rhachis of other specimens); St. 41, 61° 39′ N. Lat., 17° 10′ W. Long., 1245 fathoms, bottom-temp. + 2° C. (1 specimen, Nr. 8).

The specimen of Verrill was obtained south-west of Nantucket Island, 39° 59′ 45″ N. Lat., 68° 54′ W. Long., ca. 700 fathoms; those of Studer, on the other hand, are from the Pacific, 0° 4′ S. Lat., 90° 24′ 30″ W. Long., 885 fathoms, 23° 59′ N. Lat., 108° 40′ W. Long., 995 fathoms, 1° 7′ N. Lat., 80° 21′ W. Long., 1573 fathoms. With regard to the Atlantic I imagine that the distribution will be found to comprise the whole of the warm area at great depths and on soft bottom.

Fam. *Anthoptilidæ* Köll.

Anthoptilum Köll.

To the characteristics of the genus pointed out by Kölliker may be added, that the stem of the colony is very much bent so as to form a large curve almost in the middle, and further that it may show smaller curves, so that its form may be somewhat like an S; the concave side of the chief curve is formed by the naked dorsal surface of the colony. All the figures of Kölliker show this curve, but as it is not mentioned, it might be supposed to be individual, or even to have appeared in the preserved state. The many specimens that I have had the opportunity of seeing, taken directly from the bottom of the sea, show with certainty that the curved form is a natural feature of the colony, being already distinctly marked in small specimens. The stem ends above in a naked, longer or shorter cone without any terminal individual. The sexual organs are found in the polyps themselves.

The calcareous axis, as stated by Kölliker, is round, in so far as it has no edges; but it is distinctly compressed from the sides; it is thickest at the beginning of the chief curve or a little below this, but a more conspicuous swelling of the calcareous axis, corresponding to the elliptical thickening of the upper part of the peduncle which is a peculiarity of the genus, is not found (as in *Pavonaria finmarchica* and *Halipteris christii*).

The genus is hitherto known only from the Atlantic, where it occurs from the most northern to the most southern regions, but only at great depths.

Anthoptilum grandiflorum (Verr.).

Virgularia grandiflora Verrill. Am. J. Sc. (3) Vol. 17, 1879, p. 239.
Anthoptilum thomsoni Kölliker. Challenger Rep. Penn. 1880, p. 13, Pl. V, Figs. 16—18.
grandiflorum Verrill. Am. J. Sc. (3), Vol. 23, 1882, pp. 312, 315; Bull. Mus. Comp. Zool. Vol. XI, p. 5, Pl. I, Fig. 6.

The Ingolf has obtained six specimens at one station in the Davis Straits; three of these are well-preserved, two rather large, the third small; two are more or less damaged, and one specimen is quite denuded (Nr. 6); two specimens (Nr. 7, 8) have been taken at another station, both of them in bad condition.

Nr.		1.	2.	3.	4.	5.	6.	7.	8.
Total length	in mm.	415	300	205	172	122	180[1])	180	130
Length of peduncle	»	52	41	32	...	23	...	31	20
Diameter of the upper enlargement of the peduncle	»	8	5.5	3	...	2	..	4	3
Breadth of the naked dorsal surface of the rhachis	»	c. 4	4	3	..	1—2	..	c. 2	2
Number of polyps in the wings		5—7	5—7	3—5	...	2—3	...	3—5	2—3
Length of an extended polyp with the tentacles	in mm.	16	...	...	...	5	...	5	5

As is generally the case in the species, spicules are only found in the end of the peduncle; in one of the specimens the largest measure to 0.024—0.030^{mm}, whilst others show a size of ca. 0.012—0.020^{mm}; the smallest seem to be even smaller than the minimum size of 0.007^{mm} given by Kölliker; a regular combination of four spicules is rather common, but more irregular combinations of three or four spicules are also found.

The number of polyps increases during growth, not only in the lower, boundary part of the rhachis, but also farther up in the older part, where the oblique rows here representing the wings are often seen on the ventral side of the colony to be increased by a young polyp or a bud.

The colour of the polyps when living is violet, that of the stem reddish; in spirit this sea-pen loses its colour only the tentacles of the polyps remain coloured, and there it is turned brown. In several of the specimens from both stations peculiar, worm-like parasites were found, partly projecting from the mouth of the polyps; they were parasitic Copepoda of the genus *Lamippe* Bruz.; evidently a distinct new species, to which I give the name of *L. anthoptili.*

Anthoptilum grandiflorum has hitherto only been mentioned from the American side of the Atlantic; from North America it has been known from off Guadaloupe to off Nova Scotia (42° 46′ N. Lat. 63° 45′ W. Long.) (Verrill, Agassiz); from South America from 37° 17′ S. Lat., 53° 12′ W. Long., south of Buenos Ayres (the Challenger). To these localities two new ones are to be added, showing that the species ranges over a far wider geographical territory, as well to the north as to the east, in the Atlantic. The specimens of the Ingolf have been obtained in the Davis Straits, partly south-west of Godthaab, at St. 25, 63° 30′ N. Lat., 54° 25′ W. Long., 582 fathoms (soft mud, somewhat like potter's

[1]) The greatest breadth of the naked calcareous axis on the compressed lateral surface 2^{mm}, on the narrow surface 1.5^{mm}.

clay), partly west of Sukkertoppen, at St. 28, 65° 14′ N. Lat., 55° 42′ W. L., 420 fathoms (soft, brown-gray mud with innumerable arenaceous shells of Rhizopoda); and from the Manchester Museum our Museum has obtained a gigantic specimen[1]) taken near the Cape of Good Hope (»Lion's Head N. 67°, E. 25 miles», I think, ca. 34° S. Lat.) at 131—136 fathoms, together with several other specimens of lengths of about 3 feet, and with polyps 30mm long (according to information from Prof. S. Hickson)[2]). Otherwise the species seems to be a deep-sea form; on the American side it has not been taken at depths under 220 fathoms, but on the other hand at depths up to 1106 fathoms (U. S. Comm. of Fish. and Fisheries Rep. 1883 (1885) p. 510).

Anthoptilum murrayi Kölliker.

Anthoptilum murrayi Kölliker. Chall. Rep. Penn. 1880, p. 14, Pl. VI, Figs. 19—21.

Of this species the »Ingolf» has brought home 43 specimens from four different stations, and about half of them in a well-preserved state. In all chief characters they agree with the description of Kölliker; at the upper end of the peduncle, however, a distinct elliptical swelling is found in most of the specimens. As will be seen from the table below of the proportions of all the specimens, several small ones are included in the number; but they differ so little from the larger ones, that no doubt whatever can arise with regard to the determination of the species[3]). In a few specimens the circle of tentacles of the polyps is retracted; as a general rule, however, this is not the case, and the polyps and their tentacles are only contracted in different degrees; the proportions given below are of the polyps including the tentacles. Spicules are only found in the end of the peduncle, of a similar size and form as in the preceding species, but in somewhat greater numbers, at all events sometimes. Sexual organs are present, even in small specimens. Large eggs (or larvæ?) are often found in the tentacles.

Nr.		St. 83.			St. 40.	St. 65.	
		1.	2.	3.	1.	1.	2.
Total length	in mm.	405	310	275	55	230	145
Length of peduncle	»	47	37	40	15	30	27
Diameter of the upper enlargement of the peduncle	»	5	4	4	1.5	4	3.5
Length of a polyp	»	8	8—9	6	4—5	4	5
Breadth of the naked dorsal streak	»	2	2	2	c. 1	1.5—2	1.5—2

[1]) It measures 1350mm, the peduncle 190mm, its enlargement about 30mm in diameter. The polyps are coalesced into groups of 5—8 individuals, and measure 17—25mm. American specimens grow to a height of 2 feet, and a diameter of ca. 25mm (Verrill, U. S. Fish. Comm. p. 510).

[2]) West of Tristan d'Acunha, at 35° 41′ S. Lat., 20° 55′ W. Long., depth 1500 fathoms, the »Challenger» obtained an *Anthopt. simplex* Köll. (a damaged specimen of a length of 400mm), which resembles *A. grandiflorum*, but with only two polyps in each row; this specimen is possibly only an *A. grandiflorum* the development of which has been delayed, and in which the number of polyps for some reason or other has remained small; in other regions, however, the number of polyps may be greater at a far smaller size of the colony, which is proved by the specimens of the »Ingolf», especially the smallest of a length of only 122mm; therefore I think it rather hazardous to suppose *A. simplex* and *A. grandiflorum* to be identical.

[3]) I am therefore able to declare with complete certainty that Roule's »*Trichoptilum*» sp. (l. c. p. 307) has nothing to do with the genus *Anthoptilum*, but is really, as stated on p. 50, *Funiculina quadrangularis*.

Nr.	St. 47.											
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Total length in mm.	285	255	250	245	245	245	240	240	235	230	230	230
Length of peduncle »	43	35	34	37	37	32	33	33	31	31	32	28
Diam. of the upper enlargement of the peduncle »	5	5	5	5	5	5	5	4	4	5	5	4
Length of a polyp »	6	8	8	8	8	11	10	8—12	8—9	7	8	7
Breadth of the naked dorsal streak »	1.5—2	2	2	2	2	2	2	2	2			

Nr.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
Total length in mm.	225	225	220	220	220	220	220	210	205	200	195	185
Length of peduncle »	34	32	31	32		32	32	31	31	29	24	28
Diam. of the upper enlargement of the peduncle »	5	5	4—5	5	4	5	5	4	5	5.5	4	4
Length of a polyp »	8		8	12	6	9	10		10—11	8	6	10
Breadth of the naked dorsal streak »				2					2			1—2

Nr.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.
Total length in mm.	185	175	175	175	175	175	155	145	125	108	102	85	80
Length of peduncle »	28	30	28	26	27	21	25	26	21	20	20	17	18
Diam. of the upper enlargement of the peduncle »	4	4	3	4	4	4	4	4	3			2.5	2
Length of a polyp »	6	7	5	6	7		7—8					6	
Breadth of the naked dorsal streak »													

Anthoptilum murrayi has originally been taken by the »Challenger», south of Halifax (one specimen, 510mm long), 48° 8′ N. Lat., 63° 39 W. Long., depth 1250 fathoms; later, it has proved to be of frequent occurrence off the east coast of North America, partly at the same localities as the preceding species, in depths from 640—1362 fathoms (Verrill, Am. J. Sc. (3), vol. 28, p. 220; U. S. Fish. Comm. Rep. 1883, p. 511). On the European side of the Atlantic, it was found almost at the same time at two rather widely separated localities, viz. by the »Caudan» in the Bay of Gascony (depth 1410 metres, 45° 57′ N. Lat., 6° 21′ W. Long. (Paris), one specimen, 400mm long), and by the »Ingolf» south of Iceland, at four stations situated on almost the same line west to east between Greenland and the Færoe Isles, viz. St. 83, 62° 25′ N. Lat., 28° 30′ W. Long., 912 fathoms; St. 40, 62° N. Lat., 21° 36′ W. Long., 845 fathoms; St. 65, 61° 33′ N. Lat., 19° W. Long, 1089 fathoms; and St. 47, 61° 32′ N. Lat., 13° 40′ W. Long., 950 fathoms.

Thus it is evident that the species belongs to the deep part of the whole northern Atlantic inside the territory of the positive bottom temperatures.

Fam. *Kophobelemnonidæ* Köll.

Kophobelemnon Asbjörns.

Kophobelemnon stelliferum (O. F. Müller).

Pennatula stellifera O. F. Müller. Zool. Dan. Prodr. 1776, Nr. 3076; Zool. Dan. 1788, p. 44, Pl. XXXVI.
Kophobelemnon Mülleri Asbjornsen. Fauna litt. Norvegiæ II, p. 81, Pl. X, Figs. 1—8.

Kophobelemnon stelliferum Köll. Monogr. 1872, p. 304, Pl. XXI, Figs. 179—181.
» *Leuckartii* Köll. Ibid. p. 306, Pl. XXI, Fig. 182.
» *Mocbii* Kor. & Dan. Berg. Mus. Nye Gorgon. etc. 1883, p. 25, Pl. XII.
abyssorum Kor. & Dan. N. North-Atlantic-Exp. Penn. 1884, p. 10, Pl. IV, Figs. 17—20.
scabrum Verrill. Bull. Mus. Comp. Zool. Vol. XI, 1883, p. 7, Pl. I, Fig. 5.
? » *tenue* Rep. Comm. Fish and Fisheries 1883, p. 510, Pl. III, Fig. 5.
Gunneria borealis Dan. & Kor. N. North-Atlantic-Exp. 1884, p. 58, Pl. IV, Figs. 8—16.

Of the genus *Kophobelemnon* several species have been established, some from the Atlantic (and the different branches of that ocean), others from the Pacific. Of these species as of so many other sea-pens, the same things holds good, that the material has been too scarce to allow their determination to be reliable. Here, however, only the Atlantic species are to be mentioned in detail. As will appear from the above list of synonyms I am of the opinion that they must all be united into one species, which then receives the old specific name *stelliferum* given it by O. F. Müller. To this must further be added the genus and species *Gunneria borealis* of Danielssen and Koren (as to this see p. 72). The specimen of O. F. Müller was taken at Dröbak, the numerous specimens of Asbjörnsen at different places in the Christiania Fjord. When Kölliker worked up the genus in his monograph, he justly referred all the Scandinavian specimens at his disposal to one species, not only those originating from about the same localities as the specimens of Müller and Asbjörnsen, but also a few from somewhat great depths in the Atlantic proper, north-west of Scotland (even if he thought them to be a variety *durum* on account of the size of the spicules; later examination of another specimen from another part of the Atlantic attached this variety still more closely to the type (l. c. p. 370)). At the same time, however, he established a new species *K. leuckartii* on some specimens from the Mediterranean (Nizza); to be sure he declares this form to be very closely allied to the former, immerhin mahnt der Fundort zur Vorsicht, and he enumerates a number of differences from his *K. stelliferum*. These differences are: the size of the whole colony and of its individual animals, the number of the polyps, the fact of the calcareous axis reaching to the distal end of the peduncle, a richer provision of spicules and their larger size, the lack of colour in the epithelium of the stomach, and the boundary between the peduncle and the rhachis being less distinct. I can, however, declare all these differences to be individual peculiarities; one of them — the extent downward of the calcareous axis — is quite casual, owing to a contraction of the soft tissues in this region; and a comparison of the two specific diagnoses will show that no difference is mentioned which is not individually variable according to the knowledge we now possess of other Pennatulids. Nevertheless, the species *K. leuckartii* of Kölliker has been preserved without any objection; only Paul Fischer, relying presumably on the descriptions of Kölliker, regards the *Kophobelemnon* of the Mediterranean as the same species as *stelliferum* »dont le *K. Leuckartii* n'est qu'un race» (Note sur le *Pavonaria quadrangularis* etc., Bull. Zool. de France, Vol. 14, 1889, p. 37). That it does not, at all events, represent a »race» peculiar only to the Mediterranean — in this case the question of species or race would be rather a difficult one to solve — is shown by the fact that it is said to occur also in the north, inside the territory of the »genuine» *K. stelliferum*.

In 1872 the German »Pommerania» Expedition found some specimens of *Kophobelemnon* in the Skager Rak which were determined as *K. leuckartii* Köll. by F. E. Schultze (Jahresber. der Komm.

zur wissensch. Unters. deutsch. Meere f. d. J. 1872—73 (1875) p. 142). Koren & Danielssen, however, found that these specimens completely agreed with others, partly taken in the Skager Rak also (by the Swedish gunboat «Gunhild»), partly in fjords of the Norwegian west coast (Kors Fjord, Vest Fjord), which specimens they now made to represent a new species *K. moebii* (Nye Gorg. etc. p. 25); but at the same time they thought they had found the genuine *K. leuckartii* in a specimen from Trondhjem Fjord (l. c. p. 28), where this Pennatulid is said to be very common. Later, the same authors described still another form as *K. abyssorum* from various Norwegian fjords, in some of which *K. moebii* had been found. Thus we had no less than four Scandinavian species, of which only one seemed the same as that from the Mediterranean [1]). If we now examine the descriptions of these supposed species we shall search in vain for characters that might be taken as specific; only such differences are mentioned as change with age and size; this holds good of such features as the length of the colony, the number of polyps, the proportion between the length of the rhachis and of the peduncle, the number of rows of polyps, the size of the polyps; also, the size and numbers of the spicules are very varying; other «specific characters» arise from mere chance (e. g. a longitudinal furrow on the rhachis or the like). As very characteristic examples of the value of the supposed specific characters, the following may serve: in *Koph. abyssorum* the stalk is almost twice the length of the rhachis; in *K. leuckartii* it is only a little longer than the rhachis; in *K. moebii* the stalk is generally half the length of the rhachis — but in two very long specimens the stalk was relatively much longer, and in young specimens it was as long as or even longer than the rhachis! I have carefully compared all the type-specimens of these Scandinavian species, and I have not been able to keep them distinct; further, I have examined the specimens of the Christiania Museum and a very large material of *Kophobelemnon* in our own, and finally I have had the opportunity of examining a very large number of *K.*, partly collected in the deep channel of the Skager Rak by Dr. Joh. Petersen and Mag. A. C. Johansen, partly from different regions off Norway, taken by Dr. Hjort on the «Michael Sars». In all this large material I have only been able to see one single species; but of course it appears rather different, if we compare extreme forms without any intermediate links: young colonies with giants up to 750^{mm} long; specimens with quite few and relatively small polyps with others provided with ca. 150 large polyps with bodies of a length of ca. 20^{mm}; specimens with fully stretched polyps with such where the polyps are quite retracted (for even if the latter case is rather rare it does occur, and shows accordingly that the polyps are quite retractile); big and clumsy specimens with slender and thin ones etc. All the *K.* hitherto found at Norway and in the Skager Rak are, beyond a doubt, the same species as the *K. stelliferum* of O. F. Müller, Asbjörnsen, and Kölliker; and the different authors have also referred to this species all the specimens of *K.* taken at different localities in the Atlantic by the English expeditions of the «Lightning», the «Porcupine», the «Triton», and the «Knight Errant».

From the American side of the Atlantic, Verrill has established two species: *K. scabrum* (Bull. Mus. Comp. Zool. XI, p. 7, Pl. I, fig. 5), and *K. tenue* (Report Comm. Fish and Fisheres 1883, p. 510, Pl. III, fig. 5 (1885)). The former is short and clumsy, a young stage (56^{mm} long) with few (8) polyps, rough on account of its rich provision of spicules; from the description I must regard it as

[1]) Panceri, however, had already in 1871 found a *K.* at Naples which he had determined as *K. stelliferum*, but which Kölliker supposed to be identical more probably with *K. leuckartii* (Monogr. p. 370).

identical with *K. stelliferum*[1]); of the second it is only said that it is long, slender, and smooth, with a number of large polyps; neither this description nor the figure, which is very meagre in details, exclude the possibility that it may be the same species. The figure gives the natural size and shows by this and by the proportion as to length between the peduncle and the rhachis (they are of about equal length) that the question is only of a young form. It is my conviction that hardly more than the one species of *K. stelliferum* (Müll.) is known from the Atlantic Ocean. But on the other hand, it is known in a more complete series of stages than most other Pennatulids; for my own part I have had the opportunity of examining and comparing an almost continuous series from 7.5^{mm} with one polyp up to 750^{mm} with more than 150 polyps; such a size as the last is scarcely to be met with in previous literature; neither the first author of the species, O. F. Müller, nor Asbjörnsen, who established the genus *Kophobelemnon*, nor Kölliker, had any idea of how far their specimens — in spite of the full development of the sexual products — were from having reached the maximum development. The very circumstance that specimens of 130—135^{mm} become the types of the species *K. stelliferum* might be the reason why other stages, and especially the much larger ones, were interpreted as belonging to other species; the most unwarrantable to my mind was the *K. moebii* established by Koren and Danielssen, because these authors had so many different specimens, that its relationship to the species of Asbjörnsen should have been sufficiently plain. Asbjörnsen knew already quite small specimens; he has (l. c. p. 82, Pl. X, figs. 3 and 4) described and figured a specimen with only one polyp and another with two polyps, both about 20—30^{mm} long; later, Grieg (Bergens Mus. Aarb. 1893, Nr. 2, ibid., 1896, no. 3) has described quite a series of developmental stages from a length of 6^{mm} upwards; young stages are mentioned also in several other authors and sometimes figured (for instance F. E. Schultze, l. c. p. 142, Pl. II, fig. 2, a specimen 48^{mm} long with six polyps; M. Marshall Triton-Penn. p. 138, Marshall and Fowler Porcupine-Penn. p. 460). The very young colonies show already that no certain proportion exists between the number of the polyps and the length of the whole colony, as will appear from the following table:

Number of polyps	1.	2.	3.	4.	5.	6.	7.	8.	9.
Length of the specimens in mm.	6—27	26—30	30—41	32—47	?	45 62	70	56—69	71—88

Already at a length of 80^{mm} we have specimens with 16 polyps, and at a length of 88—90^{mm} even 18—20 polyps. In the specimens with only one polyp, the primary polyp, this is never placed terminally, but a zooid is found near the apex of the rhachis. In the least developed specimens the whole colony consists of these two individuals only, but by and by the number of zooids is increased along the dorsal side of the stem below the terminal zooid. This zooid, however, is not so markedly different from the other zooids as it is, for example, in *Pennatula* or *Renilla* (comp. also Grieg. 1893).

The »Ingolf» has only obtained young stages from four different stations: south of Iceland (St. 40), in Denmark Straits (St. 10), and in Davis Straits (Sts. 24 and 28); altogether 22 specimens. Of

[1]) In a remark in Rep. Comm. Fish. etc. p. 510, several specimens are said to have been taken later, but further information of these is wanting. I may add that a specimen from the Skager Rak of quite the same length and also with 8 polyps, agrees remarkably well with the type-specimen of Verrill.

these specimens 21 are quite small, provided only with the primary polyp and a few zooids; the number of these zooids is given in the table below. None of the zooids in these specimens appears as a real terminal zooid; I doubt therefore — as already hinted above — whether a real terminal zooid corresponding to that of *Pennatula* and *Renilla*, is on the whole to be found in the genus *Kophobelemnon*. The zooids do not occur quite symmetrically, nor always in two regular rows. In one of the specimens (Nr. 21 from St. 40) sexual organs seem to occur in the primary polyp, which, however, is at variance with the observations of Grieg (1893, p. 18).

	St. 24.																St. 28.		St. 40.	
Nr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
Total length in mm.	11	11	13	13	14	15	15	16	16	17	18	19	20	20	21	22	27	12[1])	21	23	27
Number of zooids on each side	1-1	2-1	2-1	2-2	1-0	3-3	3-2	2-2	4-4	5-5	4-4	4-4	2-3	4-4	7-6	4-3	6-6	5-5	6-6	5-5	7-6

The specimen from St. 10 is 40^{mm} long, the rhachis in its broadest part ca. 4^{mm} broad; the peduncle is remarkably short, only 15^{mm} long, ca. 2^{mm} broad, so that the whole form is unusually clumsy. All the polyps are retracted; only five of them, among which is the primary one, are fully developed, but more are beginning as buds; the zooids are numerous, and are not restricted to the dorsal side of the colony.

It was observed above that *Gunneria borealis* Kor. & Dan. must also be referred to *Kophobel. stelliferum*. These authors have given this name to a sea-pen in which they thought they had a very peculiar form approaching in some features to the Gorgonids; they say of it that we are able with considerable certainty to satisfy ourselves that this sea-pen can not be assigned to any of the known genera , but that it is, however, to be referred to the family of the Protoptiles. The name, however, ought to disappear, and the comments on the supposed peculiarities, to be consigned to oblivion; the question is only of a damaged fragment of *Koph. stelliferum*. *Gunneria borealis* was established on one single specimen figured in Norw. North-Atlantic Exp. Penn. Pl. IV. fig. 8; I have had this specimen for examination, and it was easy to determine that it is the lower end of a *Kophobelemnon* the greater part of whose rhachis has been scraped away from the calcareous axis, whilst the rest has been much displaced downward towards the peduncle, the soft tissues of which have also been compressed. The effect of this compression, however, is not seen in the figure, although it is very conspicuous, and especially so on the opposite side of the one given in the figure; the strong incrustation with spicules pointed out by the authors, is partly owing to this compression. As correctly stated in the description, little more than young polyps and buds of these are preserved; at the top, however, a few developed polyps are present, more or less retracted; two are seen in the figure (a, b).

The young polyps look the same as elsewhere in *Kophobelemnon*; they only differ from the zooids accordingly in being larger and in having rudiments of tentacles (the authors have correctly seen rudimentary tentacles); as always in this region, real zooids are found between them and are seen quite distinctly in the figure (in the description, on the other hand, the authors pronounce the specimen destitute of zooids, although they think that the part of the rhachis lacking has been

[1]) The lower end broken.

provided with such, as they have seen a zooid under one of the preserved developed polyps). When the authors attribute cells in the developed polyps to their *Gunneria*, and figure such a polyp with a »cell« in fig. 9, it is to be observed that this figure cannot exactly be called a true representation of fact, nor does the description correspond with it. *Kophobelemnon* has not a real calyx, nor has this specimen; only a superficial examination could so misinterpret the features arising from the different degree of retraction of the polyp-body and the tentacles. Otherwise, it will be found that the special statements of the authors with regard to the form of the spicules, the strong equipment with spicules of the tentacles and polyp-body, the pigmentation of the pharyngeal sac and gastric filaments etc., correspond exactly with the features in *Kophobelemnon*. It might be supposed that Danielssen and Koren have never made a comparison with this form, as any one who compares the *Gunneria*-specimen with a *Kophobelemnon* (*»mocbii«*), must be struck immediately by the similarity; even by a comparison of the not quite correct figure 8 with the corresponding part of a *Kophobelemnon* of a suitable size, the agreement will easily be seen; it seems to me superfluous, therefore, to enter into any further details.

Distribution and Occurrence. — The stations of the Ingolf extend the known territory of the species considerably:

St. 40: 62° 00′ N. Lat.,	21° 36′ W. Long.,	depth 845 fathoms,	bottom temp. 3°.3 C.
10: 64° 24′	28° 50′	788	3°.5
24: 63° 06′	56° 00′	1199	2°.4
28: 65° 14′	55° 42′	420	3°.5

The steamer »Thor« has further added as new localities: 63° 05′ N. Lat., 20° 7′ W. Long., 557 metres (St. 167 of the »Thor«, south of Iceland, $^{14}/_{7}$ 1903). Here 14 specimens were obtained, of which the largest is 105^{mm} long with 12 polyps, the smallest 50^{mm} with 7 polyps. Further: 62° 57′ N. Lat., 19° 58′ W. Long., 957 metres; here three specimens were taken: two small young stages with solitary primary polyp, the one only 8^{mm} long and very small, with one large and two quite small zooids; the other 24^{mm} long, rather big (ca. 2^{mm} broad), with a polyp-bud just appearing on the right side and with many and large zooids; the third specimen 55^{mm} long, damaged, with several polyps and large zooids.

Apart from the coast-regions of Norway where the Vest Fjord (ca. 67—68° N. Lat.) is given as its northernmost occurrence, the species has not hitherto been known farther north than 60° 18′ N. Lat., in the Færoe Channel (the »Triton« Exp. St. 8), whilst its most westerly occurrence on the European side of the Atlantic did not extend much farther than 10° W. Long., west of Brittany (the Porcupine Exp. 1870; see Kölliker, Monogr. p. 370). Now its territory is seen to extend, not only to Iceland but across the Denmark Straits and quite into the Davis Straits, west of Greenland; its occurrence there further corroborates my supposition that the *Kophobelemnon* occurring farther south on the east coast of America belong to the same species. Formerly, it was known from many of the Norwegian fjords and the adjoining coast-regions, viz. from the Vest Fjord and farther south through the channel of the Skager Rak to the Christiania Fjord and to Bohuslän; also from many places in the Færoe Channel; off Brittany; from the coast of Les Landes: from different places in the Mediterranean (Cape Béarn, Nice

Naples: *K. leuckartii*); finally on the American side of the Atlantic near George's Bank (41° 29′ N. Lat., 65° 47′ W. Long., *K. scabrum*), and at several other places, not more exactly designated. Its distribution, then, probably comprises the whole northern part of the Atlantic (at all events north of ca. 40°) within the territory of the positive bottom-temperatures. It must be observed, however, that a few specimens have been taken by the Porcupine» and the «Triton» outside the warm area, but at its very border, in the peculiar narrow strip of water which stretches from the cold depths of the North Atlantic into the Færoe Channel towards the Wyville Thomson ridge. The question is of two localities, very close to each other: 60° 14′ N. Lat., 6° 17′ W. Long., and 60° 18′ N. Lat., 6° 15′ W. Long., where the respective bottom-temperatures are given as ÷ 0.8° C. (the «Triton», St. 8, Marsh. p. 120) and ÷ 1.1° C. (the Porcupine» 1869, St. 57; see «Depths of the Sea» Pl. IV and p. 143); only two specimens were taken at either place. That the occurrence within the cold area must be regarded as a mere exception and is only possible so close to its border, will appear from the fact that neither the North-Atlantic Expedition nor the «Ingolf», any more than the «Michael Sars» or the «Thor», have obtained any *Kophobelemnon* in the really great depths of the cold area of the North Atlantic, and also from the fact that *K. stelliferum* evidently reaches its highest development in such regions as the Norwegian fjords and especially the Skager Rak where the largest specimens hitherto found have been obtained.

The bathymetrical range of the species is evidently very wide: in the Skager Rak it has been taken at depths from 26—400 fathoms; at Norway from 20—400 fathoms; in the Mediterranean at ca. 30 fathoms, as also at greater depths; in the Atlantic itself it has upon the whole been taken at considerable depths, between 420 and 1199 fathoms, but most frequently, it seems, as small or even very small specimens; at America, finally, in depths from 980 to upwards of 2000 fathoms (the latter depth is stated by A. Agassiz in: «Three Cruises of the Blake», Vol. 2, 1888, p. 142, and Verrill for his two species» gives depths from 499 to 2369 fathoms; Rep. U. S. Fish Comm., 1883, p. 510).

I shall only add further that the genus *Kophobelemnon* is also distributed over the Pacific, and, according to the statements in the literature, is represented there by several species; but the number of these will probably also be reduced in future; of one of these species, *K. affine* Stud. its author already states that it is very closely allied to *K. stelliferum* («Albatross», Rep. Bull. Mus. Comp. Zool. Vol. 25, Nr. 5, p. 57), and the same is said by Kölliker (Chall. Rep., p. 16) of a young stage from the seas north-east of New Zealand.

Fam. *Umbellulidæ* Köll.

Umbellula Cuv.

This genus, which was down to the year 1871 only known from Ellis's and Mylius's imperfect descriptions of the dried specimens of *U. encrinus* brought home from the Polar Sea in 1753 by the Jutland skipper Adrians, has been proved to have a worldwide distribution in the great depths of the sea by the expeditions of recent times, and several species have now been established. The knowledge of these species, however, leaves much to be desired with regard to accuracy; of several

— I think most — of them only young stages are known, and we know from *U. encrinus* that the appearance of the species changes much during growth; no single investigator has been able to compare to any considerable extent the many species established on more or less scarce material etc. So much seems to be certain, however, that there is a number of species with well-developed spiculation, and others where the spiculation is quite reduced, only the peduncle containing quite microscopic spicules; others again are stated to be quite devoid of spicules, but, as will be shown with regard to the two species more particularly mentioned below, not all the statements in this respect are correct.

The following species have been described as devoid of spicules: *U. encrinus* (L.), *magniflora* Köll., *lindahlii* Köll., *gracilis* Marsh., *geniculata* Stud., and (I suppose) *bairdii* Verr. Apart from *U. geniculata*, with regard to which I can say nothing, I believe all these species to be closely allied; but as long as the knowledge of the characteristics of the species, and their variability and changes during growth is so uncertain, I think that some stress is to be laid on the geographical occurrence; thus, I believe we may take it for granted that those of the mentioned species which have been found in the Pacific, viz. *U. magniflora* and *geniculata* (and Studer's »*U. encrinus*«) are specifically different from the others which belong to the Atlantic and the Arctic Oceans; and further, as the whole group of Pennatulids in its distribution within the northern parts of the ocean has proved to be remarkably dependent on the bottom-temperature, there is every reason to suppose that the form which has been found well- and even enormously developed within the »cold area«, is specifically different from those found in the »warm area« of the Atlantic and the adjoining seas. On the other hand, I am inclined to regard these latter *U. lindahlii*, *gracilis*, and *bairdii* as one and the same species.

Umbellula lindahlii Köll.

Tab. III, Figs. 37—46.

Umbellula miniacea Lindahl. Kgl. Sv. Vet.-Akad. Handl. Bd. 13, Nr. 3, 1874, p. 12, Pl. I, II, Figs. 12—19.
» *pallida* ibid. p. 13, Pl. III.
Lindahlii Kölliker. Festschr. Phys.-Med. Gesellsch. in Würzburg 1875, p. 10.
gracilis Marshall. Rep. »Triton»-Penn. 1883, p. 143, Pl. XXV.
Bairdii Verrill. Am. Jour. Sc. (3) Vol. 28, 1884, p. 219 (Note) and U. S. Fish. Comm. Rep. 1883, (1885), p. 509, Pl. I, Figs. 1—2.

Two specimens of the genus *Umbellula*, taken by the »Ingolf« respectively east and west of Greenland in the warm area, I consider to belong to the same species as the two specimens of Lindahl from West Greenland.

One of the specimens, from the deep part of the Davis Straits, is, I think, the smallest and least developed stage hitherto known of the genus *Umbellula*. It has a total length of 48^{mm}, and apparently consists only of the primary polyp (Pl. III, fig. 37); a closer inspection shows, however, that it is provided with a somewhat great number of zooids (z) and a small bud of another polyp (p). The developed polyp is supported by a fine narrow stalk, of which the lowermost 2^{mm} form an egg-shaped swelling, of a diameter hardly 1^{mm}; this swelling is really the whole peduncle, as zooids appear

immediately above it (comp. fig. 39); accordingly, the remaining part of the stalk must be regarded as corresponding to the rhachis of other Pennatulids. This part decreases regularly in thickness upwards — the middle thickness is ca. 0.448^{mm} — until ca. 8.5^{mm} from the mouth of the end-polyp it rather suddenly tapers to a thin part — only 0.24^{mm} broad, — which again widens quite evenly upwards and extends to the body of the primary polyp. The calcareous axis shines distinctly through the thin sarcosoma, and shows the characteristic quadrangular form, with rather deeply concave surfaces and ridge-like projecting edges; at the transition to the thinner part of the stalk it narrows abruptly; from this point, where the diameter is 0.192^{mm}, it continues quite thin up through the dorsal part of the polyp-body, and ends in a rather curiously shaped double curve. The polyp, unfortunately, is somewhat damaged, some of the arms being broken off, and the preserved arms are twisted together and even rather damaged; they are longer than the polyp-body; pinnules of different sizes alternate without any order. The polyp is somewhat curved in a halfmoon-shaped way and compressed laterally; reckoned from the mouth to the polyp-bud on the left side it is ca. 4^{mm} long; the dorso-ventral diameter of the part in front of the calcareous axis is somewhat more than 1^{mm}. The mouth is distinctly oval with long axis dorso-ventral, and placed on a low oral cone very sharply divided into eight lips, each corresponding to an arm and gastric cavity; eight distinct lines corresponding to the edges of the eight septa, run down the polyp-body, and disappear at its hinder end; the much folded, dark-pigmented pharyngeal sac is seen faintly through the wall of the body, and below this the six much twisted gastric filaments on the ventral and lateral septa. By a suitable clearing (in glycerine or bergamot) these filaments are seen suddenly to cease in the lower part of the gastric cavity, where their septa may still be traced for a short distance corresponding to the part which carries the sexual organs in developed colonies; of such organs no trace is seen; the lower end of the two dorsal septa which are turned towards the calcareous axis may also be seen; farther upwards they are hidden by the twisted filaments of the other septa.

On the left side of this primary polyp, immediately below the place where the septa cease, is a rudiment of a polyp Nr. 2 (p, fig. 38). This rudiment projects only quite slightly as a low truncate cone with a cleft-like oral aperture; the eight septa with their filaments are distinctly begun, but no trace of arms is seen. The length of this rudiment is 0.32^{mm}, the breadth 0.154^{mm}.

Along the primary polyp's dorsal side, which is distended by the calcareous axis, is a row of zooids (z) on each side, all placed in the usual way, i. e. with the dorsal side toward the apex of the axis. No terminal zooid is seen above the end of the calcareous axis. Zooids of quite the same appearance are further found down the stalk with intervals of 0.5—1^{mm}, down to ca. 2^{mm} from the lower end, as before mentioned (fig. 39). The zooids vary in size between 0.096 and 0.240^{mm}; the lowermost ones are generally the smallest; on the stalk they are in the main placed on the lateral surfaces, the ventral side, at all events, quite wanting zooids. None of the zooids show any trace of the tentacle which the larger zooids always possess in developed *Umbellula* elsewhere.

On the lower egg-shaped end of the stalk, which represents the peduncle proper, quite small oval calcareous spicules are seen under high magnifying powers and by suitable clearing (as I did not wish to destroy the specimen, I had to be content with only convincing myself of the existence of these spicules); the other part is quite devoid of spicules.

The other specimen, from the Denmark Straits, was unfortunately not preserved until it was quite shrunk; it had long escaped attention, because it was jammed in at the iron frame of the trawl, and was quite wrapped up in threads of swabs; the specimen was otherwise quite complete, the slender calcareous axis not even broken. The total length, the stretched polyps with their tentacles included, is (fully) 530^{mm}; ca. 500 ^{mm} from the lower end of the peduncle to the base of the polyp-bodies. The length of the peduncle is only 40^{mm}, its largest diameter somewhat more than 3^{mm}; from the peduncle the stalk decreases in thickness upward from ca. 2^{mm} to 0.5^{mm}, and then it again increases evenly in thickness towards the cluster of the polyps; it is somewhat spiral-shaped longitudinally, and bent in a large flat curve ca. 20^{mm} below the polyp-cluster whose longitudinal axis is a direct prolongation of the upper part of the stalk. Even if respect is paid to the completely shrunk condition of the specimen, which disparages, of course, the value of all the measurements to some degree, it will be seen that the form is remarkably long and thin. The polyp-cluster is relatively small and slender, ca. 37^{mm} long, measured from the point where the stalk begins to spread into the polyp-bearing part, to the point of the stretched tentacles; it consists of six developed polyps, and no rudiments are found; the polyps are of somewhat different sizes, 6—11^{mm} long, with tentacles longer than the polyp-body, the longest ones up to ca. 20^{mm}, with irregularly alternating larger and smaller pinnulæ. The primary polyp is easily recognisable from the fact that the calcareous axis may be traced distinctly into the dorsal side of its base: it is smaller than the polyps placed nearest to it laterally. The latter are arranged in such a way, that two are placed to the right of the primary polyp and three to the left; of the latter, the one placed nearest to the ventral median line is the smallest, it is even considerably smaller than the primary polyp; the others are of about equal size. The polyp-bearing part of the stalk (the »rhachis» of the authors) is about 13^{mm} long, 5^{mm} from side to side, and 3^{mm} from the dorsal to the ventral side in the broadest place.

The zooids form tongue-shaped areas between the polyps, two on the left side, one on the right; between the polyps of the two sides on the ventral aspect there is a narrow naked streak, whilst the zooids of the dorsal aspect continue up on the base of the primary polyp. On the upper part of the stalk, below the cluster, the zooids are placed all round, but they soon pass into a single row on either side, and they continue to be arranged chiefly on the two lateral surfaces quite down to the peduncle; a few may, however, be found here and there on the other surfaces. In spite of the shrunk condition the two dorsal mesenteric filaments (the only ones) of these zooids are seen very distinctly; on the other hand, no tentacle is seen on the zooids of the stalk. The calcareous axis throughout its whole extent is quadrangular with deeply concave surfaces. Spicules are wanting, except in the lower end of the peduncle, where there are numerous, very small — 0.016^{mm} long, 0.0064^{mm} broad — oval calcareous bodies, often slightly constricted in the middle, so as to get somewhat the shape of an 8; still smaller, quadruple calcareous bodies are rather numerous. The colour of the polyps was a dark chocolate-colour; in water a red-brown dye may be pressed out of crevices in the polyps.

This specimen agrees very well in appearance with Lindahl's two specimens from Baffin's Bay and the Umanak Fjord, and especially with the one he has called *U. pallida*; the whole slender form of the polyp-cluster the fact that the tentacles of the polyps are much longer than their body — about twice as long — and the exceedingly long, slender, and graceful stalk, render it certain that

our specimen belongs to exactly the same species at that of Lindahl, and on the other hand also very probable that it is a species different from *U. encrinus*. The young specimens of *U. encrinus*, to be more particularly mentioned below, as well as the more or less young specimens with few polyps in the cluster obtained by the Norwegian North-Atlantic Expedition, are far more robust and short-stalked than this specimen or those of Lindahl; I think therefore that Danielssen's incorporation of these latter into the species *U. encrinus* may, at least for the present, be regarded as unjustified, the more so indeed as I cannot find the transference well-grounded by this author.

During the cruise of the »Michael Sars» in 1902, a specimen of an *Umbellula* has been taken which is very short-stalked when compared with the specimen just mentioned (Pl. III, figs. 40—45); it thus has a robust appearance similar to the young *U. encrinus*; therefore, if the locality had not told against it, I would have been inclined to refer this specimen to this species. The locality is St. 76 of the »Michael Sars», 59° 29′ N. Lat., 7° 51′ W. Long., south of the Wyville Thomson ridge, accordingly within the »warm area», the depth 580—689 fathoms. The tentacles, however, are much longer in relation to the polyp-body, than is the case in the specimens of *U. encrinus* I have seen, being about twice as long as the body. The length of the stalk is 107^{mm}, the length of its lower swollen part 23^{mm}, the diameter of the peduncle and the swollen lower part of the rhachis ca. 2^{mm}, the thinnest part of the stalk ca. 0.5^{mm}, the length of its upper widened part ca. 9^{mm}, the length of the cluster ca. 25^{mm}, that of the club of the rhachis ca. 6^{mm}, its breadth 3.5^{mm}. The cluster has five developed polyps and one rudiment; the length of the polyp-bodies is 5—6^{mm}, that of the longest tentacles 13^{mm}. The terminal polyp (*P*, figs. 40—41) is easily recognisable as such; on its right side are two fully developed polyps and one small one, on its left side two developed polyps; the largest of the developed polyps is the one nearest to the primary polyp on the right, the smallest the second on the left counting from the primary polyp. The small polyp is remarkable from the fact that its dorsal arms are much smaller than the ventral (comp. below under *U. encrinus*). Above the circle of the lateral polyps, ventral to the primary polyp, are two large zooids, each with a well-developed tentacle with small side-branches; a similar large zooid is found to the left of the small polyp. Not only the zooids of the rhachis-club, but also many of the zooids of the other parts of the stalk quite to the lower swelling, show a tentacle; on the small zooids of the stalk it is, however, very fine and delicate. (This explains the want of a tentacle in the zooids of this region in the other specimens as probably due to some accident.)

This specimen has also the same numerous, small spicules in the lower end of the peduncle (Pl. III, figs. 44 and 45). In the living state the colour was reddish-brown passing somewhat into violet.

Being of opinion that the specimens of Lindahl and those described here, ought to be kept as a separate species I have designated it with the name *U. lindahlii* given it by Kölliker in 1875 (l. c. p. 10). The reason for referring the above described, quite small stage from the Davis Straits to this species, is partly that the tentacles of the primary polyp are so long, partly and more especially the locality where this specimen has been taken. When further, I have given *U. gracilis* Marshall and *U. bairdii* Verr. as synonyms, I have done so as a matter of judgement, as the description of these shows

nothing opposed to it[1]), whilst on the other hand, the long and slender form of both the stalk and the cluster, and also the geographical occurrence speak in favour of this opinion. As to the latter, *U. gracilis* has been taken (by the «Triton») at 59° 29′ 30″ N. Lat., 7° 13′ W. Long, 555 fathoms (the Atlantic, west of Rona), *U. Bairdii* at 38° 30′ 30″ — 38° 53′ N. Lat., 69° 8′ 25″ — 69° 24′ 40″ W. Long, 1731 —2033 fathoms, east of North America (south of Martha's Vineyard), both accordingly within a territory that has proved upon the whole to possess the very same species of Pennatulids as the northermost part of the Atlantic, so far as the warm area extends.

The species *U. lindahlii* is now known from the mouth of the Umanak Fjord, 71° 27′ N. Lat., 53° 58′ W. Long., 122 fathoms, from Baffin's Bay, 70° 43′ N. Lat., 52° 3′ W. L., 410 fathoms (Lindahl), from the Davis Straits, the «Ingolf»'s St. 36, 61° 50′ N. Lat., 56° 21′ W. Long., 1435 fathoms, from the Denmark Straits, St. 90 of the «Ingolf», 64° 45′ N. Lat., 29° 06′ W. Long., 568 fathoms, and from the Færoe Channel, St. 76 of the «Mich. Sars», 59° 29′ N. Lat., 7° 51′ W. Long., 580—689 fathoms; probably it is distributed over the whole northern part of the Atlantic. Farther south it is perhaps replaced by other species that cannot be confused with it, for one thing on account of their abundance of developed spicules, as *U. güntheri* Köll. (found in the Atlantic almost under the equator, at the West Indies, and off the east coast of North America, sometimes together with *U. bairdii*), and *U. thomsoni* Köll., found between Portugal and Madeira (the «Challenger») and in the Bay of Gascony (the «Caudan»)[2]).

Umbellula encrinus (L.).

Pl. III, Figs. 46—51.

Isis encrinus Linné. Syst. Nat. Ed. X. 1758, p. 800.
Umbellula encrinus Danielssen & Koren, Norw. North-Atlantic-Exped. Penn. 1884, p. 13—56, Pls. V—XII.

The polyps (in large specimens) form a dense, hanging cluster; this cluster is apparently radiate, the largest polyps forming an (apparently) closed, lower circle of 9—12 (13) individuals which may hide the other polyps more or less completely; the tentacles are of about the same length as the polyp-body often somewhat shorter. The part of the rhachis-club seen below the polyps is formed like a short calyx covered with zooids; each of these is provided with a ventral tentacle; between the bases of the polyps in the lower circle the zooids form regular, tongue-shaped areas; among the zooids in the cluster are always found a larger or smaller number of very considerable size. The lower part of the stalk passes rather abruptly into a swelling that is continued into the peduncle without any sharply marked boundary; the upper part of the stalk towards the cluster, passes evenly into a somewhat compressed and widened part (the sheath-formed dilation Dan.); this part again widens rather abruptly into the

[1]) With the exception, however, that the calcareous axis in *U. gracilis* is said to be cylindrical for a great part of its length. This statement I think to be incorrect, but the exact shape has probably been indistinguishable through the soft tissues. The statement of a complete want of spicules I take to be owing to the fact that the skin of the peduncle has not been examined under sufficiently high magnifying power.

[2]) It is perhaps this *Umbellula* which is mentioned by P. Fischer (1889, l. c. p. 37) as *U. ambigua* Marion taken off Bidassoa. The *Umbellula* found by the «Gazelle», which Studer (Anthoz. Gazelle. p. 674) designates as *U. thomsoni* Köll.?, is perhaps correctly determined, but no description is given of it; it is only said that the two specimens obtained were in a bad state, so that the specific identity could not be made out; the colour was brown in the living state. The locality: west of Africa, 10° 12.9′ N. Lat., 17° 25.5′ W. Long., depth 360 fathoms.

polyp-bearing rhachis-club. The whole stalk is covered with zooids, downward to the upper part of the lower swelling, where the cessation of the zooids shows the boundary to the peduncle. Of the zooids of the stalk, those of the upper swelling are almost always provided with a tentacle like those of the rhachis-club; but also farther down the stalk, for instance in the thinnest part of it, the zooids may be provided with a tentacle, but it is then a very thin one; most likely all zooids have this equipment, but the thin tentacles are easily torn off, and this I take to be the reason why it seems to be wanting in most of the zooids of the stalk. The upper part of the stalk, below the rhachis-club, is twisted and bent in various ways, but always in such a manner that the cluster remains pendent; further the whole stalk, above the lower swelling, is turned like a spiral round its longitudinal axis. The calcareous axis is quadrangular with deeply concave surfaces and rounded edges. Very small spicules are found, but only in the lower end of the peduncle. The colony grows to a height of more than two metres.

Of this species the «Ingolf» brought home five specimens (the Nrs. 2, 3, 5, 6, and 7 of the table below), and later the Amdrup—Hartz Expedition has brought three more specimens (Nrs. 1, 4, and 8), Cand. Jensen from the cruise of the «Mich. Sars», two specimens (Nrs. 9 and 11), and the steamer «Thor», one (Nr. 10). The particulars with regard to these specimens are given in the table below, which shows that only six specimens have kept the stalk entire, or kept it so far, that it has been possible to measure its length (Nrs. 4 and 10 are broken and parts of the calcareous axis wanting), and that two of these six are young stages; the specimens Nrs. 8 and 11 are torn off clusters and in a very bad condition, and therefore some of the measurements given are rather uncertain. I think that the specimen Nr. 3 is the longest one hitherto measured.

Nr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Locality	Cape Brewster	St. 105	St. 116	Canning Land	St. 116	St. 116	St. 116	Canning Land	«M. Sars» St. 34 a	«Thor» St. 51	«M. Sars» St. 34
Length of the stalk .. in mm.	148	215	2350	1090	...	...	...	.	1090	1410	.
Length of the bulbous part in mm.	22	40	312	220	...	...	...	.	230	290	.
Diameter of the lower end of the peduncle ..... in mm.	2	2.5	17	20	...	...	...	...	17	17	...
Diameter of the swelling above the peduncle ..... in mm.	2	3	23	24	...	...	...	...	18	c. 25	.
Diameter of the thinnest part of the stalk ..... in mm.	0.5	0.5	3	5—6	..	...	...	...	4,5	c. 5	.
Length of the sheath-formed dilation ..... in mm.	10	9	...	c. 100	...	...	...	c. 60(?)	c. 84	c. 100	
Length of the cluster . in mm.	17	23	150	170	110	125	105	c. 85	128	c. 130	c. 90—92
Length of the rhachis-club in mm.	...	7	33	40	38	43	20	c. 30	c. 40	40	30
Breadth of the rhachis-club in mm.	2.5—3	3—5	35	40	31	32	...	...	37	42	21
Number of polyps ..... in the lower circle	4(+1)	7(+4)	40	39(37+2)	38	38[1]	29	37(31+6)	25	41	25
	3(+1)	6(+4)	11	12	10	11	10	11	9	12	8

[1] Several small polyps, but none still in the rudimentary stage.

Nr.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Locality	Cape Brewster	St. 105	St. 116	Canning Land	St. 116	St. 116	St. 116	Canning Land	«M. Sars» St. 34a	«Thor» St. 51	«M. Sars» St. 34
Length of the body of the largest polyps . . . . . in mm.	8—9	12—13	77	100	50	67	65	c. 42—55	58	60—63	41
Length of the tentacles of the largest polyps. . . . . in mm.	9—10	10—12	c. 70	80—90	52	60—65	70	c. 40—55	49	60—62	33
Length of the body of the least developed polyps . . . . in mm.	5	7	13	20—27	20	7	20	17	36	26	6
Length of the body of the largest zooids in the cluster in mm.	. .	1	4	5	. . .	-	. .	. . .	2	c. 1.5	c. 1
Terminal polyp certainly recognisable as such	+	+	. . .	. .	+	. . .	. .	+	. . .	+	+

After the comprehensive description which Danielssen has given of this species, on the basis of the excellent material of the North-Atlantic Expedition, its identification will generally be an easy task, and the principal features of its structure be ascertained. There are, however, several places where additions or alterations have had to be made; in the above short description some of these have already been mentioned, and in the following they will be more particularly discussed. Thus, it may be pointed out that *Umbellula encrinus* like the preceding species (and probably most *Umbellula*-species), is provided with zooids on the whole stalk from its very earliest stage, at all events in all the stages hitherto known. Danielssen says indeed, l. c. p. 52, that zooids occur everywhere on the stalk with exception of the inferior part of the bulbous portion , but by this he has evidently been thinking of the large full-grown specimens, as none of his figures of young stages show zooids on the stalk much below the cluster; only in fig. 20, Pl. VII zooids seem to be indicated down the thin part of the stalk, and in the text it is for the first time mentioned in the detailed description of this specimen (Nr. 5, 380mm, with thirteen developed polyps in the cluster) that zooids are generally found «further down the stem, they become still more dispersed, and are situated, partly, in a series on each side (l. c. p. 23); in four of the large specimens later described, zooids on the stalk are especially mentioned, most thoroughly for Nr. 12. A very minute examination shows, however, as before mentioned, that they are found in the very youngest stages, which I have been convinced of by inspecting Danielssen's material. My two young stages mentioned above (Nr. 1 and 2 of the table) with respectively four and seven polyps in the cluster carry zooids all along the stalk to the bulbous part; these zooids are very small, much smaller than those placed near the cluster which feature is preserved also in the older colonies, where the number becomes very large; they certainly do not seem to have any tentacle; I have succeeded, however, in seeing such a tentacle in a single specimen (Nr. 10), in zooids placed below the sheath-formed upper dilation . In the youngest stages these zooids of the stalk are placed regularly in two longitudinal stripes, so that the dorsal and ventral sides of the stalk are naked; this latter fact, however, is only to be decided with difficulty on account of the spiral-like twisting of the stalk; frequently, individuals a little larger alternate with quite small ones; the latter have evidently just appeared. By and by, as the colony grows, the number of zooids in the stalk increases greatly; in large specimens, as Nrs. 3 and 4 of the table, they are arranged in short longitudinal rows,

right down on the upper portion of the bulbous part; in the narrow part of the stalk the small rows unite and form two broader bands; but outside of these are also found more scattered rows of zooids, so that there is hardly any quite naked dorsal and ventral surface of the stalk. From this fact it follows, that only the zooid-less part of the bulb corresponds to the peduncle of other Pennatulids, and that the greater part of the stalk from the beginning is to be regarded as the rhachis; to restrict this name to the widened upper end bearing the polyp-cluster, as has been done hitherto by all authors, is in reality misleading; I therefore designate this part as the rhachis-club.

The polyp-cluster in the younger stages is always quite distinctly bilateral, often (oftenest?) also asymmetric, and the terminal (primary) polyp is always evident as such; in the large colonies the cluster is apparently radiate, and the terminal polyp is often not to be determined with certainty. A closer inspection shows, however, that the polyp-cluster is still bilateral, and this fact may be discerned whether the terminal polyp may be made out with certainty or not.

In the younger colonies the upper end of the rhachis-club is seen to continue as a broad belt of zooids directly to the base of the polyp, that is the primary individual. The upper end of the calcareous axis runs originally under this belt of zooids; from the structure of the primary individual this belt must be determined as dorsal (Danielssen, like all other recent authors, follows Kölliker here also, and uses the expression ventral); on the opposite — accordingly ventral — side of the rhachis-club new polyps arise, often not in the ventral median line, but beside it. In my youngest specimen, Nr. 1, three developed polyps and a small rudiment (1.5^{mm} high) are placed below the terminal polyp (fig. 46 P.), but otherwise of the same mutual height; of the developed polyps the terminal polyp is the smallest. To the left of the terminal polyp are two developed polyps, to the right, one polyp and the small rudiment; these (3 + 1) polyps represent evidently only the lower circle of polyps in a developed cluster; the tongue-shaped groups of zooids on the rhachis-club between the bases of the polyps of the lower circle of the cluster are indicated in the following way: besides the dorsal belt of zooids, which has not yet assumed the tongue-shape, there is only a distinct tongue-area between the two polyps of the left side (fig. 46 t), and a quite slight indication on either side of the rudiment.

The other young stage, Nr. 2 (fig. 47), has six polyps below the terminal polyp somewhat differently developed, and in addition four small rudiments; all these six polyps and the rudiments still only represent the lower circle of polyps of the large clusters; nor are the rudiments found here in the ventral median line of the rhachis-club; the fact is that four developed polyps are found to the left of the terminal polyp, to the right only two (figs. 47—49: 1, 2); the two polyps between which the rudiments are found are evidently last developed, being both shorter and more slender than the others, the terminal polyp included; this latter is likewise also smaller than those nearest to it. The rudiments are of different sizes, so that they are seen to have arisen alternately to the right and to the left. Corresponding to the arrangement of the polyps, the rhachis-club — besides the dorsal belt (dt in figs. 47, 48, 49) — shows three distinct tongues of zooids (t, fig. 48) on the left side decreasing in size towards the rudiments, one on the right side; in the rudiment-zone (fig. 49) there are slight indications of as many tongues as there are buds. In the cluster, at the ventral base of the terminal polyp are two zooids provided with a tentacle; one of them is very large (fig. 47, z), and its tentacle has one lateral branch.

Unfortunately intermediate stages are wanting in my material between these young stages and the large ones; but the break is filled, at all events partly, by the material of the Norwegian North-Atlantic Expedition, which I have had the opportunity of seeing in the Bergen Museum. If we examine the specimens described by Danielssen as Nrs. 2, 3, and 4, we shall find that besides the terminal polyp and those representing the lower circle, 2—3 polyps are further found above the latter, which show by their smaller size that they have only arisen recently; and in the specimens described by Danielssen as Nr. 5 and 6, the polyps placed above the lower circle have increased in number and size, whilst at the same time the number in the lower circle has increased; some of the specimens mentioned show also that this latter increase is due to the fact that new rudiments of polyps arise in one certain place in the lower circle, on the ventral side of the rhachis-club [1]). The lower circle in all young stages is really interrupted in two places, viz. at the dorsal side of the colony where the rhachis-club with its dorsal belt of zooids reaches to the base of the terminal polyp, and on the opposite side where the rudiments arise; in other words: the lower «circle» is formed of two lateral rows, a right and a left, corresponding to the two lateral rows of polyps which are placed along the dorsal side of the rhachis in sea-pens of the common long form; as in such forms the polyp in each of the two rows which is placed nearest to the terminal polyp (uppermost) is the oldest one, the polyp placed farthest therefrom (lowermost) the youngest — such is also the case here in *Umbellula*.

My two young *Umb. encrinus* (Nr. 1 and 2) — in spite of their considerable size — thus represent just the stage which in *Virgularia* I have called the *Protocaulon*-stage, and the stage which I have formerly described and figured for *Pennatula phosphorea* (Vid. Medd. Nath. For. Kbhvn. 1888). This is also seen quite easily and convincingly, if we take into the comparison such *Umbellula*-species where the rhachis-club is more elongated, e. g. *U. güntheri* (partly *U. leptocaulis*, *simplex*, and *carpenteri*). The other polyps, which arise inside (above) the lower «circle», must then of necessity correspond to those placed on the ventral surface of the rhachis in other sea-pens, which is bordered by the two dorso-lateral rows of polyps; accordingly, they correspond to the polyps which in most sea-pens are arranged in oblique rows. Now the appearance and arrangement of these polyps is irregular in several sea-pens (as in *Anthoptilum murrayi*, the species of the genus *Kophobelemnon* a. o.); sometimes not even a grouping on either side of the ventral median line is preserved. In *Umbellula encrinus* the case is as in these latter; at all events, I have not been able to find any invariable regularity in the appearance and arrangement of the upper or inner polyps. So much is evident, however, that *Umbellula* like the typical Pennatulids has two regions of growth where new individuals arise: one corresponding to that where, in forms with «wings» (as a *Pennatula*), new wings arise, and one corresponding to that where the number of individuals in the wings increases. And as in all other bilateral sea-pens those polyps are largest which form the two most dorsal longitudinal rows, so in *Umbellula* the corresponding polyps, i. e. those of the lower circle, are the largest.

In large specimens of *Umb. encrinus* the polyp-cluster appears to be radiate; but a closer inspection of the tongues of zooids will show that the bilateral structure is preserved in reality. The fact is that one of these zooid-areas is always a little larger than all the others, especially somewhat

[1]) This cannot be seen from the figures of Danielssen or be gathered from his text; in some of these specimens he has overlooked the rudiments or not mentioned them.

broader; it is the dorsal belt of zooids, or, more correctly, the lower part of this belt; in several large specimens it may easily and unmistakably, though as a narrow stripe, be traced between the upper polyps to the base of a certain one, the original terminal polyp; in other specimens this tongue may be traced to the end of the rhachis among the polyps, but which of these is the terminal polyp cannot be determined with absolute certainty; not so much because this polyp has been atrophied, but that it simply has been somewhat displaced during growth. The other zooid-areas are, as mentioned, all somewhat smaller (narrower) than the dorsal one, but most conspicuously smaller are one, two, or three areas on the opposite — ventral — side of the rhachis. In my specimen Nr. 5 the fifth zooid-area to the left of the dorsal one is the smallest; in Nr. 6 the fourth and fifth are smallest, in Nr. 3 the fourth, fifth, and sixth; in Nr. 4 the sixth and seventh areas are quite narrow, and between their upper end is a quite young rudiment (in form like a zooid, see below); in Nr. 8 the fifth and sixth areas are also quite narrow, and between them is seen a quite young polyp; in Nr. 10 the sixth area is divided above into two narrow points by a naked streak; at the upper end of this streak is found an isolated large zooid (or a rudiment of a polyp).

These smallest zooid-areas must show the region where the latest appearing polyps of the lower circle are found, without regard to whether these polyps may have reached the same size as those placed nearest to the dorsal tongue or not. The place corresponds also to the zone in the younger stages where new individuals of the lower circle arise; and in the specimens Nr. 4 and 8 new individuals are seen to arise here, as well as new, quite narrow zooid-areas; but in Nr. 4 the circumstance is to be noted that the new individual is formed like a zooid, whilst rudiments of polyps of the same size elsewhere — the zooid in question is ca. 7^{mm} high on the side turned outward, ca. 2^{mm} on the opposite side — already prove themselves to be polyps by being provided with eight arms. The question then arises here; do not in *Umb. encrinus*, some of the later polyps begin as zooids, or — what is essentially the same thing — cannot some zooids by degrees be turned into polyps? It has been indicated above that, among the numerous tentacle-bearing zooids which look like those of the tongue-areas, are found a larger or smaller number of much larger zooids, several more than 1^{mm} high, a few still much larger up to 5^{mm}, on that part of the rhachis-club which is more or less hidden by the polyps (they begin to appear already in young clusters, see above Nr. 2); at the first glance, one cannot help regarding them as young rudiments of polyps; but at the same time, individuals of a similar size or not much larger may be found, which are decidedly rudiments of polyps, as they have eight distinct arms, and corresponding to this another form of the mouth-lips. I have only in one case seen a zooid which seemed to me to be in the act of turning into a polyp; in the large specimen Nr. 3, directly at the upper end of the rhachis-club, is an individual, 4^{mm} high, provided with the two mouth-lips of the zooids (but unusually large and conspicuous), and carrying four tentacles, two very long and with pinnulæ, two quite short and without lateral branches; the ventral tentacle is the longest and most developed; next to it comes the right ventro-lateral one, whilst the left ventro-lateral and the left lateral are quite small. This case, together with the one mentioned above in Nr. 4, where a gigantic zooid is found in the very place of a polyp, might tempt one to answer the question put above in the affirmative; it ought not to be forgotten, however, that these two cases may be

exceptions, i. e. abnormalities[1]), as it seems everywhere else in the octactinia to be a law that the eight arms of the polyps are formed at the same time.

It has already been stated above that *Umb. encrinus* is not quite devoid of spicules, as has always been maintained hitherto. Just as in the preceding species and in some others, the lower end of the peduncle has indeed numerous, but very small spicules which cannot be seen with the lens. These spicules (Pl. III, fig. 51) are sometimes oval, 0.012—0.016^{mm} long, and 0.008^{mm} broad, sometimes somewhat dumb-bell-shaped, sometimes finally, small, and combined into numerous groups of four measuring 0.011^{mm}. Some of the oval spicules show an indication of the common triangular form of the Pennatulids. I have seen no spicules in other parts of the colony

With regard to the construction of the polyps I may mention that the tentacles are not so long in proportion to the body of the polyp as in the preceding species. These organs, to be sure, are exceedingly variable as to length, and their chance degree of contraction plays, of course, a very great part; but in the preserved specimens they are upon the whole of about the same length as the bodies of the polyps — sometimes somewhat longer, sometimes somewhat shorter, but never, for instance, more than twice as long.

Of the sexual organs Danielssen l. c. p. 51, states the following: «The generative organs develop themselves on the gastral filaments, a circumstance, that in a material degree differs from what has previously been known relative to *Pennatulidæ*, where the sexual organs are developed on the septula». Later, on p. 52, it is said: «All of the eight gastral filaments are occupied by sexual organs; but, upon the two dorsal ones, they begin a little lower down than on the other six». I cannot corroborate these statements. The two dorsal septa do not bear sexual organs here, any more than in other octocoralla. These two septa are as always narrower than the others, and their mesenteric filaments arising from the ectoderm are of a simpler form than in the other septa: they form a finely sinuous line running from the base of the stomodæum along the edge of the septum. They retain the same appearance through the whole gastric cavity of the polyp-body, and into the continuation of this cavity in the rhachis; here they cease, but their septa still continue some way without filaments. All the other 6 septa, on the other hand, carry sexual organs; these septa have thick, much folded endodermal mesenteric filaments which begin at the stomodæum, but reach only a little way down on their respective septum, when they are replaced by the sexual organs, which accordingly take their place on the edge of the septum; the filaments as such have dissappeared in this region. In a polyp whose body is 65^{mm} long (from Nr. 7, a ♂), the much folded mesenteric filament occupies a space of 8^{mm}, then it is finely sinuous for quite a short space, almost as in the two dorsal septa, and the sexual organs then succeed. The sexual organs remind one of grapes, composed of small clusters, often of groups of three sexual organs (testicles or eggs), and the middle one is the oldest and most developed. Accordingly, the sexual organs are here in all essential features as in other Pennatulids. Marshall has in *Umb. gracilis* (= *lindahlii*) also found the six septa carrying genital organs below the filaments (l. c. p. 144); when, however, in his figure (Pl. XXV, fig. 34) he makes the sexual organs occupy a relatively considerable part of the lateral surface of the septum, this is hardly correct, and does not, at all events, agree with *U. encrinus*. In *U. thomsoni*, Kölliker (Festschr. Phys. med. Ges. Würzb. 1875, p. 9) states that two pairs of filaments»,

[1]) We know from *Penn. phosphorea* (and *Virg. mirabilis*) that zooids may turn into polyps, but only as an exception.

i. e. the lateral ones, carry the sexual organs, but he says also that he has not been able to make a thorough examination on this point.

As to the construction of the zooids, most frequently I have been unable to see any tentacle in any of the zooids of the stalk, except in those placed on the «sheath-formed dilation» and on the rhachis-club. When also many of the zooids in these latter regions want a tentacle, I take it to have been lost; the other zooids of the stalk have, I think, also had such a tentacle. I cannot acknowledge Danielssen's figure 56, l. c. Pl. X, to be correct; more especially, I must remark that the feature given at *c* of «an oblong aperture in the slightly retracted tentacle» (comp. the explanation of the figures, l. c. p. 82), is surely a misinterpretation; but several of the figured stages of retraction are also hardly correct, at all events I have never been able to find them. The tentacles may often be several times longer than the body of the zooid, and they may — as correctly stated by D. — have two rows of pinnulæ, or one, or none at all.

With regard to its distribution, *Umbellula encrinus* is limited to the Arctic Ocean and to the deeper part of the Atlantic which has the character of the Arctic sea by being situated west of the coast-banks of the Scandinavian peninsula and north of the submarine ridges connecting Greenland with Iceland, Iceland with the Færoes, and these latter with the Shetland Islands. Originally (1753) it was taken in the Arctic Ocean at 79° N. Lat., 80 miles from the coast of «Greenland»[1] (Ellis's and Mylius's specimens); then it was found again in 1873 by the Austro-Hungarian Expedition (Marenzeller: Denkschr. Ak. Wien 1878, p. 377) near 79° N. Lat., 62° 29′ E. Long. at a depth of 210 metres, east of Franz-Joseph Land (the specimen, 630^{mm} long, was lost with the ship); later by the Vega Expedition in the Kara Sea (the «Vega»'s Station 54) at 130 fathoms (Stuxberg: Vega-Exp. vetensk. Arb. I, 1882, p. 692, and V, 1887, p. 163); by the Norwegian North-Atlantic Expedition at four different places between 79° 59′ N. Lat., 5° 40′ E. Long., west of Spitzbergen, and 62° 44′ N. Lat., 1° 48′ E. Long., between Norway and the Færoes, in depths from 412—498 fathoms (a dead axis was further found at a fifth place at a depth of 536 fathoms) all within the territory of the «cold area». To these localities are to be added those of the «Ingolf»: St. 105, (1 specimen, Nr. 2) 65° 34′ N. Lat., 7° 31′ W. Long., 762 fathoms, about midway between the Færoe Islands and Jan Mayen, and St. 116, 70° 5′ N. Lat., 8° 26′ W. Long., 371 fathoms, south of Jan Mayen. At the latter place the trawl of the «Ingolf» evidently passed over a plantation of large specimens; one was caught by the crow-foot in front of the trawl, and was saved entirely (Nr. 3)[2], of three the tops were cut off (Nrs. 5, 6, 7), and one was hanging on the outside of the trawl-bag, but slipped into the sea again; at St. 126, 67° 19′ N. Lat., 15° 52′ W. Long., 293 fathoms, north of Iceland, was further taken a dead piece of the calcareous axis, 260^{mm} long, of a large specimen. Finally, Nathorst (Nat. Science, Nov. 1899, p. 319, and «Två somrar etc.», 2, p. 93) has, in 1899, taken a large specimen, 2 metres, 12^{ctm} long, close to Jan Mayen, and from the Danish East-Greenland Expedition in the summer of 1900, Mag. Sc. Sören Jensen brought home three specimens (Nrs. 1, 4, 8), a young stage from Cape Brewster, depth 250 fathoms, a large specimen and a torn off

[1] i. e. either East-Greenland or Spitzbergen (comp. Lindahl l. c. p. 3).

[2] As there was, of course, no glass tube of such dimensions on board, one of our spare trawl-beams — an iron tube 15 feet long — was, by the excellent proposal of Captain Evers, used as a reservoir, filled with spirit and properly closed at both ends.

cluster from Canning Land, 202 fathoms; the contemporary Swedish expedition got a mycket vackert» specimen on the 14th of Aug., in the mouth of the Franz-Joseph Fjord, at a depth of 200—300 metres (Kolthoff, p. 176). On the cruise of the «Michael Sars» in 1902, one entire specimen (Nr. 9) and a torn-off cluster were taken at St. 34, north-east of the Færoes, 62° 53′ N. Lat., 4° 14′ E. Long., 384 fathoms, and in 1903 one entire, but broken specimen was taken by the «Thor» at St. 51, east of Iceland, 66° 2′ N. Lat., 11° 5′ W. Long., at a depth of 900—1040 metres.

The localities enumerated show that this species, in contrast to most of the species of the genus, does not seem to thrive in very greath depths, as the known depths reach from ca. 105 fathoms to 762 fathoms. It seems to be most luxuriantly developed and most numerous on the slopes towards the cold depths, but in places and depths where the temperature is already below zero; whether it is found, otherwise than exceptionally, in the really great depths must for the present be left undecided; hitherto, we have only one instance of its being found there, viz. the specimen from St. 105 of the «Ingolf».

I doubt very much whether the species *Umb. encrinus* would be found outside the territory so well bounded geographically where it is really known; I am quite persuaded that the determination is erroneous, when Studer mentions the species *U. encrinus* from the Pacific, 0° 19′ N. Lat., 90° 34′ W. Long., at a depth of 331 fathoms. («Albatross», Bull. Mus. Comp. Zool. vol. XXV, no. 5); Studer's species is perhaps identical with Kölliker's *U. magniflora* from the Southern Ocean, east of Kerguelen Island which species I cannot, however (as Danielssen is inclined to do), regard as identical with *U. encrinus*, even if it is closely allied to it. This species of Kölliker (Chall. Rep. p. 24) is said, among other things, to want spicules entirely. That there can be no doubt of the correctness of this observation arises from the fact that Kölliker was the first who discovered that microscopically small spicules may be found only in the lower end of the peduncle in several other *Umbellula*-species (and in *Anthoptilum*). Kükenthal (Zool. Anz. 1902, p. 596) has described a new variety» of *Umb. encrinus*, a var. *antarctica*, taken east of Bouvet-Island, at a depth of 450 metres. As it differs in several respects from the northern genuine *Umb. encrinus*, I take it to be another species; perhaps also identical with *U. magniflora* Köll. (which Kükenthal however regards as another variety of *U. encrinus*).

General Review of the Occurrence and Distribution of the Northern Pennatulids.

Of the 21 species which, according to the preceding account, constitute the whole Pennatulid-fauna within the territory treated of here, the following six have not hitherto been taken in any locality north of 49° N. Lat.: *Protoptilum carpenteri*, *Anthoptilum grandiflorum*, *Anth. murrayi*, *Distichoptilum gracile*, and the two new species *Protoptilum denticulatum* and *Pennatula prolifera*.

To the fauna of Norway 13 species are to be referred, as the large number of 29 species

given[1]) in Grieg's review (Berg. Mus. Aarb. 1891) must be reduced to the following: *Pennatula phosphorea, Penn. aculeata, Penn. grandis, Virgularia affinis, Virg. mirabilis, Virg. cladiscus, Stylatula (Dübenia) elegans, Pavonaria finmarchica, Halipteris christii, Protoptilum thomsoni, Funiculina quadrangularis, Kophobelemnon stelliferum, Umbellula encrinus.*

From the Færoe Islands, Iceland, and Greenland no Pennatulid was hitherto known (apart from *Umbellula lindahli* and the statement concerning *Pavonaria finmarchica*, see p. 39). It has now been proved that several species are found in the depths of the sea near these countries, also a few in more shallow water. From the banks at the Færoes are now known *Pennatula grandis* (numerous) and *Halipteris christii*. From more shallow water (less than 100 fathoms) at Iceland (the Vestman Islands) are now known: *Pennatula phosphorea* (var. *candida*), *Virgularia mirabilis, Virg. cladiscus*, and *Stylatula (Dübenia) elegans*. From the fjords of the Færoes and Iceland — in contrast to those of Norway — sea-pens are now as little known as hitherto. This holds good also with regard to the western fjords of Greenland. From the sea between Greenland and the American polar islands only *Umbellula lindahlii* was previously known; this species has now been found again farther south, in the Davis Straits, and to it are further to be added *Pennatula aculeata, Penn. prolifera, Anthoptilum grandiflorum, Distichoptilum gracile*, and *Kophobelemnon stelliferum*, so that for the present six species of sea-pens are known as «West-Greenland» species. From East-Greenland only one species, *Umbellula encrinus*, is known, and only from its northern part.

The fact that the species upon the whole divide into an Atlantic and an Arctic territory seems to me, however, of greater interest than the reference of the species found to the fauna of the nearest land. The boundary between these regions is very far from coinciding with the purely geographical boundary of the Polar Circle between the Atlantic and the Arctic Oceans; it is contingent upon the configuration of the bottom and the influence of this upon the temperature and currents of the sea.

I have previously (Geograf. Tidsskrift, vol. 14, 1896—98, p. 38, and Förhdl. 15 Skand. Naturforskaremöte i Stockholm 1898, pp. 271—74) tried to show that the submarine ridges connecting Greenland with Iceland, Iceland with the Færoe Isles, and these with the Scottish Isles, form a boundary between an Arctic and an Atlantic deep-sea fauna; on the one hand, they prevent directly, by their height, the wanderings of many forms, that is to say forms that may be supposed always and in all ages to be confined to depths greater than 300 fathoms; on the other, they influence the distribution of animals by producing a great climatic contrast in the sea-water and by deflecting the currents. North of the ridges the temperature of the water from the bottom to about 300 fathoms below the surface is constantly below zero, whilst south of the ridges it is always positive. The cold northern basin forms part of a large and deep polar water which spreads farther north beyond the large land-masses of the northern hemisphere, but in other places is also shut out from other ocean depths by ridges or regions of more shallow water (Smith Sound etc., and the Behring Straits); the deep, warm waters occurring south of the ridges pass evenly into the great depths of the true Atlantic, only forming the northern part of this Ocean; west of Greenland it passes far north right through the Davis Straits and even some way into the Baffin Sea, constantly with positive bottom

[1]) This account contains 30 species; but *Leptoptilum gracile* Köll. var. *norvegica* Dan. Kor. has already been abandoned by Grieg himself as a young stage of *Funiculina quadrangularis*. Comp. p. 50. The account also, at the time it appeared, should have contained 31 «species», as Koren's & Danielssen's *Cladiscus Köllikeri* has been forgotten.

temperatures. The climatic influence of the submarine barriers reaches, however, to the upper layers of water also; these are considerably colder on the north than on the south side. The influence on the currents is briefly thus: the warm body of water of the Atlantic streams north-east towards Iceland and the ridges; here it is turned off in such a way, that it bends towards the west at the ridge of the Denmark Straits, and then streams south alongside the south-going East-Greenland Polar Current, forming the principal part of the Irminger Current; here accordingly, it returns to the Atlantic; at the ridge between Iceland and the Færoes the warm body of water is turned eastward and led towards Norway, where it streams northward. This water is only cooled far to the north, then sinks to the bottom, and is led southward in the Arctic basin as cold water towards the north side of the ridges without being able to pass these to any considerable degree.

From this it follows that the deep-sea animals which rise so much above the bottom as to live in this Atlantic water (which may be thought to apply among others to the larvæ of bottom animals), are partly retained in the Atlantic, and may partly wander towards Norway; here some of them may take root, as the conditions to a depth of ca. 300 fathoms agree with those of corresponding depths south of the ridges; and this holds good far north of the Polar Circle. Thus, the Atlantic fauna reigns not only south of the mentioned boundary of the cold region, but also east of this region along the whole Scandinavian peninsula. It is quite wrong to regard some deep-sea animals as arctic forms, because they were first known from high northern latitudes at Norway; like several «southern animals from the same regions they belong really to a widely spread Atlantic fauna. A great number, at least, of the animals found at the Scandinavian peninsula even to the North Cape, are also found along the Atlantic side of southern Europe; some of them even pass into the Mediterranean; several occur at the Azores, and still more on the east side of North America (at latitudes corresponding to southern, and partly to Central Europe); and now the Ingolf Expedition has been able to show further that some follow the warm layer of water far up on the west of Greenland.

When we now turn to the Pennatulids, we find that of the 21 species enumerated here, no less than 20 have been found in the Atlantic territory; only one, *Umbellula encrinus*, is an exclusively Arctic species. But among the species from the Atlantic region there are two which may occur beyond the boundary towards the cold region, viz. *Virgularia cladiscus* and *Kophobelemnon stelliferum*. With regard to the latter, however, it has only been found in single instances and only in the narrow branch sent off from the cold deep waters towards the Wyville Thomson ridge in the Færoe Channel; this species has otherwise the widest possible distribution inside the «warm area . *Virgularia cladiscus*, certainly, has been found more frequently and in several places inside the cold area, but always near to the boundary towards the warm area; both these species must assuredly be regarded as Atlantic species endowed with more than common hardiness with regard to temperature.

The preponderance in richness of forms shown by the Atlantic territory in respect to Pennatulids, is a general feature; the cold territory of the depths of the North Atlantic is upon the whole poor; but to be sure, the contrast is not so large in all groups as in this.

The common characteristic of the fauna of the Atlantic territory with regard to the northern Pennatulids will be seen plainly from the table below.

	Davis Str.	East side of N. America	South of the ridges	Norway	West of Europe	The Mediterranean	The Azores
Pennatula phosphorea	...	...	+	+	+	+	...
» *aculeata*	+	+	+	+	+	...	+
» *prolifera*	+	...	...	...	...	...	...
» *grandis*	...	+	+	+	...	...	...
Virgularia affinis	...	...	...	+	...	...	...
» *mirabilis*	...	+	+	+	+	+	+
» *cladiscus*	...	...	+	+	+	...	...
Stylatula (Dübenia) elegans	...	?	+	+	...	...	...
Pavonaria finmarchica	...	+	+	+	..	...	...
Halipteris christii	...	?	+	+	...	...	...
Protoptilum thomsoni	...	...	...	+	+	...	...
Protoptilum carpenteri	...	+	+	...	+	...	...
» *denticulatum*	...	...	+	...	...	...	...
Funiculina quadrangularis	...	+	+	+	+	+	...
Distichoptilum gracile	+	+	+	...	...	...	...
Kophobelemnon stelliferum	+	+	+	+	+	+	...
Bathyptilum carpenteri	...	...	+	...	...	...	...
Anthoptilum grandiflorum	+	+	...	...	...	...	...
» *murrayi*	...	+	+	...	+	...	...
Umbellula lindahli	+	?	+	...	...	...	...

A ? in a column means that there are indications which make it probable that the species in question might be entered as found.

The table shows how great the agreement is between the most widely separated parts of the North Atlantic territory, the west side of Norway and the east side of North America. Six of the twelve species of Norway are known from America, and there is some probability that two more may now be added. Species which previously had to be regarded as «American» (*Anthoptilum murrayi, Distichoptilum gracile*) have proved to be distributed quite to Europe; species which were hitherto only known as far more southern ones (even from south of the equator), as *Anthoptilum grandiflorum*, are found in the Davis Straits; of the other five species found there, four occur both at America and Europe; but one (*Penn. prolifera*) is as yet only known from these Straits. Apart from the quite imperfectly known *Bathyptilum carpenteri* (only taken in one mutilated fragment) and *Protoptilum denticulatum*, no form peculiar to the northern part of the Atlantic south of the ridges has appeared; of the other 14 species from this region six are found both at Norway and America, four (for the present) at Norway alone, and three at America alone; but of the last-mentioned species two also occur off the west coast of southern Europe.

It seems likely that continued researches inside the Atlantic area will show that the uniformity is still greater than I have been able to show here; so wide a distribution as is now known for *Anthoptilum grandiflorum*, which has been found from off Buenos Ayres to far up in the Davis Straits, further at the African coast off the Cape (and possibly near Tristan d'Acunha) will scarcely prove an isolated phenomenon; several other Pennatulids of which we know that they may thrive in great

depths, will certainly be found distributed over the greater part of the widely-extended depths of the Atlantic, as far as the positive bottom-temperatures are found.

With regard to the bathymetrical range, the species treated off here show the peculiar feature that most of them may occur at very different depths; many of them have a surprisingly great vertical range. In the following list the least and the greatest depth at which each species has hitherto been found, is given as far as possible.

	Fathoms
Pennatula phosphorea	5-10—114
» *aculeata*	30—1255
» *prolifera*	1199—1435
grandis	50—1255
Virgularia affinis	60—100
mirabilis	5—200
» *cladiscus*	40—555
Stylatula (Dübenia) elegans	30—550
Pavonaria finmarchica	60—980
Halipteris christii	c. 200
Protoptilum thomsoni	150—440
Protoptilum carpenteri	690—1700 [1]
» *denticulatum*	1695
Funiculina quadrangularis	10—1135
Distichoptilum gracile	700—1245 [2]
Kophobelemnon stelliferum	20—over 2000 (2369)
Bathyptilum carpenteri	650
Anthoptilum grandiflorum	131—1106
murrayi	640—1362
Umbellula lindahli	122—1435 [3]
encrinus	c. 105—762

According to this list only four specimens would seem to be exclusively deep-sea forms: *Pennatula prolifera, Anthoptilum murrayi, Distichoptilum gracile*, and *Protoptilum denticulatum*; as only one specimen of the latter has been taken, however, I think it better to make a reservation with regard to it. Several of the species which are known to reach to very great depths, seem, however, to have their natural home in somewhat higher regions: *Pennatula aculeata* occurs most frequently between 150 and 300 fathoms; *Penn. grandis, Funiculina quadrangularis, Halipteris christii, Pavonaria finmarchica, Anthoptilum grandiflorum, Kophobelemnon stelliferum, Protoptilum thomsoni, Umbellula encrinus*, perhaps still more, seem to occur in greatest numbers and to be largest and most developed in similar small and moderately great depths. With regard to these and several other sea-pens the specimens taken at very great depths are only young stages; even if they are provided with sexual organs, sometimes even with ripe sexual products, their outer form has either not reached full development, or may even be so little developed, that in several instances these specimens have been interpreted as independent species or genera of simple structure. From this fact originates the view advanced by Kölliker (Monogr. p. 449 and Chall. Report p. 39), that it is upon the whole the simple forms of Pennatulids which live in the great depths, whilst the more «complicated» or differentiated forms belong to less deep waters; and since the forms interpreted as primitive ones are as usual regarded as the oldest, he has also thought he found the supposition corroborated in the distribution of the Pennatulids, that the remainder of an otherwise extinct, ancient fauna was living in the great depths. This latter supposition is upon the whole not very probable; I shall not, however, treat of this question

1) Verrill states that he has found it at less depths, comp p. 54; but he gives no depth.
2) In the Pacific 885—1573 fathoms.
3) *U. bairdi*, which is presumably the same species, reaches to 2033 fathoms.

here, but only point out that the Pennatulids cannot be used to support it. But how is the fact to be explained that the specimens of many species taken at great depths are exclusively or most frequently young stages?

The reason may possibly be that the severe conditions of life which are undoubtedly found at great depths, check the growth, so that the few individuals which have emigrated from better regions, become more or less dwarfed. But the reason may possibly be the more casual one that hitherto the great depths have been fished so little and over so small an extent, and that the apparatus used have been very defective. The Pennatulids found at the coast and in shallow water and there regarded as «common», often occur much scattered, sometimes in strictly local and limited «plantations». Similar features are undoubtedly also found in the great depths; it has been pointed out by Kölliker (Chall. Rep. p. 36) that the «Challenger» obtained not a single Pennatulid in wide regions of the oceans; of the 118 stations, at which the «Ingolf» used fishing gear on the bottom, only 17 have yielded Pennatulids; and large specimens of forms such as *Penn. grandis, Funiculina, Halipteris, Protoptilum* etc. are seldom if ever got in the dredge, rarely enough in a trawl of the types generally used in deep-sea researches; generally, we have to thank the lines of fishermen or their large, wide-spreading nets for the large and entire specimens which give us correct ideas of these forms; and it may upon the whole be said that we have only a full representation of these forms from regions, where fishing has been far more intensely carried on than in the great depths.

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Plate I.

Plate I.

Fig. 1. *Pennatula aculeata* Kor. Dan. from Davis Straits. The specimen, which is seen from the ventral side, is of an unusual violet colour. The pen is highly contracted and somewhat damaged. The specimen when just taken, was painted on board the «Ingolf» by the artist-painter Sigurd Wandel; somewhat enlarged (See p. 12 No. 1).

Fig. 2. *Protoptilum carpenteri* Köll. (the «Ingolf» s specimen No. 3, p. 52); seen from the ventral side; × 3. *b* younger polyps which on developing will make the pen two-rowed.

Fig. 3. Id.: seen from the dorsal side; the same enlargement. *n* the naked streak.

Fig. 4. *Protoptilum thomsoni* Köll. The top of a specimen taken by the «Michael Sars» (No. 10, p. 57), seen from the left side; × 3; *n* the naked dorsal streak, *t* the top of the rhachis.

Fig. 5. Id.: a piece from the middle of the rhachis seen from the left side; × 3; from a specimen taken in the Skager Rak (No. 11, p. 57), belonging to the Riksmuseum in Stockholm.

Fig. 6. Id.: the lower part of the rhachis, seen from the left side; × 3; from the same specimen (No. 11); *n* the dorsal, *n'* the ventral naked streak.

Fig. 7. Id.: a piece of the middle part of the rhachis, also seen from the left side, but turned in such a way, that the ventral streak *n'* is seen, whilst the dorsal streak is hidden; *V* ventral side, *D* dorsal side; × 3; of the polyps only the calyxes have been drawn so that the arrangement of the polyps may be distinctly seen; the same specimen as in figs 5 and 6.

Fig. 8. Id.: the lower part of the rhachis, seen from the right side; × 3; 1, 2, 3, young polyps forming together an oblique row rising towards the dorsal side *D*; 1, 1, 1 the oldest polyps in each oblique row (comp. fig. 7). The lower part of the rhachis (together with the peduncle) is twisted round the calcareous axis in a somewhat spiral-shaped manner. The same specimen as in figs 5—7.

Fig. 9. *Protoptilum denticulatum* n. sp., seen from the dorsal side; × 2. *P* terminal polyp, *Z* terminal zooid; *a* somewhat larger, *b* somewhat smaller and more ventrally placed polyps. * the place where the lower bend of the inner calcareous axis is found.

Fig. 10. Id.: seen from the ventral side; × 2. The signification of the letters as in the preceding figure.

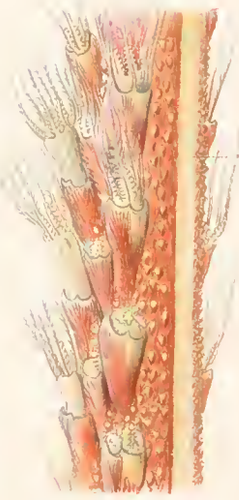
Fig. 11. Id.: the top seen from the left side; × 3. *P* terminal polyp, *Z* terminal zooid, *z* dorsal zooid, *p* lateral polyp.

Fig. 12. *Distichoptilum gracile* Verr., part of the rhachis seen from the dorsal side. The colour taken from a coloured sketch made on board the «Ingolf» by the artist-painter Sigurd Wandel. The polyps retracted; *z* dorsal zooids; × 3.

Fig. 13. Id.: the upper end of the rhachis of another specimen (No. 6, p. 64) × 5, to show the teeth of the calyx-mouth, the (apparent) terminal zooid *z*, and the (likewise apparent) terminal polyp; comp. p. 64.

Fig. 14. Id.: the upper end of a third, somewhat deviating specimen (No. 9, comp. p. 65); × 2; *k* the upper, knob-shaped end of the rhachis.

Figs. 2—14 drawn by Th. Bloch.



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Pennatula fig. 1 Protoptilum fig. 2-11 Distichoptilum fig. 12-14

Plate II.

Plate II.

Fig. 15. *Pennatula prolifera* n. sp., young specimen (comp. p. 18), seen from the ventral side; × 5. *Z* the top-zooid, only partly visible, part of it being hidden between the two uppermost lateral polyps. I—VIII the more developed pairs of wings; 1, 2, 3 the single polyps of these, according to age; IX—XII the four rudimentary wings.

Fig. 16. Id.: from the dorsal side, × 5. *n* zooid-less («naked») dorsal streak.

Fig. 17. Id.: a very young specimen, × 5, from the ventral side; there are two pairs of wings (I, II) consisting of two individuals, 1 and 2; below these, two rudiments on each side.

Fig. 18. Id.: the same specimen as the preceding one, seen from the dorsal side. *Z* top zooid, *z* dorsal zooid.

Fig. 19. Id.: a still younger specimen from the ventral side, × 5. 1, 2 the two individuals of wing I, the only wing as yet present.

Fig. 20. Id.: the same specimen as the preceding one, seen from the dorsal side; *Z* and *z* as above.

Fig. 21. Id.: the pen of a young specimen with five pairs of wings, seen from the dorsal side, × 5. The top is in process of being separated-off.

Fig. 22. Id.: the upper part of the pen of another specimen with the same number of wings, from the dorsal side; also × 5; the upper end of the calcareous axis is seen in the stem (see p. 22); the top is likewise in process of being separated-off.

Fig. 23. Id.: the top of the pen of a third specimen, from the dorsal side, × 6—7; only the uppermost polyps (I) are drawn; the constriction is present, but the top part of the stem is not yet prolonged to any considerable extent.

Fig. 24. Id.: the upper end of the pen of a specimen without any constriction at the top; from the dorsal side, × 6; in the place where other specimens are constricted, there is a large zooid *Z* (comp. p. 23).

Fig. 25. *Virgularia mirabilis* (O. F. M.), a young (*Protocaulon*-) stage, 10,5^{mm} long (belonging to the Riksmuseum in Stockholm); from the dorsal side, × ca. 8; all polyps, with the exception of one, completely retracted; *p* rudimentary (i. e. atrophied) polyps; *lz* lateral zooid, *sz* stalk-zooids.

Fig. 26. Id.: a somewhat older young stage, 22^{mm} long, from the ventral side, × ca. 6. At p_2 the polyp in question has been cut away (comp. p. 27).

Fig. 27. Id.: a still older stage, 45^{mm} long, from the ventral side, × 4. *p* the uppermost rudimentary wings; 5 wings on one side, 6 on the other, have two developed polyps; the succeeding wings below these are three-polyped. *a* the region of the developed wings, *b* that of the rudimentary wings, *c* that of the stalk-zooids.

Fig. 27 a shows a part of the specimen figured in 27, under higher magnifying power, so that the three wing-polyps may be seen more distinctly; in the lowermost wing figured here, the innermost (most ventral) polyp * is very small.

Fig. 28. *Pavonaria finmarchica* (M. Sars), young («*Microptilum*»-) stage; a small portion of the middle part of the rhachis of the specimen, figured on Pl. III, fig. 33, from the ventral side, × 5; *z* zooids.

Fig. 29. Id.: a small part of the rhachis, seen in profile from the right; of another specimen (No. 2, p. 40).

Fig. 30. *Halipteris christii* (Kor. & Dan.), young (*Lygomorpha*-) stage, ca. 73^{mm} long, × 3; from the ventral side; *a* young polyps recently developed. At * the soft parts have been rubbed away.

Fig. 31. Id.: a small part of the rhachis of another specimen, seen in profile from the right side, so that it may be compared with fig. 29 of *Pavonaria*. The specimen is the smallest one of Koren and Danielssen's two type-specimens of «*Lygomorpha Sarsii*», 106^{mm} long (see p. 46).

Fig. 32. Id.: the top of a full-grown specimen, 400^{mm} long, from the Færoes, from the ventral side; shows the different appearance of the calyx-points in different individuals.

Figs. 15 and 16 are drawn by C. Cordts, figs. 23, 24, 25 and 26 by the author, the others by Th. Bloch.

Pennatula prolifera Fig. 19–24 Virgularia mirabilis Fig. 25–27 Pavonaria finmarchica Fig. 28–29
Halipteris christii Fig. 30–32

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Plate III.

Plate III.

Fig. 33. *Pavonaria finmarchica* (M. Sars), young *(«Microptilum»-)* stage, from the ventral side, × 2. (The specimen No. 3, p. 40). The zooids are not represented in the figure; they can scarcely be seen with this enlargement; the bodies looking like zooids are young polyps.

Fig. 34. Id.: the upper part of the pen of another specimen (No. 2, p. 40), from the ventral side, × 3. *a* are quite young polyps, *t* the conical end of the stem.

Fig. 35. Id.: the lower part of the rhachis of the same specimen as in the preceding figure, *a* young polyps; × 3.

Fig. 36. Id.: the lower part of the pen of the same specimen as figs. 34 and 35, seen in profile from the left to show the *Microptilum*-character; comp. the lower part of the pen of Köllikers figure, Chall. Rep. Pl. VII, Fig. 27 b, of *Microptilum willemoësii.*

Fig. 37. *Umbellula lindahlii* Köll., young specimen, seen from the left, natural size; from Davis Straits (see p. 75).

Fig. 38. The same specimen; the primary polyp, × 8; most of the tentacles torn off; at *k* part of the upper end of the calcareous axis shines through; *p* bud of a new polyp; *z* zooids.

Fig. 39. The same specimen; the lower part of the rhachis, with zooids *z*, and peduncle; × 8.

Fig. 40. *Umbellula lindahlii,* young specimen, natural size; the cluster seen so much from the dorsal side, that *P*, the terminal or primary polyp, is distinctly seen.

Fig. 41. The same specimen, natural size; the cluster is seen from the ventral side.

Fig. 42. The same specimen, part of the cluster, × 3, seen from the ventral side to show the tentacle of the zooids, and that the ventral tentacle *v* of the small polyp is larger than the others.

Fig. 43. The same specimen; the lowermost part of the stalk, × 6; shows zooids with fine tentacles; some zooids have a tentacle with lateral branches *(t).*

Fig. 44. The same specimen; a group of spicules from the lower end of the peduncle; enlargement: Zeiss, Obj. apochr. 8.0^{mm}, Comp. ocular 4, length of tube 160^{mm}.

Fig. 45. The same specimen; spicules, under higher magnifying powers. Zeiss, Obj. apochr. 8.0^{mm}, Comp. ocular 12.

Fig. 46. *Umbellula encrinus* (L.). The cluster of a young specimen (No. 1, p. 80), seen from the rudiment-side (the ventral side), × 3; *P* the primary polyp; *t* tongue-shaped zooid-area.

Fig. 47. The same species; another specimen, young stage; natural size (No. 2, p. 80), from the right side of the terminal polyp. *P* the terminal polyp; *z* large zooid; *a* rudiment of a polyp; 1, 2 the two polyps on the right side of the terminal polyp; *dt* the dorsal zooid-belt reaching up to the base of the body of the primary polyp.

Fig. 48. The same specimen as in the preceding figure; part of the cluster, × 3; *dt, P,* 1, 2 as in the preceding figure; *t* the three tongues of zooids on the left side.

Fig. 49. The same specimen as in figs. 47—48; part of the cluster, seen from the rudiment-region (the ventral side), × 3. *P,* 1, 2, *dt* as above; *a* rudiments of four polyps; between these rudiments stripes of zooids shoot up, the first rudiments of zooid-tongues.

Fig. 50. *Umbellula encrinus:* a large zooid from the inner part of the cluster of a fully formed, large specimen, enlarged (of No. 7, p. 80); *t* tentacle with lateral branches; *m* mouth.

Fig. 51. Id.: spicules from the lower end of the peduncle (of the specimen No. 10, p. 80). Zeiss: Obj. apochr. 8.0^{mm}, Comp. ocular 12, length of tube 160^{mm}.

Figs. 37, 38, 44, 45, 50 and 51 drawn by the author, the others by Th. Bloch.

LABORATORY

Pavonaria [illegible] Umbellula Lindahli [illegible] Umbellula encrinus [illegible]

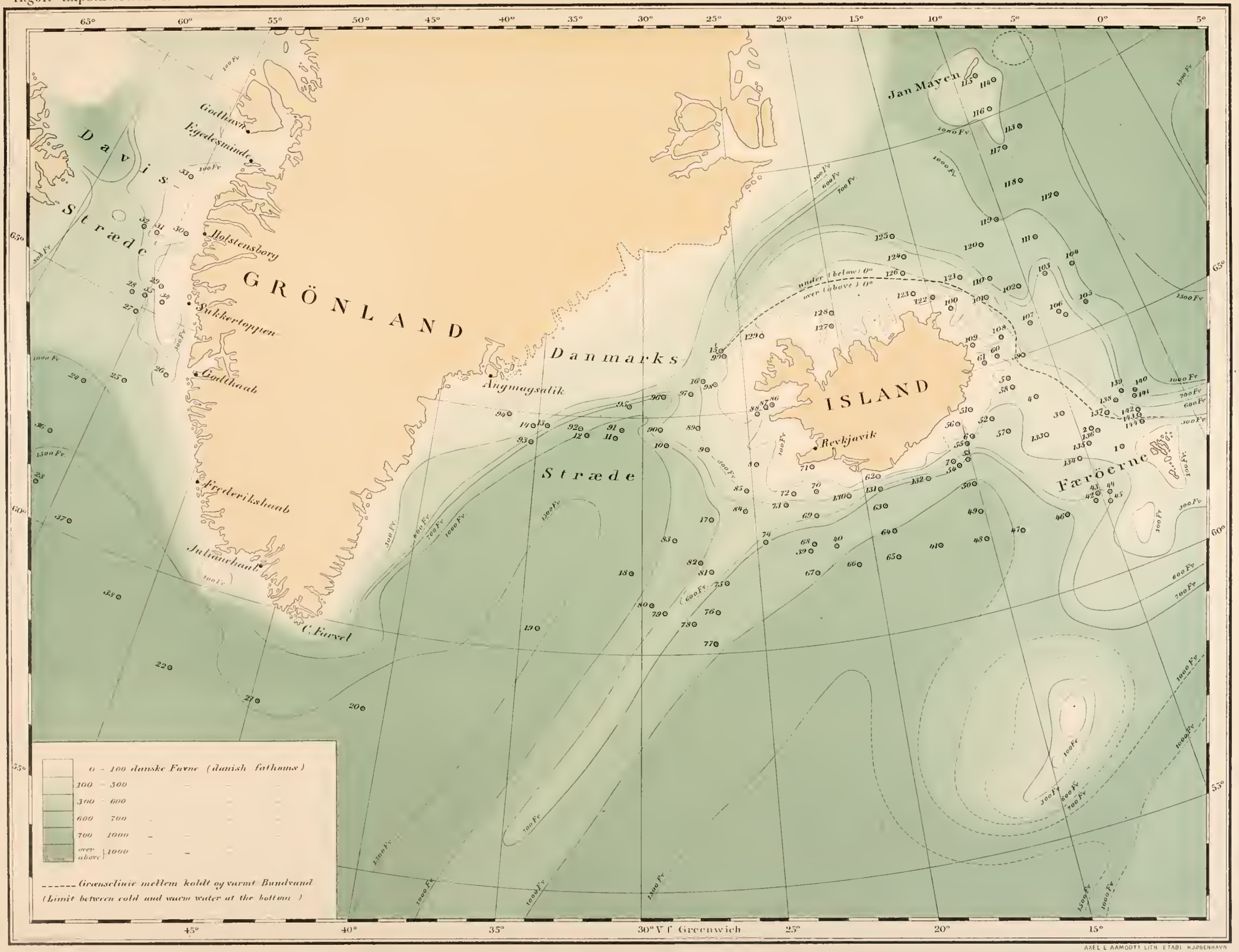
THE INGOLF-EXPEDITION

1895—1896.

THE LOCALITIES, DEPTHS, AND BOTTOMTEMPERATURES OF THE STATIONS.

Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.
1	62° 30′	8° 21′	132	7°2	24	63° 06′	56° 00′	1199	2°4	45	61° 32′	9° 43′	643	4°17
2	63° 04′	9° 22′	262	5°3	25	63° 30′	54° 25′	582	3°3	46	61° 32′	11° 36′	720	2°40
3	63° 35′	10° 24′	272	0°5		63° 51′	53° 03′	136		47	61° 32′	13° 40′	950	3°23
4	64° 07′	11° 12′	237	2°5	26	63° 57′	52° 41′	34	0°6	48	61° 32′	15° 11′	1150	3°17
5	64° 40′	12° 09′	155			64° 37′	54° 24′	109		49	62° 07′	15° 07′	1120	2°91
6	63° 43′	14° 34′	90	7°0	27	64° 54′	55° 10′	393	3°8	50	62° 43′	15° 07′	1020	3°13
7	63° 13′	15° 41′	600	4°5	28	65° 14′	55° 42′	420	305	51	64° 15′	14° 22′	68	7°32
8	63° 56′	24° 40′	136	6°0	29	65° 34′	54° 31′	68	0°2	52	63° 57′	13° 32′	420	7°87
9	64° 18′	27° 00′	295	5°8	30	66° 50′	54° 28′	22	1°05	53	63° 15′	15° 07′	795	3°08
10	64° 24′	28° 50′	788	3°5	31	66° 35′	55° 54′	88	1°6	54	63° 08′	15° 40′	691	3°9
11	64° 34′	31° 12′	1300	1°6	32	66° 35′	56° 38′	318	3°9	55	63° 33′	15° 02′	316	5°9
12	64° 38′	32° 37′	1040	0°3	33	67° 57′	55° 30′	35	0°8	56	64° 00′	15° 09′	68	7°57
13	64° 47′	34° 33′	622	3°0	34	65° 17′	54° 17′	55		57	63° 37′	13° 02′	350	3°4
14	64° 45′	35° 05′	176	4°4	35	65° 16′	55° 05′	362	3°6	58	64° 25′	12° 09′	211	0°8
15	66° 18′	25° 59′	330	—0°75	36	61° 50′	56° 21′	1435	1°5	59	65° 00′	11° 16′	310	—0°1
16	65° 43′	26° 58′	250	6°1	37	60° 17′	54° 05′	1715	1°4	60	65° 09′	12° 27′	124	0°9
17	62° 49′	26° 55′	745	3°4	38	59° 12′	51° 05′	1870	1°3	61	65° 03′	13° 06′	55	0°4
18	61° 44′	30° 29′	1135	3°0	39	62° 00′	22° 38′	865	2°9	62	63° 18′	19° 12′	72	7°92
19	60° 29′	34° 14′	1566	2°4	40	62° 00′	21° 36′	845	3°3	63	62° 40′	19° 05′	800	4°0
20	58° 20′	40° 48′	1695	1°5	41	61° 39′	17° 10′	1245	2°0	64	62° 06′	19° 00′	1041	3°1
21	58° 01′	44° 45′	1330	2°4	42	61° 41′	10° 17′	625	0°4	65	61° 33′	19° 00′	1089	3°0
22	58° 10′	48° 25′	1845	1°4	43	61° 42′	10° 11′	645	0°05	66	61° 33′	20° 43′	1128	3°3
23	60° 43′	56° 00′	Only the Plankton-Net used		44	61° 42′	9° 36′	545	4°8	67	61° 30′	22° 30′	975	3°0

Station Nr.	Long. W.	Lat. N.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.
68	62° 06′	22° 30′	843	3°4	92	64° 44′	32° 52′	976	1°4	118	68° 27′	8° 20′	1060	—1°0
69	62° 40′	22° 17′	589	3°9	93	64° 24′	35° 14′	767	1°46	119	67° 53′	10° 19′	1010	—1°0
70	63° 09′	22° 05′	134	7°0	94	64° 56′	36° 19′	204	4°1	120	67° 29′	11° 32′	885	—1°0
71	63° 46′	22° 03′	46			65° 31′	30° 45′	213		121	66° 59′	13° 11′	529	—0°7
72	63° 12′	23° 04′	197	6°7	95	65° 14′	30° 39′	752	2°1	122	66° 42′	14° 44′	115	1°8
73	62° 58′	23° 28′	486	5°5	96	65° 24′	29° 00′	735	1°2	123	66° 52′	15° 40′	145	2°0
74	62° 17′	24° 36′	695	4°2	97	65° 28′	27° 39′	450	5°5	124	67° 40′	15° 40′	495	—0°6
	61° 57′	25° 35′	761		98	65° 38′	26° 27′	138	5°9	125	68° 08′	16° 02′	729	—0°8
	61° 28′	25° 06′	829		99	66° 13′	25° 53′	187	6°1	126	67° 19′	15° 52′	293	—0°5
75	61° 28′	26° 25′	780	4°3	100	66° 23′	14° 02′	59	0°4	127	66° 33′	20° 05′	44	5°6
76	60° 50′	26° 50′	806	4°1	101	66° 23′	12° 05′	537	—0°7	128	66° 50′	20° 02′	194	0°6
77	60° 10′	26° 59′	951	3°6	102	66° 23′	10° 26′	750	—0°9	129	66° 35′	23° 47′	117	6°5
78	60° 37′	27° 52′	799	4°5	103	66° 23′	8° 52′	579	—0°6	130	63° 00′	20° 40′	338	6°55
79	60° 52′	28° 58′	653	4°4	104	66° 23′	7° 25′	957	—1°1	131	63° 00′	19° 09′	698	4°7
80	61° 02′	29° 32′	935	4°0	105	65° 34′	7° 31′	762	—0°8	132	63° 00′	17° 04′	747	4°6
81	61° 44′	27° 00′	485	6°1	106	65° 34′	8° 54′	447	—0°6	133	63° 14′	11° 24′	230	2°2
82	61° 55′	27° 28′	824	4°1		65° 29′	8° 40′	466		134	62° 34′	10° 26′	299	4°1
83	62° 25′	28° 30′	912	3°5	107	65° 33′	10° 28′	492	—0°3	135	62° 48′	9° 48′	270	0°4
	62° 36′	26° 01′	472		108	65° 30′	12° 00′	97	1°1	136	63° 01′	9° 11′	256	4°8
	62° 36′	25° 30′	401		109	65° 29′	13° 25′	38	1°5	137	63° 14′	8° 31′	297	—0°6
84	62° 58′	25° 24′	633	4°8	110	66° 44′	11° 33′	781	—0°8	138	63° 26′	7° 56′	471	—0°6
85	63° 21′	25° 21′	170		111	67° 14′	8° 48′	860	—0°9	139	63° 36′	7° 30′	702	—0°6
86	65° 03′ 6	23° 47′ 6	76		112	67° 57′	6° 44′	1267	—1°1	140	63° 29′	6° 57′	780	—0°9
87	65° 02′ 3	23° 56′ 2	110		113	69° 31′	7° 06′	1309	—1°0	141	63° 22′	6° 58′	679	—0°6
88	64° 58′	24° 25′	76	6°9	114	70° 36′	7° 29′	773	—1°0	142	63° 07′	7° 05′	587	—0°6
89	64° 45′	27° 20′	310	8°4	115	70° 50′	8° 29′	86	0°1	143	62° 58′	7° 09′	388	—0°4
90	64° 45′	29° 06′	568	4°4	116	70° 05′	8° 26′	371	—0°4	144	62° 49′	7° 12′	276	1°6
91	64° 44′	31° 00′	1236	3°1	117	69° 13′	8° 23′	1003	—1°0					



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