On some remarkable forms of animal life from the great deeps off the Norwegian coast...

Christiania, Printed by Brøgger & Christie [etc.], 1872-75
https://www.biodiversitylibrary.org/bibliography/11274

Article/Chapter Title: Spongiae from deep Norwegian
Author(s): Sars, M
Subject(s): Porifera, sponges
Page(s): Title Page, Text, Table of Contents, Text, Text, Text, Text, Text, Page 62, Page 63, Page 64, Page 65, Page 66, Page 67, Page 68, Page 69, Page 70, Page 71, Page 72, Page 73, Page 80, Page 81, Page 82, Text

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ON

SOME REMARKABLE FORMS OF ANIMAL LIFE

FROM THE GREAT DEEPS OFF THE NORWEGIAN COAST.

I.

PARTLY FROM POSTHUMOUS MANUSCRIPTS OF THE LATE

PROFESSOR Dr. MICHAEL SARS

BY

GEORGE OSSIAN SARS.

With 6 Copper plates.

University-Program for the 1st half-year 1869.

CHRISTIANIA.

PRINTED BY BRØGGER & CHRISTIE.

1872.

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Spongiæ.

Preface.

Under the above title I purpose, if I can obtain the necessary assistance, to make known little by little the most important discoveries which I have had opportunity to make during my deep-sea investigations in recent years; and I shall consider it my duty first to treat those animal forms which my Father has already partially examined and designated. The present university-program comprises some of these belonging to 6 different classes of animals, namely 2 Polyzoa, 2 Conchifera, 3 Cephalophores, 2 Annelids, 2 Corals and 3 Sponges.

These animal forms had already been partially destined by my Father for more detailed notice in a university-program similar to that composed on the subject of the Rhizocrinus; and application for the requisite assistance was already sent in to the academical college, when his unexpected death put a sudden end to the important investigations which he had commenced.

It is therefore with deep gratitude that I here acknowledge the kindness of the college, in confiding to me the elaboration and publishing of the intended program; and although I am well aware of my want of that thorough acquaintance with the invertebrate animals, and of that clear and precise method of treatment which always distinguished my Father's works, it is still a pleasure for me to have opportunity given for prosecuting to the best of my power those investigations, to which my Father devoted himself with so much zeal and perseverance, until the day of his death.

Although, as above stated, the present program was intended to be published by my Father, still the necessary detailed investigations were scarcely more than commenced, for which reason also no manuscript had been compiled. I find however, among my late Father's papers, notes on most of the animal forms mentioned in the following lines, and with respect to some of them also more complete descriptions, which have been of great help to me in the elaboration of the present program. I have also always quoted as conscienciously as possible my Fathers's more coherent remarks, which certainly will have their important value. Where this has taken place, I have always expressly remarked it in the text. Finally I am bound to express my warmest thanks for the valuable information relative to the Mollusca, which has been communicated to me by the celebrated English Conchologist I. Gwyn Jeffreys Esq.; and for the remarkable kindness with which the equally highly celebrated Swedish

Zoologist Professor S. Lovèn has sent me specimens of deep-sea sponges, for comparison with those discovered by me.

With regard to the composition in its entirety, I must represent myself as alone responsible; so that the possible defects noticeable in this respect may be attributed to me and not to my Father.

That I have chosen a foreign language, instead of my mother tongue as the medium of this communication, is a circumstance which I think does not call for any justification on my part. Science is cosmopolitan, and therefore requires a generally intelligible language. Our language has not reached this point yet; and to facilitate the reading of this little work, I have adopted one of the great universal languages. I have preferred the English language, as well because it has most affinity with our own, and consequently affords greater facility for rendering the Norwegian expressions, as in acknowledgment of the great progress which zoological science has made in recent times, through the medium of the English language.

G. O. SARS.

Introduction.

A wide field for zoological research, which has given, and will surely continue to give results of the highest scientific interest, has been lately opened by the investigation of the great depths of the sea, which had formerly been generally considered as void of all life, but which have been found in some places to contain a wonderfully rich and varied animal world. Such deep-sea investigations have indeed been occasionally made at various points of our coast; and my Father gave already in 1864[1] a catalogue of 92 different forms of animal life, which were discovered by him and by other Norwegian naturalists, at the great depth of 200—300 fathoms; and he had likewise previously — as early as 1850[2] — decidedly declared himself opposed to the hypothesis set forth by Forbes, and subsequently generally adopted, that the limit for the propagation of animal life in the depths of the sea should be fixed at about 300 fathoms. It is however only quite recently that such deep sea investigations have been conducted in a systematic manner on our coast. I had myself a particularly convenient opportunity for such research during my stay in Lofoten, where depths of 300 fathoms and more occur at a relatively small distance from land. I therefore determined, notwithstanding the great difficulties connected with dredging at such great depths, and although I had only an ordinary fishing-boat with a crew of 3 men at my disposal — to devote as much time as I could to these investigations, abandoning the far easier, and as I then thought far more productive, investigation of the smaller depths. The result of these my deep-sea researches was however, great and interesting quite beyond all anticipation. I found to my great surprise at this enormous depth — not, as might be presumed according to Forbes' hypothesis — a poor and oppressed Fauna, but on the contrary a richly developed and varied animal life; so that my Father was able in 1868[3] to increase the catalogue of the forms of animal life observed at the depths of 200—300 fathoms, by the addition of not less than 335 species (in all 427) of which nearly all were taken in one locality, namely at the fishing-place Skraaven in Lofoten. And so far was I from observing any sign of diminished intensity in this animal life at increased depths, that it seemed, on the contrary, as if there was just beginning

[1] „Bemærkninger over det dyriske Livs Udbredning i Havets Dybder." Christiania Videnskabs-Selskabs Forhandlinger for 1864.

[2] „Reise i Lofoten og Finmarken."

[3] „Fortsatte Bemærkninger over det dyriske Livs Udbredning i Havets Dybder". Chr. Vid.-Selsk. Forh. f. 1868.

to appear a rich and in many respects peculiar deep sea Fauna, of which only a very incomplete notion had previously existed. The number of new forms of animal life was therefore also very considerable; and some of these were of peculiar interest, as more or less evidently carrying us back to former telluric periods, especially the Fauna of the Cretaceous period. This was specially evident in the case of an animal which my Father has therefore made the subject of a separate and detailed treatise. I mean the little remarkable sea-lilly Rhizocrinus lofotensis belonging to the family of the Apiocrinidæ, which has been considered as long ago extinct, but which flourished in the Oolitic period. The discovery excited great interest in the scientific world, and may be said to have given the impulse to the comprehensive investigations of the Atlantic depths, which have been instituted with great liberality by the English government in later years. By these grand English deep-sea expeditions, in connexion with the deep-soundings executed during the Swedish Spitzbergen expeditions in the Arctic Ocean, which have both extended even to the enormous depth of between 2000 and 3000 fathoms, it has now been further ascertained that the great depths of the Ocean do not form, as was formerly supposed barren tracts or deserts, but are peopled with a richly developed and peculiar animal world, which on the whole shews a very clearly marked affinity to the Fauna of the Cretaceous period, and in a great measure may really be considered as consisting of descendents in direct line from the forms existing in that telluric period. This cannot indeed be always so evidently proved, as in the case of the above mentioned sea-lilly, but it is also in many other forms very distinctly expressed. We may therefore with Carpenter [1] presume that the Cretaceous formation is continued undisturbed at this present day in the depths of the Ocean; and we may therefore assume that just here, there has been little change during all the periods of the earth; and we may also expect to find just here, the descendents from the chalk period most unchanged; while the Fauna at smaller depths, and especially the shore-Fauna, would in a relatively short time, by reason of telluric and physical revolutions, be forced entirely to change its character. It is also very probable that many of the remarkable forms of animal life, from the great depths off our coast, more particularly described in the following lines, are just such ancient slightly altered forms, which thus — apart from purely zoological considerations — excite a very peculiar interest, as giving us important indications with respect to the historical, or rather the palæontological development of animal life.

[1] See Carpenter on this subject. Preliminary report of dredging operations in the seas to the North of the British islands. p. 192.

Spongiæ.

12. Trichostemma hemisphæricum. M. Sars.

nov. gen. et spec.

(Pl. VI. fig. 1—15).

Of this sponge, so peculiar in its appearance, I have seen a number of specimens of various size; and all these shewed the same characteristic form, which must thus be considered as perfectly constant for the present species.

The largest specimens have a transverse diameter of nearly 2" and a height of 1". The form (see fig. 1 & 2) is more or less high hemispherical, circular with the lower surface plane, or in the middle a little concave; the upper surface evenly convex; the circular edge rather sharp, and in its whole length closely bordered with a ring of numerous capillary radiate spicula which together form a corona round the sponge like a nimbus, and in width about $^1/_5$—$^1/_7$ of the sponge's transverse diameter. The plane or somewhat concave lower surface of the sponge is sunk in the mud, and the circular rim of radiating spicula contributes essentially to secure its position, by spreading out in the mud on all sides. Of the whole sponge there is thus only the upper convex surface which projects above the mud. From this upper surface arise a greater or less number of obtusely conical, fistular processes curved in various manners, each having at its extremity a circular aperture, the so-called out-flow aperture (osculum). These fistular oscula, of which the number may vary from a very few up to 20, are always confined only to the highest part of the convex surface; between them and the circular rimmed border, there is always a tolerably wide field without any oscula (see fig. 2) which is naturally accounted for by the sponge being probably sunk in the mud considerably beyond the border-rim. The latter performs doubtless the same service as the root-fibres in other sponges; that is, it serves to fix the sponge in the soft mud in which it is found. Only in a few specimens I have found that the lower concave surface had attached itself to a small stone or to a larger shell, round which it had grown entirely; so that only a small part of the object was visible externally. The sponge must therefore properly be said to be free, not attached, but only by help of its border-rim lying, as it were, at anchor in the soft mud.

The whole sponge is of rather firm consistency, and of a white grey color. The lower surface is quite smooth, the upper convex part is on the contrary somewhat uneven or corrugated with small roundish tolerably regular elevations and depressions.

The smallest specimen which I have found (fig. 3) had already the characteristic hemispherical form. The upper convex surface had only one fistular osculum in the centre. The circular rim of spicula was already completely developed; and its width was equal to $^1/_3$ of the transverse diameter of the sponge.

When the sponge is dried, the upper convex side sinks considerably; so that it becomes nearly flat, which justifies the supposition that its interior is of a very loose texture. This is also easily ascertained by cleaving a fresh or spirit specimen along the middle. It then appears (see fig. 4) to enclose a rather large cavity filled with soft parenchym, wherein the interior support or skeleton formed of spicula is only very slightly developed. But on the other hand the dermal stratum is particularly thick, and of very firm consistency, owing in a great measure to the numerous siliceous spicula, with which it is filled. This cortical stratum is sharply distinguished from the interior parenchym, and has its greatest thickness in the middle of the lower side, where it occupies about $^1/_3$ of the height of the whole sponge, but becomes gradually thinner towards the periphery; on the upper convex side, the cortical stratum is on the contrary everywhere of uniform thickness, and about half as thick as in the middle of the lower side. The inner cavity, filled with sarcode, has therefore a crescent-like section, as the thickened lower cortical stratum rises in the centre like a watch glass. In this interior sarcode-cavity may be distinguished many irregular cavities anastomosing with each other, and bounded by thin lamellæ of parenchym, which are partly supported by spicula arranged in fascicles. These cavities shew on the whole a radial arrangement, and have their out-let above in a greater or less number of cylindrical tubes which pierce the cortical stratum, and open each at the end of one of the exterior fistular processes. The whole upper cortical stratum seems moreover to be perforated with particularly fine pores, through which the water is led into the interior of the sponge, to be afterwards emptied out through the fistular oscula.

The spicula are of 4 different kinds, which yet have all the same general form, namely the simple needle-shape. In the interior parenchym of the sponge there are found spicula almost exclusively of one sort (fig. 11) long, straight and somewhat fusiform or tapering at both ends, but so that one end always forms a bulbous enlargement (fig. 13) while the other terminates in a fine elongated point (fig. 12). These spicula, which thus according to Bowerbank's terminology must be called „fusiformi-acuate" are of very different length (from 0.60 to 5.40 Mm.) and have an evident axial canal. They are connected in long ramified fascicles which radiate (see fig. 4) from a point lying in the centre of the periphery of the sponge, but nearer to the lower than to the upper surface, or near the most prominent part of the lower cortical stratum in the interior of the sponge. These fascicles of spicula support the thin lamellæ of the parenchym which divide the interior cavity, and thence penetrate into the upper cortical stratum to the greater part of its thickness, yet without reaching to the extreme dermal layer (see fig. 5). In the lower cortical stratum, these fascicles are still much closer, and radiate on all sides almost horizontally, penetrating not the thickness, but

the length of the stratum, even to the edge of the periphery, where they become gradually mixed with spicula of another sort (fig. 14) which are much thinner and longer (up to 8 Mm.) very elastic, bristle-like, not enlarged in the middle, but evenly tapered in their whole length, and terminating in an extremely fine elongated point. These bristle-like spicula form exclusively the wide border which gives to the sponge so peculiar an appearance, and radiate on all sides standing out horizontally from the circular rim. In the upper cortical stratum no trace is to be found of these bristle-like spicula. On the contrary it derives its firmness chiefly from spicula of another form, which are also found in the lower cortical stratum near the edge, and now and then also in the interior parenchym. These spicula, which are particularly closely packed round about the ends of the long fascicles of spicula that radiate from the interior of the sponge, and have here usually a transversal position, or stand at right angles to the exterior surface and with their points turned outwards (see fig. 5) are very short (about 0.24 Mm. long) and pin-shaped (fig. 6 a) or furnished at one end with a globular enlargement or head (see also fig. 8) while the shaft itself is rather strongly enlarged in the middle, and at the other end sharply pointed (fusiformi-spinulate Bowerbank). In the exterior part of this cortical stratum, we find again spicula of a somewhat different form, although most corresponding with those last named, from which they differ by the small development of the head, this being often scarcely perceptible, and by the capillary form of the shaft scarcely enlarged in the middle (fig. 6, c). These spicula, which are about of the same length as the pin-shaped ones, are (see fig. 5) extremely closely packed, and stand all side by side at right angles to the exterior surface which they penetrate with their extreme point. These closely packed exterior spicula form, as it were, a separate thin outer layer of the cortical stratum (a–b) distinguished by a great degree of firmness, and by a lighter color than the other part.

The size of the different sorts of spicula is moreover, as already remarked, rather various; and more casual deviations in the form may not seldom be observed; this is especially the case with the pin-shaped spicula in the cortical stratum. The head is not always round in these, but often shews at the extremity a more or less prominent peg-shaped process (see fig. 10, a). In one case (fig. 10, b) this peg was quite unusually long and obliquely inclined to one side, whereby the head came to be situated at the end of the first 4th part of the length of the spiculum. In another case (fig. 9) there appeared in the middle of the spiculum a few irregular enlargements or nodulous excrescences. Very seldom there were found, especially in the lower cortical stratum, single spicula of the same sort which were more than double as long (fig. 7). Otherwise the length of the pin-shaped spicula is tolerably constant, and only varies within very narrow limits (from 0.21. to 0.28 Mm.). Between these and the capillary spicula lying in the extreme dermal stratum there were also evident transition-forms (fig. 6 b) in which the shaft although still extremely thin. shewed itself evidently enlarged in the middle. In some of these last the head was unusually wide, lancet-like or top-shaped (fig. 6, d).

This peculiar sponge occurs not rarely at Lofoten (at the fishing-places Skraaven and

Guldbrandsöerne) in a depth of 120—300 fathoms on soft clay bottom. I have not yet found it in any other place; but it is probable that when the great depths off our coast shall have been more closely examined, this sponge will also be found in many other places.

As regards the systematic place of this sponge, it is according to the nature of the spicula easy to see that it is a siliceous sponge; likewise the arrangement of the spicula shews that it belongs to the 1st group or sub-order established by Bowerbank characterised by „spiculo-radiate skeletons"; it is further easy to see that it belongs to the group named by Oscar Smith Corticata and for which the well known genus Tethea is the type. But on the other hand it will not agree with any of the formerly established genera, from which it differs as well by its characteristic form, as by its peculiar attachment and fistular oscula.

The genus may be characterised in the following manner.

Gen. **Trichostemma.** M. Sars.

Spongia silicea, simplex, libera, in limo demersa et hic fimbria spiculorum setiformium, flexibilium, radiantium sustentata, cortice crasso compacto circumdata, interiore multo minus compacto, parenchymatoso, lacunis numerosis irregularibus trajecto. Oscula numerosa tubiformia in facie superiore libere prominentia. Sceletum ex spiculis acuformibus fasciculato-radiantibus compositum, aliis brevissimis capite globoso in cortice densissime accumulatis, aliis multo longioribus, fasciculos tenues parenchyma et corticem trajicientes formantibus.

Spec. **Trichostemma hemisphæricum.** M. Sars.

Forma regulariter hemisphærica, facie inferiore plana vel paulo concava, superiore æqualiter convexa, limbo distincto circulari spiculis setiformibus tenuissimis et longissimis ubique radiantibus fimbriam latam et elegantissimam formantibus ornato. Color albido-cinereus. Diametros speciminum majorum fimbria exclusa 43 Mm. altitudo 20 Mm.

Habitat non infrequens ad insulas Lofotenses in profunditate 120—300 orgyarum, fundo argillaceo.

13. Cladorhiza abyssicola. M. Sars.

nov. gen. et spec.

(Pl. VI. fig. 16 - 34).

This remarkable sponge living in the great depths at Lofoten, has also such a peculiar and characteristic exterior, that it is immediately known from all other sponges; and indeed one might, at a cursory glance, be tempted not to consider it to be a sponge at all, but rather some animal of the polyp kind, for instance a Sertularide, or a Polyzoon.

The sponge consists (see fig. 16 & 17) of a main stem, the lower end of which divides itself into numerous finely ramified roots, by which it is fixed in the ooze. From this main stem — at a greater or less distance from the root, and at nearly right angles on different sides — issue undivided lateral branches of the same nature as the stem, and like it, terminating in a somewhat enlarged obtusely rounded point. Everywhere, as well from the stem as from the side-branches, there issue again secondary continuations in the form of thin conical pointed and somewhat curved processes, all about of the same length, and usually arranged, with short intervals, circularly around the stem or side-branches. Towards the extreme end of the latter they become gradually shorter and more obtuse (see fig. 21) and at last they disappear entirely, so that it looks as if the enlarged end had been produced by a confusion of these processes with each other and with the branches. As regards the side-branches themselves they are of somewhat different length, and seem usually to be longest nearer to the base of the sponge, and to decrease successively in length towards the point of the stem. The branches as well as the main stem are very thin, of the same thickness, and mostly quite straight. But on the other hand the secondary processes are as already stated, always more or less strongly and evenly curved towards the point in one direction or in another, and strongly compressed laterally.

The color is in fresh specimens yellowish transparent, more or less going over to reddish yellow; and the height of the largest specimens is about 60 Mm.

Such is the exterior appearance of this peculiar sponge, which, as may be seen, is very different from anything previously known.

Closer investigation shews that the whole sponge is supported, and receives its form by means of numerous very long siliceous spicula of the form called by Bowerbank fusiformi-acuate, which lie longitudinally close together, and are united with each other by a cementing substance in close and solid fascicles. These needle-shaped spicula form everywhere the more solid axis, round which the organic parts lie. In the main stem they form a continuous fascicle (see fig. 18) which at the basis gradually resolves itself into thinner and thinner fascicles (see fig. 23) continued through the branched roots into which the stem divides itself. At the base of these roots the spicula are still surrounded by an exterior organic stratum; but this soon disappears entirely; and the exterior ramifications are formed exclusively by the spicula themselves, the fascicles of which continue branching, becoming at the same time thinner and thinner, until the last ramifications only consist of 2 single rows, in which the spicula are arranged, not side by side but alternating, and so that the ends of the spicula in each row lap over each other, or wedge themselves in between the preceding ones in the same row and the corresponding ones in the second row (see fig. 24); each of these terminal ramifications ends, when in a perfect (uninjured) state, in one single spiculum.

From the fascicle of spicula in the main stem, there issue in the side-branches similar fascicles, the innermost spicula of which are wedged with their extremities in between the spicula of the main stem. Also in the numerous tapered processes which are arranged cir-

cularly around the stem and the branches, thin fascicles of the same sort of spicula occur in the same manner; so that their basis frequently rests on several fascicles diverging towards the main axis (see fig. 18) while the process otherwise (fig. 19) only contains one single thin fascicle, which is continued centrally up to the very point. In the enlarged end of the branches these central spicula are very irregularly arranged; although they appear usually to exhibit a radial arrangement; their points are seen protruding (fig. 21) on all sides through the outer skin.

On examining more closely these central spicula, we find them, wherever they form the solid axis, of tolerably similar appearance and size (fig. 25), about 0.60 Mm. long, perfectly straight, thickest in the middle, and evenly tapering towards both extremities, of which one is simply rounded (fig. 28) and the other shortly pointed (fig. 27); in the interior there may be observed a distinct but extremely fine axial canal. Only in the extremities of the branches there are found, among the normal spicula, some few considerably shorter (scarcely half as long) which are not perceptibly enlarged in the middle, and the proximal extremity of which often shews an irregular curve towards one of the sides, (fig. 26).

The organic substance forms everywhere a tolerably thick stratum, which surrounds the spicular axis (see fig. 18) and in which there are found imbedded some few needle-shaped spicula apparently detached from the axis. Otherwise it makes a uniform parenchym, wherein absolutely no canals or cavities can be discerned. Outwardly this parenchym is covered with a more solid dermal layer, in which are found imbedded numerous spicula of a figure quite different from that of the central spicula above noticed. Three different sorts of them are to be distinguished, all belonging to the group named by Bowerbank „retentive spicula“. The largest of these (fig. 29 & 30) the length of which scarcely exceeds 0.10 Mm. are simply two-hooked (bihamate) and are rather scantily distributed round the stem and the branches with their processes (see fig. 18), but more plentifully in the enlarged ends of the branches (see fig. 22). The second form of superficial spicula (fig. 33) which I have found only in the enlarged ends of the branches, but here in rather considerable number (see fig. 22), are like the former bihamate, but much thinner and smaller (only 0.04 Mm. long) and decidedly distinguished by the incurved hooks not lying in the same plane but inclining to different sides, often so that they lie nearly opposite, giving to the spiculum the form of a more or less distinct S. They thus belong to what Bowerbank calls contort bihamate spicula. The 3rd and last form (fig. 20. 31. & 32) belongs to the inequi-anchorate spicula; and these are found in quite extraordinary numbers everywhere in the outer skin, particularly at the ends of the secondary processes, very closely packed together (see fig. 19). They are remarkably small (only 0.02 Mm. long) so that their exact figure cannot be represented, unless by application of the highest magnifying power. They appear (see fig. 32) to consist of a somewhat curved stem enlarged at both the bent ends, but much more at one end than at the other. Both ends seem (fig. 32 a) to terminate in 3 sharp hook-like, somewhat flattened, acutely pointed teeth; but at the one end these teeth are so small that they can only be discerned

with the greatest difficulty, while at the other end they are very large and crooked inwards. Usually only 3 such teeth appear; but in some (fig. 32 b) it was evident that behind these there were still a couple of teeth; so that the teeth were on the whole 5 in number. Whether this applies to all or only to some, the position of which happened to be more favorable, I am not able with certainty to decide. By means of these innumerable microscopic „claws“ which project everywhere from the surface of the sponge, all the more minute animals and the light floating particles which come into immediate contact with the sponge, become attached to it, and thus probably fulfil an essential condition for its nourishment. The specimens which I got up in the dredge shewed also a very peculiar appearance; an infinity of small creatures adhering to it, especially various sorts of Calanus, small Amphipodes, and young Annelides, which adhered so closely that I had the greatest difficulty in cleansing the sponge from all these extraneous bodies. These small animals came probably for the most part in contact with the sponge, by being taken up in the dredge together with it; but that a similar occurrence, even if on a smaller scale, would take place normally in the deep, I consider very probable. As there appears here no trace of any pores interior cavity or oscula, the alimentation must be supposed to be effected by a process different from that which takes place where these apparatus exist.

If a small piece from the end of a branch is taken and treated with a weak solution of caustic potass to make it transparent, there will appear in it under the microscope (fig. 22) a peculiar structure of the parenchym, which is not found elsewhere. It will be observed that there are imbedded in this part numerous small globular bodies, with finely granular contents, occurring in greatest numbers near the surface, but which seem also to be found in the central part. It seems indubitable that we have here the place from which the reproduction of the sponge proceeds. In one of the specimens obtained (fig. 16) there were observed in the branches themselves, and partly also in the main stem, imbedded here and there in the parenchym, between the interior spicular axis and the exterior skin, several globular bodies many times larger, easily discernible by the naked eye from their darker yellowish red color and greater opacity. These bodies, which under the microscope exhibited a cellular consistency (see fig. 34) are undoubtedly the fully developed eggs or gemmules. These had certainly not developed themselves in the place where they lay imbedded, but had in all probability been generated at the extremities of the branches, and in the process of development at last become free or released from the cellular tissue wherein they had originated, and thence distributed themselves around in the soft parenchym of the sponge.

I have only found this remarkable sponge in one single locality, namely at the fishing station Skraaven in Lofoten at the great depth of 300 fathoms on soft clay bottom. The specimens obtained are of very unequal size, but exhibit all the same characteristic shrub-like form. The largest and most perfect specimen, which is delineated fig. 17, had 14 branches springing out from the stem at different heights; the lowest about half the length of the main stem, not reckoning the root; the others successively shorter. Close under the

place where the side-branches commenced, a little Arca pectunculoides was attached to the stem by its byssus (a).

By its highly characteristic form, and peculiar attachment, this sponge differs from all other known forms. The arrangement of the central spicula in close axial fascicles, from which again radiate other smaller fascicles in the single processes, seems to shew that it must be more nearly referable to the 1st of the groups of siliceous sponges, established by Bowerbank, and characterised by a spiculo-radiate skeleton. Of the genera belonging to this group, the genus *Hymedesmion* is that, which in respect of the structure of the superficial retentive spicula, appears to approach it most closely; but the species of this genus are of a quite different form, namely consisting of thin crusts over extraneous bodies (shell &c.). It exhibits moreover some conformity in the structure of the spicula with the genus *Desmacidon*, which belongs to quite another group, distinguished by a spiculo-fibrous skeleton. The form is however here entirely different; and the skeleton cannot either be properly called fibrous; unless the whole sponge can be considered as one single ramified fibre.

The genus may be characterised in the following manner.

Gen. **Cladorhiza.** M. Sars.

Spongia silicea ramosa, fasciculis densis spiculorum acuformium axem solidam formantibus sustentata, radiculis numerosis arborescentibus ex spiculis ejusdem generis formatis in limo affixa. Parenchyma axem internam corticis instar circumdans spiculis superficialibus anchoratis et bihamatis ornatum. Oscula et pori nulla. Ova in apicibus dilatatis ramorum se evolventia.

Spec. **Cladorhiza abyssicola.** M. Sars.

Spongia ex stirpe composita tenui erecta ad basin in fibrillas radicales numerosas arborescentes se dividente, de cujus parte superiore exeunt undique radiantes rami laterales simplices, recti, latitudine eadem ac stirps ipsa et apice tumefacto terminati. Stirps in tota fere longitudine et rami processibus numerosis subæqualibus attenuato — conicis, subarcuatis, lateraliter compressis, fasciculis spiculorum centralium sustentatis circumcirca ornata. Parenchyma axem spiculosam ubique (radiculis exceptis) investiens, simplex, sine lacunis interstitiisve, membrana vero ornatum externa distincta spiculis numerosissimis minimis inæqualiter anchoratis in processibus conicis imprimis dense accumulatis instructa, inter quæ obveniunt alia multo majora bihamata sparsa in apicibus ramorum tamen frequentiora et cum illis hic etiam spicula alia multo tenuiora bihamata sed hamulis in directiones diversas vergentibus insignia. Ova (vel gemmulæ) magna spiculis omnino carentia in parenchymate ramorum et stirpis libere accumulata. Color dilute pallide-fulvus. Altitudo speciminum maximorum 60 Mm., latitudo stirpitis et ramorum 1 Mm., longitudo processuum secundarium 3—5 Mm.

Habitat rara ad insulam Lofotensem Skraaven in profunditate 300 orgyarum fundo argillaceo.

14. Hyalonema longissimum. M. Sars.

n. sp.

(Pl. VI. fig. 35—45).

Among the deep-sea sponges, which I have occasionally taken up in the dredge at Lofoten together with other marine animals, I had already during my first stay there (in 1864) noticed one form distinguished by its peculiar appearance. I therefore kept very carefully all the specimens I could obtain, in order to examine them afterwards. My Father thought at first that we had before us a very anomalous new genus, which he in his notices called preliminarily Chætoropalium (Bristle-club). A short time afterwards Professor Lovén's interesting and important treatise on the Hyalonema boreale came out, in which paper the author describes a very similar form, shewing its near relationship to the problematic „glas roop Spongia" (Hyalonema), long ago well known from the Japan Sea, and completely correcting the numerous misconceptions of the nature of this remarkable sponge. That the form from Lofoten belongs to the same genus as Lovén's species, is sure enough; nay it stands so near to it, that I have even been in great doubt as to the validity of our form as a distinct species; and the more so because its dissimilarity seemed chiefly referable to the exterior shape, which in sponges is known to be usually very variable in the several individuals. It seems however that in some cases, even the exterior form of sponges may exist with great constancy within certain limits; and to this category the genus Hyalonema seems precisely to belong, as well as the 2 sponges mentioned in the foregoing lines. I have had occasion to examine a great many specimens of the Lofoten Hyalonema, and have found in them all a remarkable agreement in this respect; and I have also had the opportunity, through the kindness of Professor Lovén, of comparing them with other specimens. probably of the same species, from widely different localities, namely from the Atlantic Ocean, and from the sea near Greenland; and also in these have found the same differences from the H. boreale Lovén as the Lofoten specimens exhibit. On the other hand there was among the Greenland Hyalonema, a magnificent specimen which immediately shewed a very different habitus, and in this respect very closely corresponded with the specimens described by Lovén as H. boreale which I have also had sent to me for comparison. As there does not therefore appear to be any evident transition between these 2 northern Hyalonemes, I cannot do otherwise than consider the form here noticed as a proper species, although very nearly allied to the H. boreale; and I note it here under the specific name preliminarily applied to it by my Father.

The length or the height of my largest specimens is 75 Mm. that is considerably greater than in those described by Lovén as H. boreale. But the whole form (see fig. 35. & 36) is far more slender and delicate; and it is specially the very different proportion between the body or head of the sponge and the stem, that immediately strikes the eye and has also given rise to the specific appellation. While in the H. boreale, the proportion of length be-

tween the head and the stem is as 1 : 3, it is here as 1 : 6 or 8; in other words the stem is here proportionally double as long as in the H. boreale, and proportionally much thinner.

Usually the stem exhibits a more or less strong but even curve on one side, and is everywhere cylindrical, increasing quite evenly in thickness towards the base which often forms a great enlargement (see fig. 46) at the place where the root-fibres begin to appear. This part of the stem sunk in the ooze, and which may fitly be called the root, is curved in various ways; sometimes (see fig. 35) even in a right angle, but everywhere so thickly covered with the numerous sinuous root-fibres full of extraneous matter, that its shape is often not easily discernible. I have however always found that its extremity tapers again, and gradually resolves itself into terminal root-fibres.

As to the root-fibres themselves, they are of very solid consistency, and so tough that they cannot be pulled asunder without difficulty. They are (fig. 41) rather transparent, of yellowish color, and apparently in their interior of a perfectly homogenous compact structure. Usually they exhibit a cylindrical form, which is retained even under strong pressure; they are variously contorted and ramified, and are everywhere covered with extraneous matter of different sorts (Rhizopod-shells, siliceous spicula, grains of sand &c.) so adherent as not to be entirely removed without considerable trouble.

The body or head of the sponge (fig. 37) is club-shaped, with the upper surface more or less flattened, yet most frequently so that such flattening is not at right angles with the axis but somewhat oblique, From the highest side rises a very remarkable conical process terminating in an opening, which is bounded by long projecting spicula and leads to the interior of the sponge. This fistular process, which represents the out-flow aperture (osculum) is usually situated on the edge of the head, so that its exterior side is flush with the side surface of the head. Such I have found to be the case in nearly all the numerous specimens from Lofoten which I have examined. Only in 1 specimen in which the head was unusually thin and elongated, and probably on account of an accidental mutilation rather irregularly shaped, the osculum was a little within the edge of the upper surface (here more directly truncated) but still far removed from the centre.

In the H. boreale there is also (at least in one of the specimens examined by Lovén) a single widely gaping out-flow aperture on the upper side of the head; but this aperture is firstly not fistular nor prominent, and next, it is situated nearly in the centre of the upper surface, which is also clearly the case in the specimen from Greenland before-mentioned, which I presume belongs to the same species.

The whole head is moreover everywhere hirsute with rather long projecting fine spicula, which together form, in whatever position the sponge is viewed, a tolerably wide transparent border around the head. These spicula projecting from the exterior skin are also found in the H. boreale, but are proportionally shorter and less conspicuous.

The color is greyish brown; in very small specimens much lighter or nearly yellowish white.

As to the interior structure form and arrangement of the spicula, I can refer entirely to Professor Lovén's masterly treatise; as in these respects both species are very similar. I shall only notice a few points which possibly might indicate a specific difference.

The spicula of the stem do not exhibit in any of my specimens an evident spiral arrangement, but only lie (see fig. 40) longitudinally sometimes rather irregularly, so that one has its point turned a little more to one side, and another more towards the other side. Their form and length are moreover (fig. 42. a) almost exactly as in the H. boreale. Only it seems to me that the medial enlargement in the present species is less sharply marked; often it is (see fig. 43) so slight that it cannot be discovered without attentively tracing the successive increase of the spiculum from both extremities. In some spicula there may be remarked (ibid) a very clearly defined interior outline, in some (a) situated nearer to the axial canal, in others (b) nearer to the exterior surface, and which appears to indicate 2 different strata; in most of them however the substance of the spiculum exhibited everywhere complete homogeneity.

In a longitudinal central section of the head, it appears (fig. 38) that the spicula of the stem do not as in the H. boreale run conically into the interior of the club, but spread themselves out fan-like in close diverging fascicles, whence again the secondary small fascicles which support the parenchym radiate to the sides and upwards. On making the longitudinal section through the fistular osculum, it will be seen that the latter forms a very large and wide cavity, which reaches deep into the body of the sponge and here communicates with other smaller cavities. The dermal part of the body of the sponge forms (see fig. 36) as it were a sort of cortical layer, which however is not sharply distinguished from the interior parenchym, and owes its solidity principally to the extremely numerous minute fusiform spicula (fig. 42, f) packed together without order, which are also characteristic of the skin of the stem (see fig. 40). From this dermal stratum proceed again (see fig. 39), at right angles with the exterior surface of the sponge, the numerous fine terminally curved spicula (fig. 45) which produce, in the perfect specimens, the very conspicuous silky exterior down that surrounds the whole head.

As to the exterior surface of the head, it appears under the microscope rather regularly punctated; and this is especially plain in younger specimens. Each of the points seems to be a fine pore leading into the substance of the sponge. In older specimens this fine porous structure is less evident, chiefly on account of the various extraneous particles always lodged between the projecting spicula, such as ooze, fine sand &c. which are not easily removed.

I have only met with the present sponge in the great depths at Lofoten. It occurs there occasionally at the fishing-stations Skraaven and Guldbrandsöerne in 120—300 fathoms water on soft clay bottom.

It has however in all probability a far wider distribution, namely both in the great depths of the Atlantic Ocean and in the Arctic Ocean around Greenland, presuming that the specimens sent to me by Professor Lovén for comparison should really turn out, on more

minute examination, to belong to this species. We may characterise our species in the following manner.

Hyalonema longissimum. M. Sars.

Forma gracillima et elongata, capite clavato, supine plerumque oblique truncato, osculo singulo, magno, tubiformi, longe porrecto, marginali instructo, ubique pluma densa spiculorum induto; stirpe longissima et tenuissima, 6ies—8ies capite longiore, basin versus sensim latiore, radice plus minusve dilatata et curvata fibrillas numerosas flexuosas et arborescentes emittente. Spicula stirpis vix spiraliter disposita in capitis interiore divergentia fasciculum formantia magnum et latum, de quo fasciculi tenues spiculorum similium sed minorum parenchyma capitis sustendentes radiant. Osculum cum cavo magno interno communicat. Color fusco-cinereus, Longitudo maximorum 75 Mm.

Habitat non infrequens ad insulas Lofotenses in prof. 120—300 orgyar, radice in argillo immersa.

What therefore distinguishes our species from the very nearly related H. boreale Lov. is: the far slighter and thinner form; the very unequal proportion between the head and the stem; the situation and shape of the out-flow aperture (osculum) the proportionally longer spicula projecting from the exterior skin, and the arrangement of the axial part penetrating into the interior of the head, which does not run conically, but spreads out fan-like into a wide and thick fascicle of spicula.

The characteristic form for the Hyalonema: a club-shaped enlarged part, borne at the extremity of a long and thin stalk or stem, the other end of which is sunk in the ooze, and there attached by means of numerous root-fibres, is certainly something quite unusual in this class, but does not appear to be exclusively confined to the genus Hyalonema. On the journey which my Father and I undertook together in the summer 1869 to examine the Fauna of the Hardangerfjord, my Father discovered in the ooze brought up by the dredge from a great depth (150—300 fathoms) a number of specimens of a minute sponge, which had a very similar habit to that of the H. longissimum already previously found by me at Lofoten, but in certain points exhibited a constant dissimilarity; for which reason also my Father noted it preliminarily as a new species of Hyalonema under the appellation H. parvum. The closer examination to which I have subsequently subjected this supposed Hyalonema has however shown that it belongs to an entirely different generic type; the spicula being formed according to quite a different type; as also the interior structure of the head seems to be very different: The spicula in the head are proportionally of quite an enormous size, and mostly belong to the form of connecting spicula which are named by Bowerbank „furcated attenuato-patento-ternate“; among these are found in the exterior skin extremely small star-shaped siliceous deposits. The Spicula in the stem are not, as in the Hyalonema, fusiform with a medial enlargement, but simply needle-shaped.

Fig. 15. A calcareous joint, with a lateral process in the middle (rudiment of a lateral branch).
— 16. An unusually short and thick calcareous joint.
— 17. An other likewise unusually thick but more elongated and somewhat twisted calcareous joint.
— 18. The root of an unusually large colony; side view.
— 19. The same, seen from above.
— 20. A single root-blade greatly enlarged at the extremity, seen from the outer side.
— 21. The same, from the inner side.
— 22. The lower part of a colony, with abnormally developed root, seen from the side.
— 23. The same, seen from above.

Fig. 24—32. **Fungiacyathus fragilis.**

Fig. 24. A specimen with the animal seen from above, not quite twice the natural size. The ciphers indicate the different orders of septa.
— 25. The same, seen from below.
— 26. An other specimen with more enlarged bucal aperture.
— 27. The same, seen from below.
— 28. One of the inner tentacles, with a piece of the skin investing the corresponding primary septum, more strongly magnified.
— 29. The skeleton of a 3rd specimen, seen from the side, shewing the high thin septa. *1. 2. 3* the primary, secundary, and tertiary septa.
— 30. The same specimen seen from above. *1* the primary septa.
— 31. One of the primary septa, seen from above.
— 32. The same, seen from the side.

Pl. VI.

Fig. 1—15. **Trichostemma hemisphæricum.**

Fig. 1. The largest specimen found, seen from above, natural size.
— 2. The same specimen, seen from the side.
— 3. One of the smallest specimens obtained, with only a single osculum, seen from above.
— 4. An other specimen, cut through the middle, shewing the interior parenchymatous cavity and the exterior cortical stratum, with 2 of the fistular oscula in section.
— 5. A thin lamella, cut out of the sponge perpendicularly to the surface, strongly magnified, shewing the arrangement of the spicula. *a-c* the cortical stratum; *a-b* the dermal layer of the same; *c-d*, the interior parenchym.
— 6. Pin-shaped (fusiformi-spinulate) spicula from the cortical stratum. *a*, the ordinary form; *b*, a very thin spiculum, which however still shews the fusiformi-spinulate shape; *c*, one of the spicula which are closely packed in the dermal layer; *d*, the head and base of the shaft of a somewhat abnormal spiculum of the same sort.

Fig. 7. An unusually elongated spiculum, of the fusiformi-spinulate form, from the lower cortical stratum.
— 8. The head and basis of the shaft of the same.
— 9. A fusiformi-spinulate spiculum, with lateral excrescences.
— 10. 2 spicula of the same sort, with abnormally shaped head.
— 11. One of the long needle-shaped spicula from the radiating fascicles that penetrate the parenchym.
— 12. The pointed end of the same, strongly magnified.
— 13. The opposite bulbously enlarged end.
— 14. The outer part of one of the marginal bristle-shaped spicula.
— 15. The thicker end of a similar spiculum.

Fig. 16—34. **Cladorhiza abyssicola.**

Fig. 16. A perfect specimen, with developed gemmules in the interior of the parenchym, slightly magnified.
— 17. An other more ramified specimen, also slightly magnified. *a*, an Arca pectunculoides attached to the stem.
— 18. A piece of stem with basis of one of the lateral processes, treated with a weak solution of caustic potass, shewing the arrangement of the spicula.
— 19. The extremity of one of the lateral processes, shewing the central fascicle of spicula, and the superficial closely packed inequi-anchorate spicula.
— 20. Some of the latter, more strongly magnified.
— 21. The extremity of a branch, shewing the club-shaped enlarged point.
— 22. A small portion of the extremity of a branch treated with caustic potass and compressed, more strongly magnified; shewing the gemmules in process of formation, and the 4 different sorts of spicula.
— 23. A piece of the ramified root, shewing the fascicles of spicula gradually becoming disunited.
— 24. One of the extreme ramifications of the root, more strongly magnified, shewing the arrangement of the spicula in the same.
— 25. One of the central spicula of the stem.
— 26. One of the smallest central spicula from the extremity of a branch.
— 27. The pointed ends of 2 different central spicula.
— 28. The obtuse end of the same.
— 29. One of the simply bihamate spicula; side view.
— 30. A somewhat smaller Do. seen from the side and below.
— 31. 3 of the inequi-anchorate spicula, magnified to the same degree.
— 32. The same sort of spicula, more strongly magnified. *a*, as they most usually shew themselves; *b*, with 5 distinct hooks (rare).

Fig. 33. 3 of the contort-bihamate spicula from the extremity of a branch (magnified to the same degree as the simple bihamate).

— 34. A fully developed gemmule taken out of the parenchym of the sponge.

Fig. 35—45. **Hyalonema longissimum.**

Fig. 35. 1 specimen with an unusually short stem, and much enlarged rectangularly bent root, very slightly magnified.

— 36. 1 other specimen with a longer stem and less enlarged root.

— 37. The head or body with the upper part of the stem of a young specimen; shewing the fistular osculum, the exterior down of spicula, and the fine pores in the skin.

— 38. The head of an other specimen split along the middle; shewing the fan-like expansion of the spicula of the stem in the interior, the great interior cavity opening into the fistular osculum, and the parenchym with its lacunes and interstices.

— 39. A thin lamella cut from the head perpendicularly to the surface; shewing the radiating fascicles of spicula, the dermal layer and the exterior spicula.

— 40. A piece of the stem; the lower part with its exterior skin; the upper part shewing the arrangement of the spicula in the axis.

— 41. A root-fibre, strongly magnified and partly freed from the adherent extraneous particles.

— 42. Spicula: *a*, of the stem; *b*, *c*, *d*, of the secundary radiating fascicles in the interior of the head; *e*, one of the spicula projecting beyond the skin; *f*, some of the small spindle-shaped spicula irregularly imbedded in the dermal stratum (all equally magnified).

— 43. The middle of 2 of the fusiform spicula from the parenchym of the head, strongly magnified; shewing the very slightly marked medial enlargement, the axial canal and the 2 different layers in the substance of the spicula.

— 44. The end of one of these spicula.

— 45. One of the exterior projecting spicula, strongly magnified.

Pl. VI.

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45.

C. O. Sars del.

Lövendal sc.

1–15 Trichostemma hemisphaericum
16–34 Cladorhiza abyssorum
35–45 Hyalonema lusitanicum