

## Sponge-collecting from a drifting ice floe: the Porifera obtained in the Kara Sea by the Dutch Polar Expedition 1882-83

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### Abstract

Sponges from the Kara Sea (Arctic Russia) collected by the Dutch Polar Expedition 1882-83 are identified and discussed. The expedition experienced an unfortunate course of events, as the research vessel RV 'Varna' was ice-bound and eventually got crushed by ice, leaving the crew and the scientists stranded on an ice floe drifting around in the Kara Sea. The scientists still managed to do many observations and made collections of bottom animals lowering collecting gear through a hole in the ice. After being enclosed for more than a year in the ice, the men travelled in small boats and sledges to the mainland of Russia and from there returned home. The zoological collections were brought to Copenhagen by the Danish research vessel RV 'Dijmphna', from where the material was picked up by the Dutch scientists. Most animal groups were subsequently discussed in a series of papers published in the *Bijdragen tot de Dierkunde* volume 14 (1887). The sponges of the Dutch Polar Expedition were in a rather bad condition when they arrived in Amsterdam and possibly for that reason were largely ignored. They nevertheless appear to be interesting and are here presented as a belated contribution to the 1887 issue, including the description of a species new to science, *Lycopodina ruijsi* sp. nov. The results are discussed in the framework of our present knowledge of the sponge fauna of the Kara Sea. In Appendix ten already known species are briefly described and SEM images of their spicules provided as a contribution to Kara Sea sponge morphology,

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### Introduction

The present study is a belated report on the sponges of the Kara Sea collected by the Dutch Polar Expedition of 1882-83 (Snellen, 1886; Snellen and Ekama, 1910). This expedition was intended foremost as a meteorological contribution to the 1<sup>st</sup> International Polar Year. The expedition plan was to travel by ship (the hired Norwegian RV 'Varna') to the mouth of the Yenisei River, in Western Siberia, and to spend the winter period observing weather conditions and measuring a large number of meteorological parameters. The opportunity was taken to make also observations of the natural history of the region, which included collecting arctic bottom fauna. The expedition was ill-fated due to the loss of the ship in the Kara Sea, caused by crushing ice masses. By chance, the Danish research vessel 'Dijmphna' became ice-bound alongside of the 'Varna' and the two vessels and their scientific staff and crews shared almost a year of drifting - lodged firmly in the ice floe - along with the currents of the Kara Sea. The 'Dijmphna' remained intact, while the Dutch during and after the demise of the 'Varna' were living on the ice in a prefabricated house brought along. In the fall of 1883, the Dutch expedition members travelled to the mainland by sledges and boats, leaving the heavier instruments and collections on board the 'Dijmphna'. Shortly before the next winter arrived, the 'Dijmphna' became freed of the ice and managed to return to Copenhagen.

In spite of these setbacks, many of the original aims of the Dutch Polar Expedition were still achieved, as the crew and the scientists were able to do their observations from the drifting ice. The Dutch natural history collections were picked up from Copenhagen by expedition members and were deposited in the collections of the Zoological Museum of the University of Amsterdam, now part of the Naturalis Biodiversity

Table 1. Stations of the Dutch Polar ('Varna') Expedition which yielded sponges, as noted by J.M. Ruijs (from Ruijs, 1887). Collecting gear indicated by the French 'faubertage' involved the use of so called swabs made of hemp in which spiny or wiry bottom organisms become tangled (see Tendal, 2002). The 'large dredge' was rectangular and measured 40 × 70 cm. Bold printed rows indicate stations that were mentioned on one or more of the labels of the 30 specimens that survived from the collecting activities of the Dutch Polar Expedition.

| Station   | day       | month    | year        | latitude      | longitude     | depth        | bottom            | gear                | sponges noted                 |
|-----------|-----------|----------|-------------|---------------|---------------|--------------|-------------------|---------------------|-------------------------------|
| 1         | 8         | 8        | 1882        | 70.483        | 52.6          | 122          | sand with stones  | large dredge        | a few                         |
| 2         | 16        | 8        | 1882        | 69.917        | 58.9          | 77.4         | loam with sand    | large dredge        | a few                         |
| <b>3</b>  | <b>1</b>  | <b>9</b> | <b>1882</b> | <b>70.25</b>  | <b>60.417</b> | <b>192.8</b> | <b>brown loam</b> | <b>large dredge</b> | <b>some cup sponges</b>       |
| 5         | 27        | 9        | 1882        | 70.133        | 64.1          | 111.8        | grey loam         | small dredge        | a few                         |
| 10        | 29        | 1        | 1883        | 71.05         | 64.567        | 106.4        | brown mud         | large dredge        | some cup sponges              |
| 12        | 2         | 2        | 1883        | 71.067        | 64.333        | 108          | grey loam         | large dredge        | some cup sponges              |
| <b>20</b> | <b>20</b> | <b>2</b> | <b>1883</b> | <b>71.133</b> | <b>64.45</b>  | <b>91.8</b>  | <b>grey loam</b>  | <b>large dredge</b> | <b>no sponge recorded</b>     |
| 15        | 12        | 2        | 1883        | 71.017        | 64.0          | 108          | grey loam         | large dredge        | some cup sponges              |
| 22        | 24        | 2        | 1883        | 71.217        | 64.717        | 107.1        | brown mud & sand  | large dredge        | cup sponges & other           |
| 23        | 26        | 2        | 1883        | 71.283        | 64.833        | 119.5        | grey loam         | large dredge        | one                           |
| 24        | 27        | 2        | 1883        | 71.333        | 64.883        | 138.6        | loam              | large dredge        | cup sponges & other           |
| 27        | 5         | 3        | 1883        | 71.617        | 65.117        | 149.4        | greyblue loam     | large dredge        | one                           |
| 29        | 8         | 3        | 1883        | 71.6          | 65.05         | 135.9        | grey loam         | faubertage          | a few                         |
| 31        | 12        | 3        | 1883        | 71.667        | 64.817        | 118.8        | grey loam         | faubertage          | a few                         |
| 32        | 15        | 3        | 1883        | 71.667        | 64.883        | 134.1        | grey loam         | faubertage          | one                           |
| 34        | 19        | 3        | 1883        | 71.567        | 64.633        | 123.3        | grey loam         | faubertage          | many specimens of one species |
| 37        | 27        | 3        | 1883        | 71.55         | 64.717        | 97.2         | brown loam clumps | large dredge        | three species                 |
| 38        | 29        | 3        | 1883        | 71.55         | 64.75         | 105.3        | brown mud         | faubertage          | young cup sponges             |
| 39        | 31        | 3        | 1883        | 71.55         | 64.783        | 109.8        | brown mud         | faubertage          | a few                         |
| 40        | 2         | 4        | 1883        | 71.483        | 64.867        | 99.9         | brown mud         | faubertage          | one                           |
| 43        | 11        | 4        | 1883        | 71.6          | 64.967        | 121.5        | brown mud         | faubertage          | a few                         |
| 45        | 14        | 4        | 1883        | 71.717        | 65.217        | 147.6        | brown mud         | faubertage          | a few                         |
| 46        | 16        | 4        | 1883        | 71.733        | 65.417        | 158.4        | brown mud         | faubertage          | two                           |
| 48        | 23        | 4        | 1883        | 71.65         | 64.967        | 140.4        | brown mud         | faubertage          | one                           |
| 49        | 27        | 4        | 1883        | 71.583        | 64.817        | 124.2        | brown mud         | faubertage          | a few                         |
| 50        | 29        | 4        | 1883        | 71.633        | 64.867        | 90           | grey loam         | large dredge        | one                           |
| 51        | 4         | 5        | 1883        | 71.517        | 64.217        | 84.6         | brown mud         | faubertage          | two                           |
| 52        | 5         | 5        | 1883        | 71.55         | 64.233        | 79.2         | brown mud         | faubertage          | a few                         |
| 53        | 7         | 5        | 1883        | 71.517        | 64.267        | 88.2         | brown mud         | faubertage          | a few                         |
| 54        | 10        | 5        | 1883        | 71.483        | 64.283        | 91.8         | brown mud         | faubertage          | three species                 |
| 55        | 12        | 5        | 1883        | 71.433        | 64.283        | 92.7         | brown mud         | faubertage          | young cup sponges             |
| <b>56</b> | <b>15</b> | <b>5</b> | <b>1883</b> | <b>71.417</b> | <b>64.267</b> | <b>91.8</b>  | <b>grey loam</b>  | <b>faubertage</b>   | <b>one</b>                    |
| 57        | 17        | 5        | 1883        | 71.367        | 64.283        | 126          | brown mud         | faubertage          | one                           |
| 59        | 23        | 5        | 1883        | 71.417        | 64.15         | 90           | grey loam         | faubertage          | young cup sponges & one other |
| 60        | 26        | 5        | 1883        | 71.317        | 64.05         | 100.8        | grey loam         | faubertage          | three species                 |
| 61        | 29        | 5        | 1883        | 71.333        | 63.95         | 99           | grey loam         | faubertage          | three                         |
| 62        | 1         | 6        | 1883        | 71.317        | 63.933        | 102.6        | grey loam         | faubertage          | three                         |
| 63        | 4         | 6        | 1883        | 71.283        | 64.1          | 100.8        | grey loam         | faubertage          | cup sponges & other           |
| 64        | 7         | 6        | 1883        | 71.283        | 64.1          | 109.8        | brown mud         | faubertage          | four species                  |
| 65        | 9         | 6        | 1883        | 71.267        | 64.133        | 138.6        | grey loam         | faubertage          | one                           |
| 66        | 12        | 6        | 1883        | 71.2          | 64.1          | 99           | brown mud         | faubertage          | a few                         |
| 67        | 15        | 6        | 1883        | 71.217        | 64.25         | 106.2        | brown mud         | faubertage          | one                           |
| <b>68</b> | <b>18</b> | <b>6</b> | <b>1883</b> | <b>71.3</b>   | <b>63.517</b> | <b>135</b>   | <b>grey loam</b>  | <b>faubertage</b>   | <b>three species</b>          |
| 69        | 19        | 6        | 1883        | 71.317        | 63.567        | 118.8        | grey loam         | large dredge        | cup sponges & two other       |
| <b>70</b> | <b>20</b> | <b>6</b> | <b>1883</b> | <b>71.333</b> | <b>63.633</b> | <b>135</b>   | <b>grey loam</b>  | <b>large dredge</b> | <b>two</b>                    |
| 71        | 23        | 6        | 1883        | 71.317        | 63.6          | 153          | greyblue loam     | large dredge        | one                           |
| 72        | 25        | 6        | 1883        | 71.25         | 63.6          | 169.2        | brown mud         | large dredge        | one                           |
| 73        | 30        | 6        | 1883        | 71.2          | 63.6          | 137.7        | brown mud         | faubertage          | one                           |
| 74        | 3         | 7        | 1883        | 71.1          | 63.267        | 126          | brown mud         | faubertage          | a cup sponge and one other    |
| 75        | 6         | 7        | 1883        | 71.1          | 63.067        | 136.8        | brown mud         | faubertage          | one                           |
| 78        | 16        | 7        | 1883        | 71.083        | 62.7          | 136.8        | greyblue loam     | large dredge        | one                           |
| 79        | 18        | 7        | 1883        | 71.067        | 62.75         | 138.6        | brown mud         | large dredge        | one                           |
| 80        | 20        | 7        | 1883        | 71.1          | 62.8          | 135.9        | grey loam         | large dredge        | cup sponges                   |
| 81        | 23        | 7        | 1883        | 71.083        | 62.867        | 131.4        | brown mud         | large dredge        | one                           |
| 82        | 26        | 7        | 1883        | 71.083        | 62.75         | 132.3        | brown mud         | large dredge        | one                           |



Center at Leiden. The collector of the expedition team, J.M. Ruijs, published the results of the natural history of the Kara Sea (Ruijs, 1887; see also Snellen and Ekama, 1910: 115-130). He identified and provided numbers of most species and animal groups that were collected, but omitted details on Porifera, other than merely noting the stations, which contained specimens of the group. Monographic reports on the animals collected by the Dutch Polar Expedition were published by Carpenter (1887: comatulids) and Kerbert (1887: Fishes). Other reports used expedition material in more general studies (e.g. Augener, 1933: polychaetes).

This study provides evidence on the identity of the sponge taxa collected by Ruijs. It parallels the study of the Porifera of the Danish Dijnphna expedition (Levinsen, 1887), and since the overlap in species is large, it also provides the opportunity to modernize the taxonomy and descriptions of Levinsen. The collection is relatively rich in ‘carnivorous’ sponges, which occur at unusually shallow depths of 75-150 m. Another deep water species, *Stylocordyla borealis*, likewise was collected at such relatively shallow depth, inducing the upward adjustment of depth occurrence records of the species. The results induced me to review and update the faunal composition of the sponges of the Kara Sea.

### Material and methods

The specimens described here are a small part of the collections made in situ by J.M. Ruijs. A total of 30

specimens survived until today, from an estimated amount of at least 200 specimens obtained at 55 of the 83 stations (Table 1). Whether the loss of specimens was intentional or not is unclear from the reports of the expedition. However, due to the difficulty of transporting the soft, easily damaged material from the drifting ice floe to the Zoological Museum of Amsterdam, it is a small miracle any sponge specimen arrived there. Also for that reason, the surviving specimens are poorly documented: of the 30 specimens only 10 had sufficient information on the label to deduce the exact locality (coordinates, date, depth, bottom conditions, collecting gear), the remaining specimens lacked this label information. They are assumed to have been collected at one of the stations indicated in Ruijs (1887: 15-26) as having one or more sponges in the catch (see Table 1). Depth for those specimens is summarized below as between 75 and 170 m, based on the information in the station list. The position and dates of all stations sampled inside the Kara Sea are depicted in Fig. 1.

The collecting methods varied along with the events that occurred during the expedition. Specimens that survived were all obtained by collecting from the ice floe, all from the southern and western parts of the Kara Sea (only a few samples were obtained west of Yugor Strait and the sponges did not survive). The ice conditions were such that even when the ‘Varna’ was still afloat no movements of the ship were possible. This meant that holes or squares had to be sawn in the thinner parts of the surrounding ice in order to be able



Fig. 2. The prefabricated house in which the participants of the Dutch Polar Expedition 1882-83 spent most of their overwintering period on the ice floe drifting around in the Kara Sea. Photo taken by H. Ekama on 13 July 1883 (from Snellen, 1887).

to lower the collecting gear into the water. The gear consisted to begin with of larger and smaller rectangular and semi-circular dredges, drifting nets and collecting swabs ('faubertage') (see Tendal, 2002). During most of the winter period, when the overwintering accommodation had been erected (Fig. 2), all collected material had to be quickly brought inside as the catch became frozen solid more or less immediately after it was brought up. After several ice crushes, which caused loss of dredge nets, the only remaining gear was the large 40 × 70 cm rectangular dredge (Fig. 2 left), and a number of swabs. Most of the material was collected using these two types of gear.

Dredging from drifting ice needed its own improvised methodology. Where normal dredging from a ship means a bottom time of 10-30 minutes, the rate of movement of the ice was so slow, that for the dredge or the swabs to be effective periods of more than 20 hours were no exception. At times, drift was minimal and the dredge so heavy that it ploughed deeply into the soft bottom, with the result that it arrived at the surface filled with 'grey loam' that had to be sieved patiently (and inside the living quarters!).

Material was sorted at the locality on the ice, preserved in 60-70% ethanol, and stored in tins, glass tubes and glass bottles, the latter probably *a.o.* containing the sponges. Delivered in Amsterdam, the sponges remained unidentified, until the Norwegian spongologist E. Arnesen (1867-1928) arrived for a four months' work visit to what later became the Zoological Museum of the University of Amsterdam (ZMA) in 1903 by invitation of the director Professor Max Weber. She provisionally identified most specimens, except for ZMA Por. 01012 and 02382, which according to the label were identified by O. Schmidt (1823-1886). However, this cannot be concluded with certainty, because his characteristic handwriting is not on the labels, and Schmidt's biography (Desqueyroux-Faúndez and Stone, 1992) makes no mention of any visit to Amsterdam, so briefly before his death in 1886. It is perhaps surprising that the Dutch contemporary spongologist G.C.J. Vosmaer (1854-1916), author of two publications on the sponges of the Barents Sea (adjacent to the Kara Sea) (Vosmaer, 1882, 1885), was apparently not involved in the identification of the Varna sponges, but this is understandable because at that time he was working in Naples (1882-1889).

All specimens are registered in the ZMA collection, now housed in Leiden, and labelled 'Kara Zee Varna-Exp. 1882/83', with E. Arnesen's unpublished names. The specimens were re-identified by the present author

and provided with additional new labels bearing the names mentioned below. To make the descriptions and illustrations, below and in the Appendix, thick sections, dissociated spicule slides and SEM preparations were made in the way described in Van Soest *et al.*, (2014). Measurements of spicules are based on 15 spicules of each distinguished type, randomly chosen.

## Results

### *Sponges collected by the Dutch Polar Expedition 1882-83*

The following 11 species were identified in the Varna collection:

*Thenea valdiviae* Lendenfeld, 1907

*Tetilla polyura* Schmidt, 1870

*Tetilla sandalina* Sollas, 1886

*Radiella hemisphaerica* (Sars, 1872)

*Stylocordyla borealis* (Loven, 1868)

*Phorbas claviger* (Levinsen, 1887)

*Lycopodina lycopodium* (Levinsen, 1887)

*Lycopodina robusta* (Levinsen, 1887)

*Lycopodina infundibulum* (Levinsen, 1887)

*Lycopodina ruijsi* sp. nov.

*Semisuberites cribrosa* (Miklucho-Maclay, 1870)

One new species was detected in the material, which is described below. The other species are treated in the Appendix. Since most of the species were already described by Levinsen (1887) on the basis of the Dijnphna material that was collected in the same area in the same period, I provide summarized descriptions and measurements in the Appendix, including SEM images of the spicules of all the collected species of the Dutch Polar Expedition as a contribution to the morphological information on Kara Sea sponges.

### *Systematic description of a species new to science*

Class Demospongiae

Order Poecilosclerida

Family Cladorhizidae

Genus *Lycopodina* Lundbeck, 1905

*Lycopodina ruijsi* sp. nov. (Figs 3a-g)

*Holotype*. ZMA Por. 01012, Russia, Kara Sea, Varna Expedition, locality not noted on the available labels, depth between 75 and 170 m, coll. J.M. Ruijs,

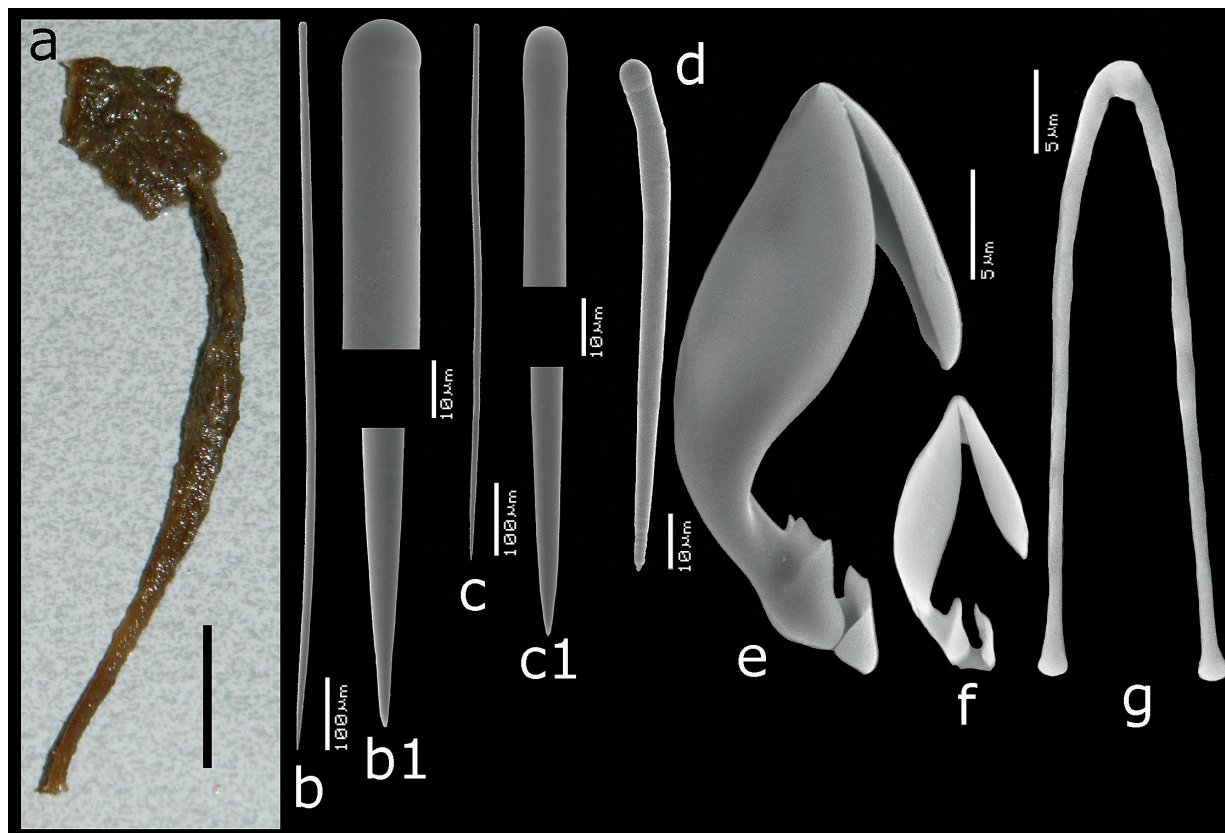


Fig. 3. *Lycopodina ruijsi* sp. nov., holotype ZMA Por. 01012, a habitus (scale bar 1 cm); b-g SEM images of spicules; b longest style, b1 details of apices of longest style; c shorter style, c1 details of apices of shorter style; d microstyle; e large anisochela; f small anisochela; g forcipes.

1882-1883; label text: 'Esperia spec. Varna-Exp. 1882/83, O. Schmidt det.'

*Additional material* (not type material). ZMA Por. 15404, Russia, Kara Sea, Varna Expedition, locality not noted on the available labels, depth between 75 and 170 m, coll. J.M. Ruijs, 1882-1883; label text: 'Cladorhiza spec.', but there is no further text and no identifier mentioned.

*Description.* The specimens, dark brown in alcohol, consist of a narrow fleshy stalk-like lower part and a broader blade-like upper part. The holotype (Fig. 3a) is 50 mm long, with the stalk  $38 \times 5$  mm and the main body  $12 \times 8$  mm. The second sample is now broken into three tiny fragments of undetermined shape.

*Skeleton.* The thinner lower part has a skeleton of loosely packed aligned spicules, the main body has a largely confused skeleton of intercrossing spicule tracts.

*Spicules.* (Figs 3b-g) Styles, microstyles/strongyles, anisochelae and forcipes.

Styles in a large size range, with overlapping larger (Figs 3b, b1) and smaller (Figs 3c, c1) styles, but not divisible in size categories, overall range  $390\text{--}875 \times 9\text{--}11 \mu\text{m}$ .

Microstyles (Fig. 3d) or microstrongyles, usually with one end with a slight tyle, curved more or less strongly,  $63\text{--}145 \times 2.5\text{--}7 \mu\text{m}$ .

Anisochelae, shaped like the usual *Lycopodina* chelae, with the shaft uncovered by the upper alae for a shorter or larger stretch, usually the naked shaft is less than 20% of the length of the alae, in two clear non-overlapping size categories, larger (Fig. 3e) with lengths  $23\text{--}29 \mu\text{m}$  (average 26.4) and smaller (Fig. 3f) with lengths  $11\text{--}21 \mu\text{m}$  (average 15.9).

Forcipes (Fig. 3g), common, with straight legs that are only slightly expanding, with swollen tips, legs  $24\text{--}45 \mu\text{m}$ .

*Etymology.* Named after J.M. Ruijs in recognition of his tireless efforts to collect bottom fauna from a drifting ice floe under extreme polar conditions.

*Remarks.* The new species belongs to the newly revived genus *Lycopodina* Lundbeck, 1905 because of its possession of forceps microscleres in combination with the spiculation and architecture of the genus *Asbestopluma*. Hestetun *et al.* (2015) established on morphological and molecular evidence that Lundbeck's subgenus *Asbestopluma* (*Lycopodina*) deserves recognition at the genus level.

The two specimens differ somewhat in sizes of the spicules, with the holotype having generally slightly longer styles, forcipes, and both categories of anisochelae. The microstyles of ZMA Por. 15404 are more often strongyles and are frequently much more strongly curved than those of the holotype. The anisochelae of 15404 have a longer stretch of shaft visible (resembling those of *L. infundibulum*), than those of the holotype. For the time being, this is interpreted as variability, but in view of the scanty material and the observed differences I refrain from assigning paratype status to ZMA Por. 15404. Future studies might demonstrate that the two specimens belong to closely related but different species.

The spicule complement is generally similar to that of *Lycopodina robusta* (Levinsen, 1887) (described

below in Appendix), but that species has a different habitus with 'grooved' side-branches, and there are no microstyles and only a single category of anisochelae. The latter have their shafts covered entirely by the lateral alae in *L. robusta*, in contrast with those of the present species.

Two related cladorhizid species occurring in the Arctic region possess two sizes of anisochelae, viz. *Asbestopluma* (*A.*) *pennatula* (Schmidt, 1875) [(with junior synonym *Asbestopluma bihamatifera* (Carter, 1876) (originally as *Esperia cupressiformis* var. *bihamatifera*, see also description in Lundbeck, 1905, p. 51)] and *Asbestopluma* (*A.*) *furcata* Lundbeck, 1905 (p. 54). Both differ clearly from the new species in having sigmancistras, and the larger category of anisochelae in the two species is twice as large (respectively 48–63  $\mu\text{m}$  and 44–54  $\mu\text{m}$ ) as that of the present species. The habitus of *A.* (*A.*) *pennatula* is pennate, that of *A.* (*A.*) *furcata* is dichotomously arborescent, unlike the new species.

For further information on Kara Sea cladorhizids collected by the Dutch Polar Expedition 1882–1883 see Appendix.

Table 2. Porifera obtained by the 'Dijmphna' Expedition to the Kara Sea, collected by Th. Holm, reported and described by G.M.R. Levinsen (1887) (left hand column) with the names corrected on the basis of the present study, and the World Porifera Database (Van Soest *et al.*, 2015, consulted on May 30, 2015) (right hand column). The order of the names follows the treatment in Levinsen's study. Names with an asterisk were also identified in the present collection.

| Levinsen's name   | Currently accepted name   |
|---|---|
| <i>Leucosolenia fabricii</i> (Schmidt, 1859)                          | <i>Leucosolenia complicata</i> (Montagu, 1814)                                |
| <i>Leucosolenia blanca</i> (Miklucho-Maclay, 1868)                    | <i>Clathrina blanca</i> (Miklucho-Maclay, 1868)                               |
| <i>Sycon arcticum</i> (Haeckel, 1870)                                 | <i>Sycon arcticum</i> (Haeckel, 1870)   |
| <i>Thenea muricata</i> (Bowerbank, 1858)                              | * <i>Thenea valdiviae</i> Lendenfeld, 1907                                    |
| <i>Tetilla polyura</i> Schmidt, 1870                                  | * <i>Tetilla polyura</i> Schmidt, 1870  |
| <i>Polymastia penicillus</i> (Montagu, 1814)                          | * <i>Radiella hemisphaerica</i> (Sars, 1872)                                  |
| <i>Stylocordyla borealis</i> (Lovén, 1868)                            | * <i>Stylocordyla borealis</i> (Lovén, 1868)                                  |
| <i>Pachychalina caulifera</i> Vosmaer, 1882                           | <i>Isodictya palmata</i> (Ellis and Solander, 1786)                           |
| <i>Pachychalina compressa</i> (Schmidt, 1870)                         | <i>Isodictya palmata</i> (Ellis and Solander, 1786)                           |
| <i>Reniera clavata</i> Levinsen, 1887                                 | <i>Haliclona</i> ( <i>Haliclona</i> ) <i>urceolus</i> (Rathke and Vahl, 1806) |
| <i>Halichondria bibula</i> (Schmidt, 1870)                            | <i>Halichondria</i> ( <i>Halichondria</i> ) <i>panicea</i> (Pallas, 1766)     |
| <i>Halichondria assimilis</i> Levinsen, 1887                          | <i>Hymeniacion</i> <i>assimilis</i> (Levinsen, 1887)                          |
| <i>Cribrochalina sluiteri</i> Vosmaer, 1882                           | * <i>Semisuberites cribrosa</i> (Miklucho-Maclay, 1870)                       |
| <i>Gellius capilliferus</i> Levinsen, 1887                            | <i>Biemna variantia</i> (Bowerbank, 1858)                                     |
| <i>Esperella vosmaeri</i> Levinsen, 1887                              | <i>Mycale</i> ( <i>Mycale</i> ) <i>lingua</i> (Bowerbank, 1866)               |
| <i>Esperella picea</i> (Vosmaer, 1882)                                | <i>Iophon piceum</i> (Vosmaer, 1882)  |
| <i>Esperella</i> ( <i>Myxilla</i> ) <i>clavigera</i> Levinsen, 1887   | * <i>Phorbas claviger</i> (Levinsen, 1887)                                    |
| <i>Esperella cupressiformis</i> var. <i>robusta</i> Levinsen, 1887    | * <i>Lycopodina robusta</i> (Levinsen, 1887)                                  |
| <i>Esperella cupressiformis</i> var. <i>lycopodium</i> Levinsen, 1887 | * <i>Lycopodina lycopodium</i> (Levinsen, 1887)                               |
| <i>Esperella infundibulum</i> Levinsen, 1887                          | * <i>Lycopodina infundibulum</i> (Levinsen, 1887)                             |

### Comparison with previous studies on sponges of the Kara Sea

The *Dijmphna* sponges of the Kara Sea, collected at the same time and in the same area by Th. Holm (cf. Bergh *et al.* 1887), were studied by Levinsen (1887). The results of his study are presented in Table 2, left hand column, with currently accepted names given in the right hand column (from the World Porifera Database (WPD), cf. Van Soest *et al.*, 2015). Also in the latter, asterisks indicate whether the species was also collected by the Dutch Polar Expedition. The collection consisted of specimens of 20 sponge species, several of which were collected outside the Kara Sea (deduced from the shallow depth they were collected). Next to collections made by the ‘*Dijmphna*’ from the drifting ice floe, there were also some shallow-water sponges collected along the way travelling to and leaving from the Kara Sea. Unfortunately, Levinsen (1887) provided only depth data, so the validity of their Kara Sea occurrence is somewhat in doubt because the precise localities are not given. As could be expected, there is a great resemblance in the sponges collected by the Dutch and Danish expeditions, with 9 out of 11 species of the Dutch collection also represented in the Danish collection. The two species not reported by Levinsen, *Tetilla sandalina* and *Lycopodina ruijsi* sp. nov. might easily be hiding in the Danish collection under the 13 reported specimens of *Tetilla polyura* and among the *Esperella cupressiformis* ‘varieties’ (respectively 27 and 20 specimens of both varieties).

Further reports on sponges from the Kara Sea are those of Fristedt (1887, 4 species), Hentschel (1929, 3 species), Rezvoi (1924, 12 species), Rezvoi (1931, 6 species), and especially Koltun (1959, 1966, 49 species). The latter author also partially included the results of the previous authors. Lundbeck (1905) re-named *Esperella picea* sensu Levinsen as *Iophon frigidus*, and this name is so far retained in the WPD awaiting reexamination. It is assumed here that *Iophon frigidus* is a junior synonym of *Iophon piceum*. The reported Kara Sea sponge fauna is here assembled in Table 3 (placed in Appendix): in the left part the currently accepted names, which number 60 species and in the right part the original combinations and synonyms found in the original studies.

Almost all of the records of sponges were obtained from more eastern and northern parts of the Kara Sea, which are deeper and/or from inshore localities or from the mouth of the Yenisei. The sponges of the southwestern Kara Sea, where the Dutch Polar

Expedition and the ‘*Dijmphna*’ collected their specimens, are known almost exclusively from these 19<sup>th</sup> century research activities.

### Conclusion

On the basis of the present and previous published sources, the sponge fauna of the Kara Sea is found to contain 60 species: 5 of these belong to the Calcarea, 55 are Demospongiae, with as the most striking feature a proportionally high amount of ‘carnivorous’ sponges of the genus *Lycopodina*. So far no records exist of Hexactinellida, although the eastern deeper parts are likely to contain such sponges. The sponges of the southeastern parts of the Kara Sea are known predominantly from the ice floe collections of the Dutch and Danish expeditions of 1882-83.

### Acknowledgements

Dr O.S. Tendal (Zoologisk Museum of Copenhagen) helped to answer the question whether the present collection of sponges is indeed all that remains from the Dutch Polar (‘*Varna*’) Expedition of 1882-83. Olga Bozhenova (ZIN RAS, St. Petersburg) provided copies of Rezvoi (1924, 1931). Elly Beglinger (Naturalis) helped locating and registering the *Varna* specimens.

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## Appendix

*Additional taxonomic descriptions of sponges collected by the Dutch Polar Expedition 1882-83*

Class Demospongiae  
Order Tetractinellida  
Suborder Astrophorina  
Family Theneidae

*Thenea valdiviae* Lendenfeld, 1907 (Fig. 4a-g)

*Material.* ZMA Por. 02382, Russia, Kara Sea, Varna Expedition, locality not noted on the available labels, depth between 75 and 170 m, coll. J.M. Ruijs, 1882-1883. Label text: ‘*Thenea muricata* Gray (Vosmaer) det. O. Schmidt’.

*Description.* Lump-shaped specimen (Fig. 4a) with at least two oscules, apparently without sieve plates, and a small fragment; dark brown color, hispid surface.

*Skeleton.* Radiately confused, with long spicules protruding beyond the surface.

*Spicules.* (Fig. 4b-g) Oxeas, anatriaenes, protriaenes, dichotriaenes, amphiasters/spirasters, plesiasters.

Oxeas (Figs 4b, b1), curved, flexuous, often broken in the preparations, in a large size variation, frequently around  $3500 \times 15\text{-}20 \mu\text{m}$  in size, but largest observed oxea  $6500 \times 36 \mu\text{m}$ .

Anatriaenes (Fig. 4c, c1), with rhabds  $2000\text{-}7500 \times 16\text{-}42 \mu\text{m}$ , cladomes relatively narrow,  $66\text{-}240 \mu\text{m}$ , cladi  $58\text{-}300 \times 9\text{-}22 \mu\text{m}$ .

Protriaenes (Figs 4d, d1) (not common), with flaring cladi, with rhabds up to  $3000 \times 30 \mu\text{m}$ , cladome up to  $400 \mu\text{m}$ , cladi  $300\text{-}400 \times 20\text{-}25 \mu\text{m}$ .

Dichotriaenes (Fig. 4e), length of rhabds variable, up to  $7200 \times 76 \mu\text{m}$ , with cladomes  $720\text{-}960 \mu\text{m}$  in diameter, primary cladi shorter than secondary, primary  $200\text{-}240 \times 30\text{-}60 \mu\text{m}$ , secondary  $250\text{-}780 \times 20\text{-}54 \mu\text{m}$ .

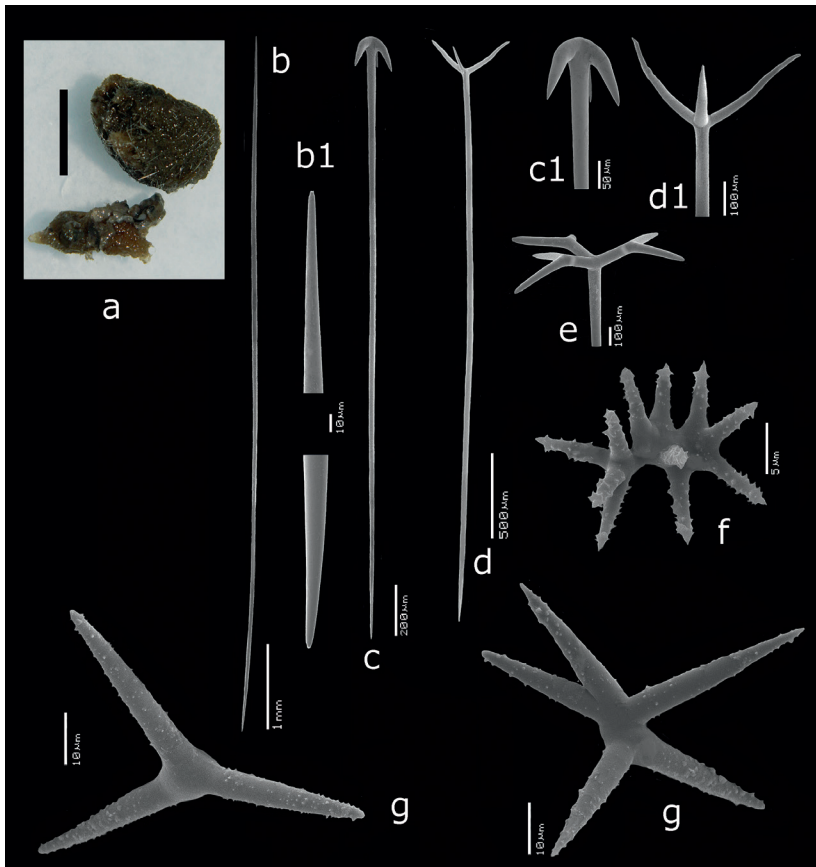


Fig. 4. *Thenea valdiviae* Lendenfeld, 1907, ZMA Por. 02382, a habitus of specimen and fragment (scale bar 1 cm); b-g SEM images of spicules; b oxea, b1 detail of apices of oxea; c anatriaene, c1 detail of cladome of anatriaene; d protriaene, d1 detail of cladome of protriaene; e cladome of dichotriaene; f amphiaster/spiraster; g differently shaped plesiasters.

Spirasters/amphiasters (Fig. 4f), variable in size, ray number and shaft thickness, but not clearly separated in two categories, ray number 8-11 (average 9.2), size 21-31  $\mu\text{m}$  (average 24.9).

Plesiasters (Fig. 4g), finely spined, with 3-5 rays, 52-111  $\mu\text{m}$ .

*Remarks.* This specimen is assigned to *Thenia valdiviae* on the basis of Steenstrup and Tendal's (1982) and Cárdenas and Rapp's (2015) observations on the North Atlantic and Arctic *Thenia* species. The present specimen is not in a very good condition, so the sieve plates, which are characteristic for *T. valdiviae*, may not have been preserved. The rarity of the protriaenes and the plesiasters is in accordance with descriptions of *T. valdiviae*.

Suborder Spirophorina  
Family Tetillidae

*Tetilla polyura* Schmidt, 1870 (Fig. 5a-g)

*Tetilla polyura* Schmidt, 1870: 66, pl. 6 fig. 8.

*Material.* ZMA Por. 02362, Russia, Kara Sea, Varna Expedition, locality not noted on the available labels, depth between 75 and 170 m, coll. J.M. Ruijs, 1882-1883. Label text: 'Bruchstück wahrscheinlich Tetilla polyura O. Schm., KKY' + illegible small label, possibly original.

*Description.* A dark brown, conical-shaped fragment (Fig. 5a), spinous, firm condition.

*Skeleton.* Radiate.

*Spicules.* (Fig. 5b-g) Oxeas, anatriaenes, protriaenes, sigmaspires, raphides.

Oxeas (Fig. 5b, b1) in two rather sharply divided categories, (1) long, thin and flexuous with gradually tapering thin apices, usually broken in the slides, largest unbroken oxea up to  $4200 \times 7 \mu\text{m}$ , (2) short, fusiform,  $600-1080 \times 12-19 \mu\text{m}$ .

Anatriaenes (Fig. 5c, c1), common, with long wispy shaft, usually broken, up to  $2100 \times 8 \mu\text{m}$ . Cladomes narrow, 29-63  $\mu\text{m}$  in diameter, cladi  $28-81 \times 4-8 \mu\text{m}$ .

Protriaenes, shafts thin and wispy,  $960-1600 \times 3-10 \mu\text{m}$ , in two types, (1) normal shaped cladomes (Fig. 5d), and (2) with '2+1' cladomes (Fig. 5e), long cladus  $88-225 \times 3-7 \mu\text{m}$ , short cladi  $24-78 \times 3-5 \mu\text{m}$ .

Sigmaspires (Fig. 5f), C or S-shaped, faintly centrotyle, 10-13  $\mu\text{m}$ .

Raphides/oxeotes (Fig. 5g, g1), sinuous or wispy, in trichodragmas or frequently single, length 215-345  $\mu\text{m}$ , thickness around 1  $\mu\text{m}$ .

*Remarks.* The fragment conforms to Schmidt's description and figure as far as the spicules are concerned (both anatriaenes and protriaenes present). The outer morphology deviates in lacking the conical surface elevations, but that can be attributed to the fragmentary condition of the specimen. There is considerable similarity in the spiculation with *Tetilla sandalina* Sollas, 1886 (see below), but that species lacks anatriaenes.

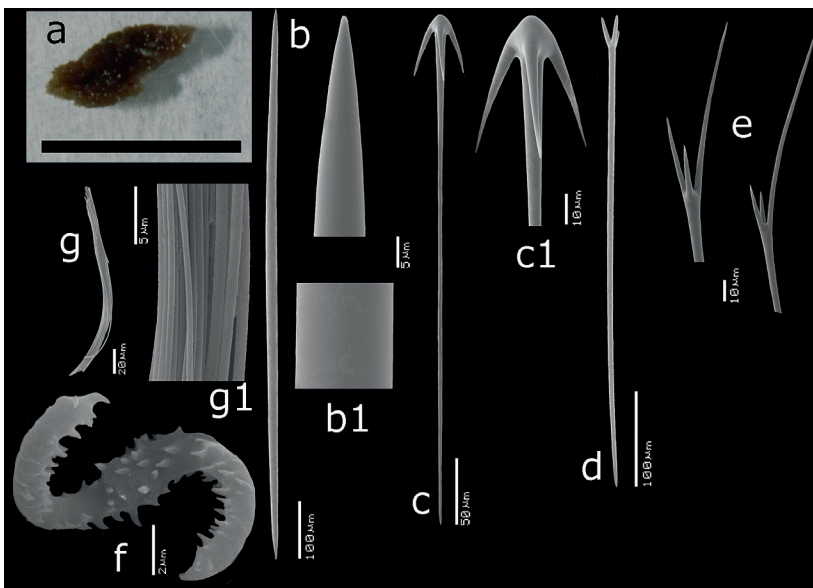


Fig. 5. *Tetilla polyura* Schmidt, 1870, ZMA Por. 02362, a habitus of fragment (scale bar 1 cm); b-g SEM images of spicules; b oxea, b1 details of oxea; c anatriaene, c1 detail of cladome of anatriaene; d 'normal' protriaene; e cladomes of '2+1' protriaenes; f sigmaspire; g dragma of raphides/oxeotes, g1 detail of dragma.

*Tetilla sandalina* Sollas, 1886 (Fig. 6a-f)

**Material.** ZMA Por. 02353, Russia, Kara Sea, Varna Expedition, locality not noted on the available labels, depth between 75 and 170 m, coll. J.M. Ruijs, 1882-1883. Label text: ‘*Tetilla* cranium (Müller)’ no further text, no identifier.

**Description.** The sample consists of five fragmentary specimens (Fig. 6a) which may be part of a single larger specimen. One fragment is attached to a shell. Color grey-brown, surface very spinous-hairy, condition firm.

**Skeleton.** Radiate, predominantly made up of the shorter oxeas.

**Spicules.** (Fig. 6b-f) Oxeas, protriaenes, raphide-like oxeas, sigmaspires.

Oxeas in two overlapping categories, (1) long, with gradually tapering thin apices (Fig. 6b, b1), usually broken in the slides, largest unbroken oxea up to  $3900 \times 36 \mu\text{m}$ , (2) short, fusiform (Fig. 6c, c1),  $600\text{--}1260 \times 12\text{--}21 \mu\text{m}$ .

Protriaenes (Fig. 6d, d1), with ‘2+1’ cladomes, shaft thin and wispy,  $1260\text{--}2900 \times 2\text{--}6 \mu\text{m}$ ; long cladus  $22\text{--}147 \times 1.5\text{--}4 \mu\text{m}$ , short cladi  $15\text{--}51 \times 1\text{--}3 \mu\text{m}$ .

Sigmaspires (Fig. 6e), C or S shaped, distinctly centrotolote,  $10\text{--}16 \mu\text{m}$ .

Raphides/oxeotes (Fig. 6), sinuous or wispy, in trichodragmas or frequently single, length  $320\text{--}400 \mu\text{m}$ , thickness around  $1 \mu\text{m}$ .

**Remarks.** Cárdenas and Rapp (2015) described a specimen of this species from the adjacent Barents Sea and their spicule size data are closely similar to the above cited with the exception of the sigmaspires, which were  $15\text{--}25 \mu\text{m}$ . A major discrepancy with previous records, including those of Cárdenas and Rapp (2015) is the depth, at which the present fragment was collected. The precise depth is unfortunately not known, but the dredgings of the Dutch Polar Expedition did not exceed 200 m in depth. Most of the dredgings were done between 70 and 125 m (Ruijs, 1887). The species shares with *T. polyura* (see above) the ‘2+1’ protriaenes, but differs in the absence of anatriaenes.

Order Polymastiida  
Family Polymastiidae

*Radiella hemisphaerica* (Sars, 1872) (Fig. 7a-d)

*Trichostemma hemisphaericum* Sars, 1872: 63, pl. 6 figs 1-15.

*Polymastia hemisphaerica*; Vosmaer, 1885: 12, pl. 1 figs 20-21, pl. 2 figs 17-20, pl. 3 figs 1-5, pl. 5 figs 8-11, 16; Koltun, 1966: 78, text-fig. 51, pl. 29 figs 1-5.

**Material.** ZMA Por. 01844, Russia, Kara Sea, Varna Expedition, stat. 70,  $71.3333^\circ\text{N } 63.6333^\circ\text{E}$ , depth 77.5 m, coll. J.M. Ruijs, field nr. 40, 20 February 1883; label

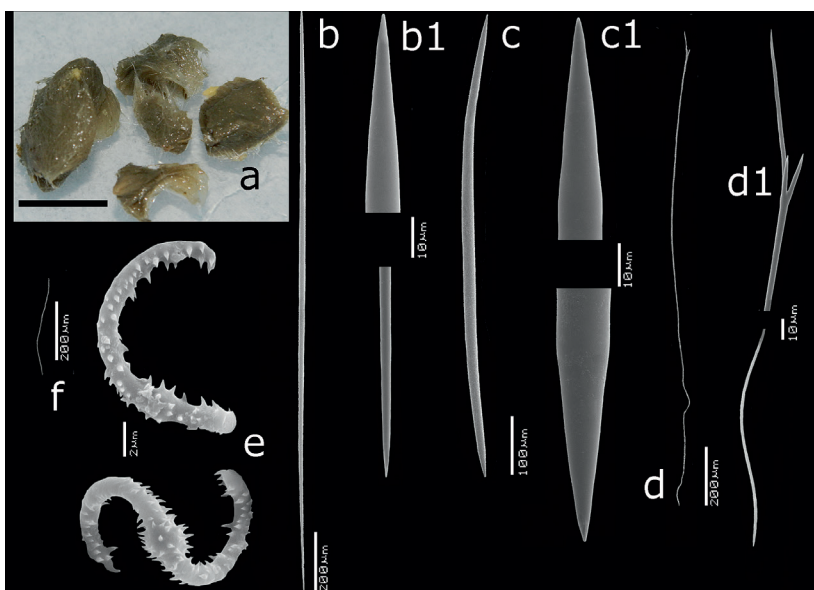


Fig. 6. *Tetilla sandalina* Sollas, 1886, ZMA Por. 02353, a habitus of four fragments presumed to be from a single specimen (scale bar 1 cm); b-f SEM images of spicules; b long thin oxea, b1 details of apices of long thin oxea; c short fusiform oxea, c1, details of apices of short oxea; d ‘2+1’ protriaene, d1 details of cladome and pointed end of a ‘2+1’ protriaene; e sigmaspires; f raphide.

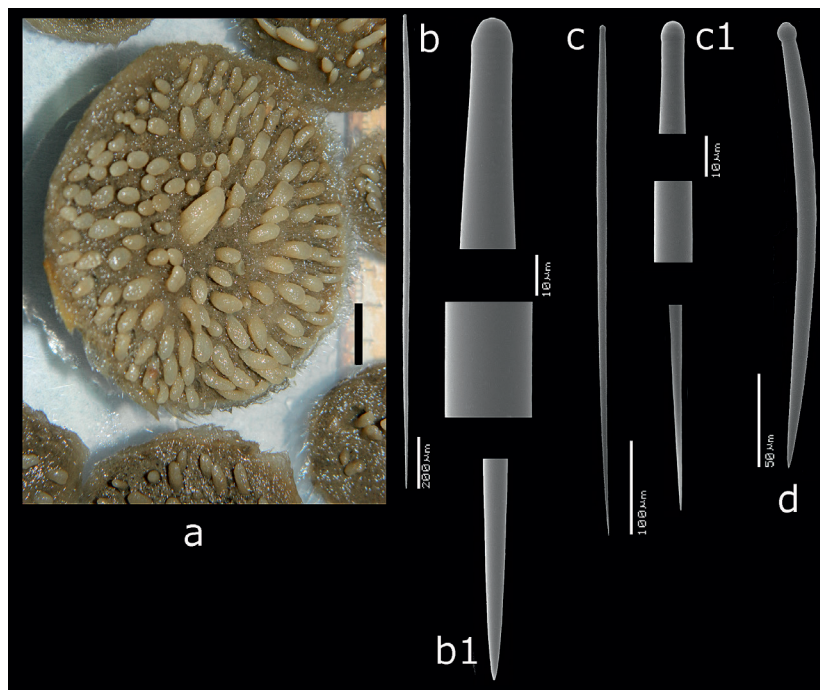


Fig. 7. *Radiella hemisphaerica* (Sars, 1872), ZMA Por. 01844, a habitus (scale bar 1 cm); b-d SEM images of spicules; b longest tylostyle, b1 details of apices and middle of longest tylostyle; c intermediate subtylostyle, c1 details of apices and middle of intermediate subtylostyle; d ectosomal tylostyle.

text ‘*Polymastia mammillaris* Müller, det. E. Arnesen’; ZMA Por. 01850, Kara Sea, Varna Expedition, locality not noted on the available labels, depth between 75 and 170 m, coll. J.M. Ruijs, 1882-1883; label text ‘Bruchstück *Polymastia spec.*’ + illegible small label, possibly original.

**Description.** Discoidal, circularly-flattened, dark brown sponges (Fig. 7a), with a transparent fringe at the peripheral edge, at the upper surface covered by light brown papillae, with a single central larger oscular papilla. Ten individuals (ZMA Por. 01844) and a small fragment on a mussel (01850). Largest individual 5 cm in diameter, 1 cm in thickness, papillae number approximately 100; smallest complete individual 1 cm in diameter, with four papillae including the oscular papilla. Fringe of the larger specimens approximately 3-4 mm wide.

**Skeleton.** The upper surface skeleton consists of a palisade of smaller spicules, which are proper tylostyles, arranged at right angles to the surface; choanosomal skeleton consists of a subectosomal confused layer of intermediate sized spicules, and below that and also forming the lower surface are the longest spicules parallel with the undersurface and fanning out into the fringe. All these longer spicules are ‘subtylostyles’, i.e. they are stylote with a faint subterminal constriction.

**Spicules.** (Fig. 7b-d) Fusiform tylostyles and subtylostyles.

Longest subtylostyles (Fig. 6b, b1), possibly divisible in the choanosomal ones  $1146-2100 \times 16-19 \mu\text{m}$  and those forming the fringes,  $2400-3600+ \times 15-26 \mu\text{m}$  (upper size probably considerably longer but no unbroken spicules were observed in the preparations).

Intermediate subtylostyles (Fig. 7c, c1)  $468-1520 \times 11-13 \mu\text{m}$ .

Ectosomal tylostyles (Fig. 7d)  $162-306 \times 8-18 \mu\text{m}$ .

**Remarks.** The specimens conform closely to Sars’ (1872) description and figures, and at least to Vosmaer’s (1885) and Koltun’s (1966) *P. hemisphaerica*. Other records may need further verification.

Order Suberitida  
Family Stylocordylidae

*Stylocordyla borealis* (Loven, 1868) (Fig. 8a-c)

*Hyalonema boreale* Loven, 1868: 105, pl. 2

*Hyalonema longissima* Sars, 1872: 73, pl. 6 figs 35-45 (new synonymy)

*Stylocordyla borealis*; Van Soest, 2002: 225, fig. 1 (with synonymy and distributional data); Uriz *et al.*, 2010: 245 (lectotype description and further discussion)

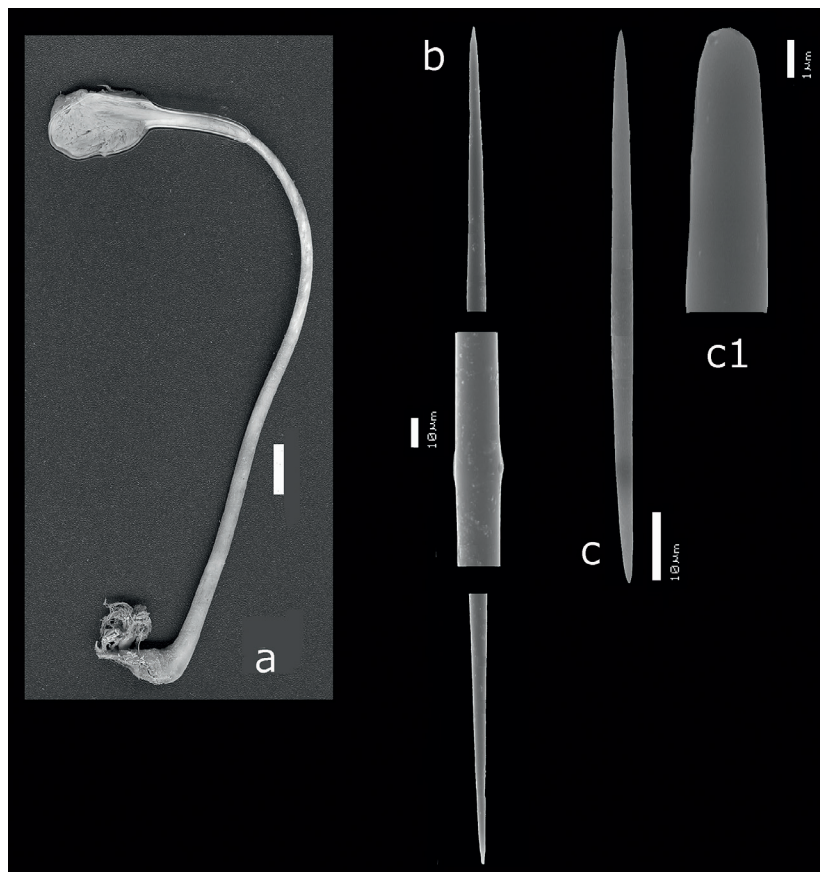


Fig. 8. *Stylocordyla borealis* (Loven, 1868), ZMA Por. 02224, a habitus (scale bar 1 cm); b centrotylote oxea; c ectosomal oxea, c1 blunt apex of ectosomal oxea (images copied from Van Soest, 2002: Fig. 1D-G).

**Material.** ZMA Por. 02224, Russia, Kara Sea, Varna Expedition, locality not noted on the available labels, depth between 75 and 170 m, coll. J.M. Ruijs, 1882-1883. Label text: 'Stylocordyla, det. E. Arnesen'. The specimen has already been treated and illustrated in the *Systema Porifera* (see Van Soest, 2002: 225-226).

**Description.** Club-shaped sponge (Fig. 8a) on a thin stalk, with a root system of spicule bundles, anchoring the specimen in the soft bottom. Length of specimen 9 cm, stalk approximately 0.5 cm in diameter, main body 2 cm long 1.2 cm in diameter, bearing a single oscule of 2 mm diameter.

**Skeleton.** The stalk skeleton consists of aligned long oxeote spicules. The stalk penetrates somewhat into the main body where shorter oxeotes fan out towards the surface. Smaller oxeotes form bundles in-between the long oxeotes and at the surface small oxeas form a palisade.

**Spicules.** (Fig. 8b-c) Oxeotes in several size classes.

Long oxeotes (Fig. 8b) from the stalk, occasionally centrotylote, up to  $3000 \times 50 \mu\text{m}$ .

Intermediate oxeotes from the main body, usually centrotylote,  $400-1150 \times 4-10 \mu\text{m}$ .

Small oxeotes from the main body,  $300-450 \times 4 \mu\text{m}$ .

Ectosomal microxeas (Fig. 8c, c1), often with bluntly rounded ends, up to  $100 \times 2 \mu\text{m}$ .

**Remarks.** Previous treatments of this species so far have ignored *Hyalonema longissimum* Sars, 1872, collected slightly to the north of the type locality of *S. borealis*, as an almost certain synonym of this species. The differences are entirely size and growth form, whereas all other details are similar to those of *S. borealis*.

Order Poecilosclerida  
Family Hymedesmiidae

*Phorbas claviger* (Levinsen, 1887) (Fig. 9a-e)

*Esperella* (*Myxilla*) *clavigera* Levinsen, 1887: 360, pl. 31 figs 3-6.

*Ectyomyxilla* (?) *clavigera*; Hentschel, 1929: 948.  
Not: *Hymedesmia clavigera*; Alander, 1942: 34.

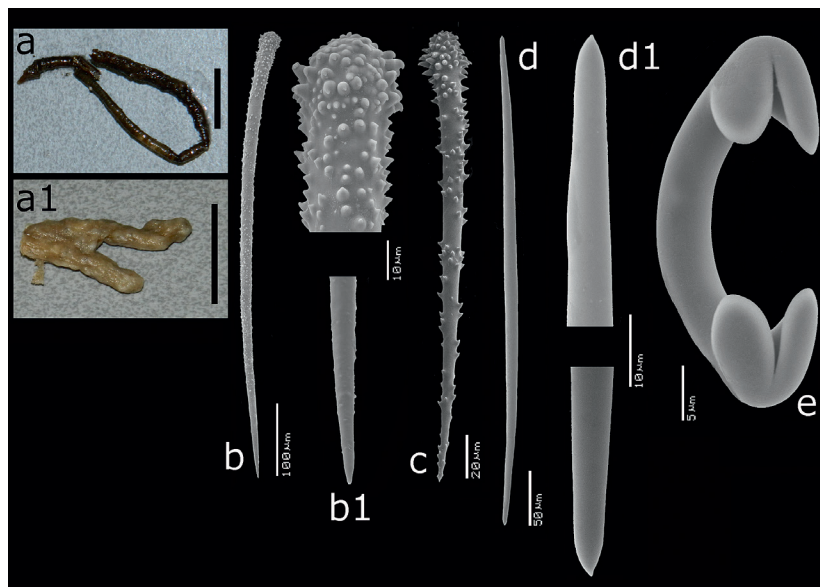


Fig. 9. *Phorbas claviger* (Levinsen, 1887), a habitus of ZMA Por. 00834, a1 habitus of ZMA Por. 00842 (scale bar 1 cm); b-e SEM images of spicules of ZMA Por. 00834; b large acanthostyle; b1 details of apices of large acanthostyle; c small acanthostyle; d oxeote tornote; d1 details of apices of tornote; e arcuate isochela.

**Material.** ZMA Por. 00834, Russia, Kara Sea, Varna Expedition, locality not noted on the available labels, depth between 75 and 170 m, coll. J.M. Ruijs, 1882-1883; label text: 'Dendoryx spec. ?, det. E. Arnesen, Varna Expeditie LL3'; ZMA Por. 00842, Russia, Kara Sea, Varna Expedition, locality not noted on the available labels, depth between 75 and 170 m, coll. J.M. Ruijs, 1882-1883; label text: 'Desmacidon spec. Kara Zee, Varna-Exped. 1882/83', no further text, no identifier.

**Description.** The specimens (Fig. 9a, a1) at first glance appear to be branch-shaped, but closer inspection reveals them to be thinly encrusting worm tubes. One of the specimens (00842, Fig. 8a1) has a light brown surface with pale oval patches, which are likely to be remnants of areolated pore fields. Size of specimens up to 2 cm long, tube diameter including the encrusting sponges 4-5 mm. Sponge thickness 1-1.5 mm.

**Skeleton.** From surface to substratum the skeleton shows three layers, (1) a densely spiculated tangential ectosomal crust, (2) a choanosomal skeleton consisting of thick spicule tracts carrying the surface skeleton, in between there are numerous, loose spicules, mostly microscleres, and (3) a continuous hymedesmioid basal skeleton of single acanthostyles with heads embedded in the substratum (worm tube surface).

**Spicules.** (Fig. 9b-e) Acanthostyles, tornotes, isochelae.

Acanthostyles in two categories, (1) long with

heavily spined swollen head (Fig. 9b, b1), and spines gradually diminishing towards the points,  $292-1032 \times 18-22 \mu\text{m}$  (heads  $24-33 \mu\text{m}$ ), (2) small, entirely heavily spined (Fig. 9c), with swollen heads,  $131-271 \times 10-14 \mu\text{m}$  (heads  $18-20 \mu\text{m}$ ).

Tornotes (Fig. 9d, d1), fusiform oxeotes, approximately symmetrical, with mucronate apices, often slightly curved,  $348-522 \times 8.5-12 \mu\text{m}$ .

Isochelae (Fig. 9e), arcuate, robust, usually with smoothly and continuously curved shaft and ends, and short vaguely mucronate alae,  $29-39 \mu\text{m}$ .

**Remarks.** The data match those of Levinsen's description, although most of the present spicule sizes have a higher upper limit. The species is here assigned to *Phorbas* Gray, 1867 (which means that according to the ICZN the species name has to undergo a mandatory change to *claviger*) on account of the presence of thick spicule tracts carrying the surface skeleton combined with the presence of a hymedesmioid basal skeleton of single acanthostyles. The genus assignment of Hentschel (1929) as *Ectyodoryx* was mistaken, as this (sub)genus has a reticulate skeleton and lacks the hymedesmioid basal skeleton.

Alander (1942) reported a species as *Hymedesmia clavigera* from the Skagerrak at greater depth (540 m), but he did not provide a description. Moreover, it appears that he mistook Levinsen's species for *Hymedesmia clavigera* Lundbeck, 1910, because in his key he states that the chelae are  $40-50 \mu\text{m}$  and that the species would also occur at Stavanger. This latter



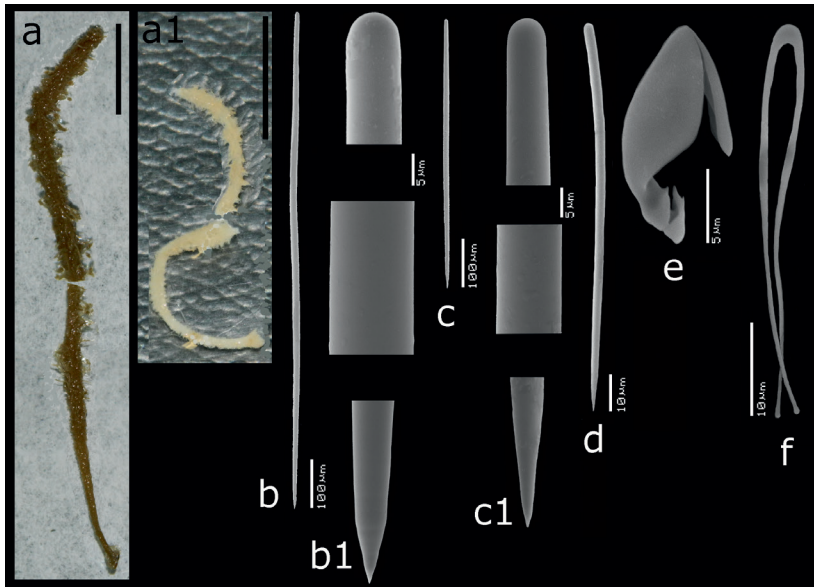


Fig. 10. *Lycopodina lycopodium* (Levinsen, 1887), a habitus of ZMA Por. 01002, a1 habitus of ZMA Por. 15309 (scale bar 1 cm); b-f SEM images of spicules of ZMA Por. 01002; b longest style, b1 details of apices and middle of longest style; c shorter style, c1 details of apices and middle of shorter style; d microstyle; e anisochela; f forcip.

record is apparently based on Burton's (1930) record of *Hymedesmia clavigera* Lundbeck, not Levinsen.

So far this species appears to be endemic to the Kara Sea.

#### Family Cladorhizidae

*Lycopodina lycopodium* (Levinsen, 1887) (Fig. 10a-f)

*Esperella cupressiformis* var. *lycopodium* Levinsen, 1887: 365, pl. 29 figs 12-13, pl. 31 figs 15, 16d.

*Asbestopluma (Lycopodina) lycopodium*; Lundbeck, 1905: 62, pl. 2 figs 15-17, pl. 11 figs 6-7.

*Lycopodina lycopodium*; Hestetun *et al.*, 2015: 335.

**Material.** ZMA Por. 01002, Russia, Kara Sea, Varna Expedition stat. 68, 71.3°N 63.5167°E, depth 135 m, coll. J.M. Ruijs, field nr. 83, 18 June 1883; label text: 'Esperella cupressiformis var. lycopodium Lev., Varna-Exp. E. Arnesen det'; ZMA Por. 15309, Russia, Kara Sea, Varna Expedition, stat. 70, 71.3333°N 63.6333°E, depth 77.5 m, coll. J.M. Ruijs, field nr. 40, 20 February 1883, label text: 'Asbestopluma spec.', not original, no identifier mentioned; illegible small label present, possibly original.

**Description.** Two stalked-pennatuliform specimens (Fig. 10a, a1), the largest of which is 6 cm high, with a naked stalk of 1.5 cm and the part with side branches ca. 4.5 cm. Side branches 2-3 mm. The second

specimen is 3.5 cm high. Color in alcohol red-brown or pale beige. Both specimens have become broken.

**Skeleton.** Axial skeleton of aligned longer styles, with side tracts of smaller styles at right angles to the axial skeleton. Surface skeleton crowded with clusters of anisochelae.

**Spicules.** (Fig. 10b-f) Styles, microstyles, anisochelae, forcipes.

Styles in two size categories, both slightly fusiform, (1) longest (Fig. 10b, b1) 1110-1170 × 11-12.5 μm, (2) shorter (Fig. 10c, c1), 570-780 × 10-13 μm.

Microstyles (Fig. 10d), slightly curved, equidiametrical until close to the pointed apex, rather variable in length and thickness, 115-180 × 2-8 μm.

Anisochelae (Fig. 10e) with the characteristic *Asbestopluma*-shape with lower alae sharply incised and provided with one or more spines on the middle ala rim, upper side alae covering the shaft entirely, 11.5-14.5 μm.

Forcipes (Fig. 10f), not common, with thin, somewhat irregular legs, ending in faintly swollen apices, sometimes crossed in the lower parts, length 28-48 μm.

**Remarks.** This species is the type of the newly revived genus *Lycopodina* Lundbeck, 1905. The shape of the specimens and the size of spicules are identical to the drawings and measurements given by Levinsen (1887). Lundbeck's (1905) drawings of the habit of his specimens in his pl. II figs. 15 and 16 also conform to the present material, but the drawing of pl. II fig. 17

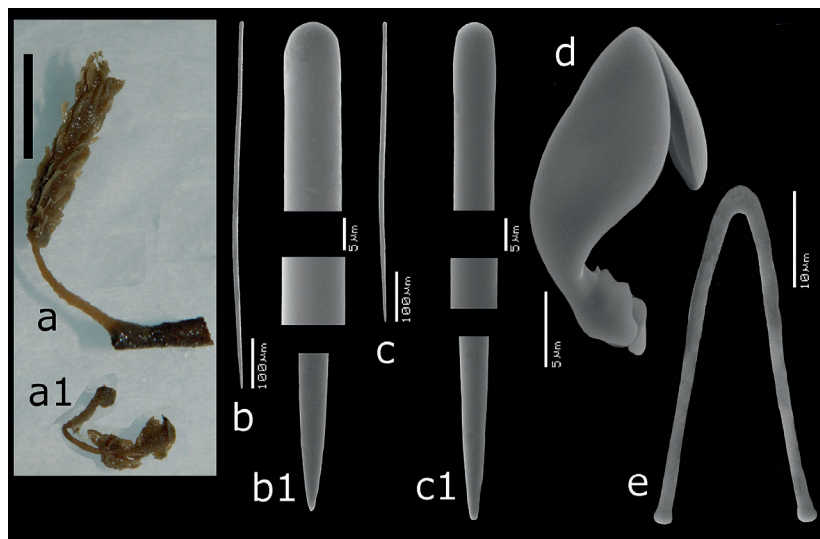


Fig. 11. *Lycopodina robusta* (Levinsen, 1887), a habitus of ZMA Por. 01003a, a1 habitus of ZMA Por. 01003b (scale bar 1 cm); b-e SEM images of spicules of ZMA Por. 01003a; b longer style, b1 details of apices and middle of longer style; c shorter style, c1 details of apices and middle of shorter style; d anisochela; e forceps.

appears different. Lundbeck's measurements of the forcipes (50–56  $\mu\text{m}$ ) exceed those of the present and Levinsen's measurements, whereas measurements from a specimen from Rockall Bank, W of Ireland (Van Soest and Baker, 2011: table 2, as *Asbestopluma*) are smaller than the present. *L. lycopodium* still remains a species that needs revision before it can be assumed that the wide distribution (Kara Sea, The Faroes) is accurate.

*Lycopodina robusta* (Levinsen, 1887) (Fig. 11a-e)

*Esperella cupressiformis* var. *robusta* Levinsen, 1887: 364, pl. 29 figs 10–11, pl. 31 figs 7–9, 10a–c, 11–14.

*Asbestopluma (Lycopodina) cupressiformis*; Lundbeck, 1905: 58, pl. 2 figs 11–14, pl. 11 figs 4–5.

**Material.** ZMA Por. 01003a, Russia, Kara Sea, Varna Expedition, stat. 70, 71.3333°N 63.6333°E, depth 77.5 m, coll. J.M. Ruijs, field nr. 40, 20 February 1883, label text: 'Esperella cupressiformis var. robusta'; ZMA Por. 01003b, Russia, Kara Sea, Varna Expedition stat. 56, 71.4167°N 64.2667°E, depth 92 m, coll. J.M. Ruijs, field nr. 70, 15 May 1883; label text: 'Esperella cupressiformis var. robusta'.

Both specimens are in the same bottle, 01003a in a glass tube.

**Description.** Two stalked specimens (Fig. 11a, a1), red-brown in color, with a distinct separation in a thin stalk and a thick somewhat club shaped body, but keeping

the elongate pennatuliform form. Side branches in the main body are directed upwards causing a 'grooved' outlook of it. Size of the larger more complete specimen, which is fixed on a worm tube, 30 mm in total, with stalk 12  $\times$  1–1.5 mm, and main body 18  $\times$  2.5 mm. The second specimen is less than half the size of the first specimen.

**Skeleton.** Consisting of a tight-packed axial tract of spicules and branching tracts of the upper body. The surface of the main body is crowded with anisochelae.

**Spicules.** (Fig. 11b–e) Styles, anisochelae and forcipes.

Styles (larger, Fig. 11b, b1), (smaller, Fig. 11c, c1) variable in size, but not clearly divisible in categories, 550–910  $\times$  10–13  $\mu\text{m}$ .

Microstyles not certainly present, only one or two small styles were observed.

Anisochelae (Fig. 11d), as usual in *Lycopodina*, with upper side alae covering the shaft entirely and spiked rim of lower alae, 20–27  $\mu\text{m}$ .

Forceps (Fig. 10e), fairly common, with short, straight, relatively thick legs curving outwards, ending in clearly developed swollen tips, 31–40  $\mu\text{m}$ .

**Remarks.** The specimens conform closely to Levinsen's *Esperella cupressiformis* var. *robusta* in shape as well as spicule complement. Lundbeck (1905) assigned this species to the synonymy of *Asbestopluma (Lycopodina) cupressiformis* (Carter, 1874), because of the similarity in spicule sizes and shapes with Carter's descriptions. Lundbeck's specimens as depicted in his pl. II figs 11–14 appear to be different from Carter's drawings

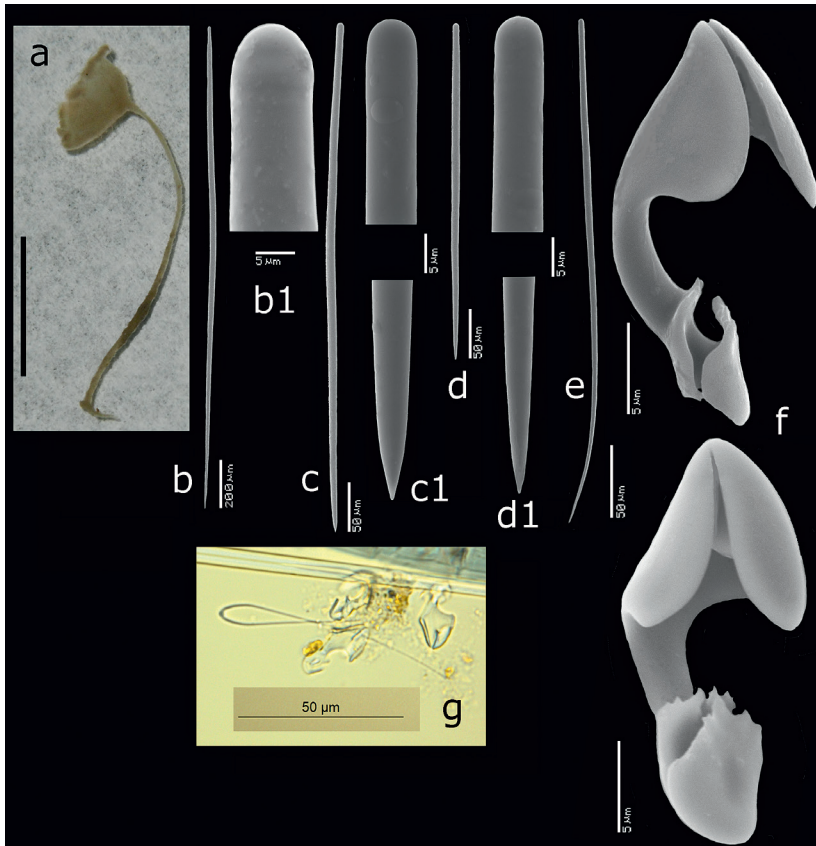


Fig. 12. *Lycopodina infundibulum* (Levinsen, 1887), ZMA Por. 01004, a habitus (scale bar 1 cm); b-g SEM images of spicules; b longest style, b1 detail of head of longest style; c intermediate-sized style, c1 details of apices of intermediate-sized style; d short style, d1 details of apices of short style; e wispy thin style; f anisochelae; g light-microscopic image of rare forcipes.

(1874: pl. 14 figs 16-19). Possibly, some of Lundbeck's specimens, e.g. those reported from The Faroes, are genuine *L. cupressiformis*, but others, e.g. those from East Greenland may possibly be a different species. Spicule sizes of Lundbeck and the present ones are more or less the same as those of Carter's specimens, but the differences in habitus point toward specific difference.

*Lycopodina infundibulum* (Levinsen, 1887) (Fig. 12a-g)

*Esperella infundibulum* Levinsen, 1887: 366, p. 29 fig. 14, pl. 31 figs 17-19.

*Asbestopluma (Lycopodina) infundibulum*; Lundbeck, 1905: pl. 2 figs 20-21, pl. 11 fig. 9.

*Lycopodina infundibulum*; Hestetun *et al.*, 2015: 335.

**Material.** ZMA Por. 01004, Russia, Kara Sea, Varna Expedition, locality not noted on the available labels, depth between 75 and 170 m, coll. J.M. Ruijs, 1882-1883; label text: 'Esperella infundibuliformis Lev. n.var., E. Arnesen det.'.

**Description.** A single specimen (Fig. 12a), light brown in alcohol, consisting of an open cup-shaped main body with a thin curved stalk ending in a small hold-fast. Total length of specimen 27 mm, stalk  $20 \times < 1$  mm, size of cup  $9 \times 5$  mm.

**Skeleton.** Stalk consists of aligned tightly packed styles, main body a confused mass of styles with anisochelae crowded over the surface.

**Spicules.** (Fig. 12b-g) Styles, anisochelae, forcipes.

Styles in a large size range, but not clearly separable in categories, overall size  $155-1340 \times 5.5-20 \mu\text{m}$ , but with some overlappings three categories may be distinguished, (1) the larger styles (Fig. 12b, b1) are usually  $>1000 \times 15-20 \mu\text{m}$ , (2) intermediate sizes, usually  $300-600 \times 5-10 \mu\text{m}$ , normal shaped (Fig. 12c, c1), or with thin wispy ends (Fig. 12e), the latter from the cup walls, and (3) short styles (Fig. 12d, d1),  $155-420 \times 2-5 \mu\text{m}$ , apparently from the rim of the cup (cf. Lundbeck, 1905: 69).

Anisochelae (Fig. 12f), with upper side alae only partially covering the shaft, which is naked for approximately 1/3 of its length, lower alae with spiked rims,  $16-23 \mu\text{m}$ .

Forceps (Fig. 12g), not common (not found on the SEM stub, only on the glass slide), size 65-70  $\mu\text{m}$ .

*Remarks.* The label text, which was made by the original identifier, the Norwegian spongologist E. Arnesen, concluded that this specimen belongs to an undescribed variety of *Asbestopluma (Lycopodina) infundibulum*. However, Lundbeck's (1905) extensive treatment of specimens from the The Faroes as well as specimens from the Kara Sea from Levinsen's collection, shows that there is no difference between his descriptions and the present specimen.

Family Esperiopsidae (?)

*Semisuberites cribrosa* (Miklucho-Maclay, 1870) (Fig. 13a-c)

*Veluspa polymorpha* var. *cribrosa* Miklucho-Maclay, 1870: 6, pl. 1 figs 12-16.

*Semisuberites artica* Carter, 1877: 39.

*Cribrochalina sluiteri* Vosmaer, 1882: 36, pls 1 and 3; Levinsen, 1887: 352, pl. 29 figs 6-9, pl. 30 fig. 6.

*Tragostia sluiteri*; Rezvoi, 1924: 246.

*Semisuberites cribrosa*; Van Soest and Hajdu, 2002: 661 (with further synonyms and discussions).

*Material.* ZMA Por. 2400a, Russia, Kara Sea, Varna Expedition, locality not noted on the available labels, depth between 75 and 170 m, coll. J.M. Ruijs, 1882-1883; label text: 'Tragostia sluiteri (Vosm.), 20', no identifier; ZMA Por. 2400b, Russia, Kara Sea, Varna Exped. stat. 20, 71.1333°N 64.45°E, depth 92 m, coll. J.M. Ruijs, 20 February 1883, label text: 'Tragostia sluiteri (Vosm.), det. E. Arnesen'; ZMA Por. 02400c, Russia, Kara Sea, Varna Exped. stat. 20, 71.1333°N 64.45°E, depth 92 m, coll. J.M. Ruijs, 20 February 1883, label text: 'Tragostia sluiteri (Vosm.), det. E. Arnesen'; ZMA Por. 02004d, Russia, Kara Sea, Varna Exped. stat. 3, 70.25°N 60.4167°E, depth 77.5 m, coll. J.M. Ruijs, 1 September 1882, label text: 'Tragostia sluiteri (Vosm.), det. E. Arnesen'; ZMA Por. 2400e, Russia, Kara Sea, Varna Exped. stat. 20, 71.1333°N 64.45°E, depth 92 m, coll. J.M. Ruijs, 20 February 1883, label text: 'Tragostia sluiteri (Vosm.), det. E. Arnesen'; ZMA Por. 02004f, Russia, Kara Sea, Varna Exped. stat. 70, 71.3333°N 63.6333°E, depth 77.5 m,

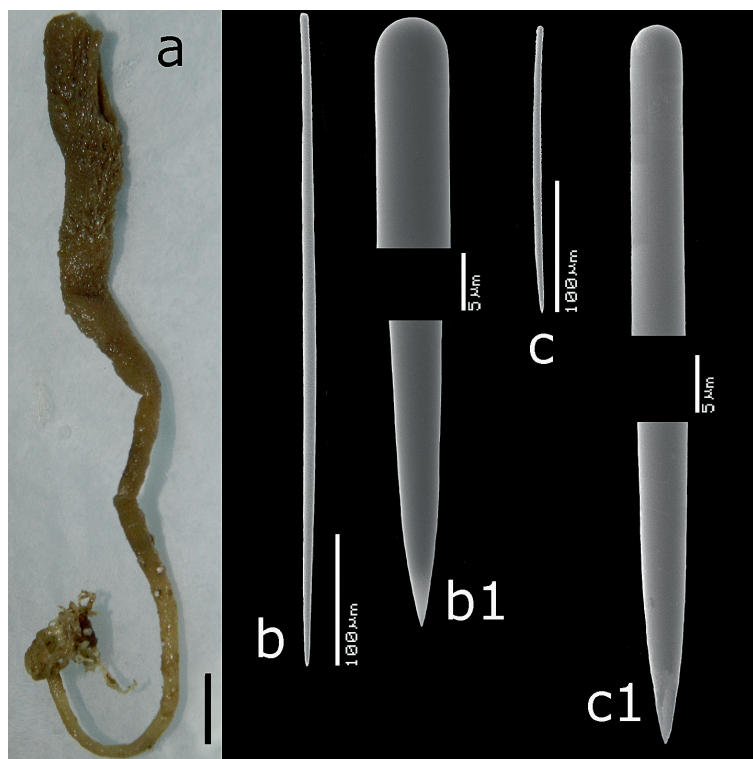


Fig. 13. *Semisuberites cribrosa* (Miklucho-Maclay, 1870), ZMA Por. 02004a, a habitus (scale bar 1 cm); b-c SEM images of spicules; b long style, b1 details of apices of long style; c short style, c1 details of apices of short style.

coll. J.M. Ruijs, 20 February 1883, label text: 'Tragosia sluiteri (Vosm.), det. E. Arnesen'; ZMA Por. 15282, Russia, Kara Sea, Varna Expedition, locality not noted on the available labels, depth between 75 and 170 m, coll. J.M. Ruijs, 1882-1883; label text: 'Hymeniacion spec.', no further text, no identifier.

*Description.* Numerous specimens of brown-colored (alcohol preserved) stalked tubular sponge (Fig. 13a) with a wide, occasionally flaring or with outwardly curved vent ('trumpet-shaped'). Largest available specimen 18 cm high, stalked part approximately  $10 \times 0.4/0.5$  cm grading into the tubular body of  $7-8 \times 1.5$  cm, vent approximately 1 cm in diameter. Surface irregular, without macroscopic openings. Consistency soft, limp.

*Skeleton.* Loosely reticulated with vaguely delimited spicule tracts rising upwards in the wall of the tubes giving rise to frequent perpendicular or oblique side tracts, equally vaguely delimited, ending in loose bouquets at the surface. The smaller spicules are concentrated in the surface bouquets, the larger spicules make up the choanosomal tracts.

*Spicules.* Styles only.

Styles (Fig. 13b-c), smooth, faintly fusiform, in two overlapping size categories, (1) (Fig. 13b, b1)  $500-565 \times 9-11 \mu\text{m}$ , (2) (Fig. 13c, c1)  $215-260 \times 5-7 \mu\text{m}$ .

*Remarks.* The specimens match those of the revised description in Van Soest and Hajdu (2002), but swollen heads are absent in the specimens studied here. The affiliation of *Semisuberites* should be investigated anew, as the lack of chelae, the size categories of the styles and the structure of the skeleton renders membership of the order Poecilosclerida and family Espeperiopsidae less likely. These are indications that the genus should be referred to the order Suberitida, along with the genus *Ulosa*, which is a likely Suberitida, according to molecular sequence data presented by Redmond *et al.*, 2013.

*Additional 'Varna' material.* Two additional Dutch Polar Expedition samples are present in the Naturalis sponge collection, ZMA Por. 15316 labelled 'Hymeniacion spec.', no identifier mentioned, which appears to be an indeterminable piece of an *Asbestopluma* or *Lycopodina* stalk, the other ZMA Por. 01077 labelled 'Ficulina sp., E. Arnesen det.', which turned out to be an encrusting colonial tunicate, possibly *Didemnum* sp.

Table 3. Sponges reported from the Kara Sea. The first four columns provide the identities of 60 species under the currently accepted systematics with as references either the World Porifera Database (Van Soest *et al.*, 2015, consulted on May 30, 2015) or the present study. The next three columns provide one or more original genus and species names for the Kara Sea species and their original references.

| Higher taxa   | Accepted genus                                 | Accepted species                     | Reference accepted combination | Original genus record | Original species record   | Reference for Kara Sea occurrence  |
|---|--|--------------------------------------|--------------------------------|-----------------------|---|--|
| Class Demospongiae Sollas, 1885                                   |  |                                      |                                |                       |   |  |
| Subclass Heteroscleromorpha Cárdenas, Perez & Boury-Esnault, 2012 |  |                                      |                                |                       |   |  |
| Order Tetractinellida Marshall, 1876                              |  |                                      |                                |                       |   |  |
| Suborder Astrophorina Sollas, 1887                                |  |                                      |                                |                       |   |  |
| Family Theneidae Carter, 1883                                     | <i>Thenea</i>                                  | <i>valdiviae</i><br>Lendenfeld, 1907 | present study                  | <i>Thenea</i>         | <i>muricatum</i><br>(Bowerbank, 1858)<br><i>muricatum</i><br>(Bowerbank, 1858)  | Levinsen, 1887<br>Rezvoi, 1924, 1931   |
| Suborder Spirophorina Berquist & Hogg, 1969                       |  |                                      |                                |                       |   |  |
| Family Tetillidae Sollas, 1886                                    | <i>Tetilla</i>                                 | <i>polyura</i><br>Schmidt, 1870      | present study                  | <i>Tetilla</i>        | <i>polyura</i><br>Schmidt, 1870<br><i>polyura</i><br>Schmidt, 1870<br><i>sandalina</i><br>Sollas, 1886  | Levinsen, 1887<br>Rezvoi, 1924<br>present study  |
| Order Polymastiida Morrow & Cárdenas, 2015                        |  |                                      |                                |                       |   |  |
| Family Polymastiidae Gray, 1867                                   | <i>Polymastia</i>                              | <i>uberrima</i><br>(Schmidt, 1870)   | WPD 2015                       | <i>Polymastia</i>     | <i>uberrima</i><br>(Schmidt, 1870)<br><i>uberrima</i><br>(Schmidt, 1870)<br><i>penicillus</i><br>(Montagu, 1814)<br><i>hemisphaerica</i><br>(Sars, 1872)<br><i>hemisphaerica</i><br>Sars, 1872<br><i>mamillaris</i><br>(Müller, 1806) | Rezvoi, 1931<br>Koltun, 1959<br>Levinsen, 1887<br>Rezvoi, 1924<br>Rezvoi, 1931<br>Koltun, 1966   |
| Order Suberitida Chombard & Boury-Esnault, 1999                   |  |                                      |                                |                       |   |  |
| Family Stylocordylidae Topsent, 1892                              | <i>Stylocordyla</i>                            | <i>borealis</i><br>(Lovén, 1868)     | present study                  | <i>Stylocordyla</i>   | <i>borealis</i><br>(Lovén, 1868)<br><i>borealis</i><br>(Lovén, 1868)<br><i>bibula</i><br>(Schmidt, 1870)<br><i>panicea</i> (Pallas, 1766)<br><i>panicea</i><br>(Pallas, 1766)<br><i>oblonga</i>                                       | Levinsen, 1887<br>Rezvoi, 1931<br>Levinsen, 1887<br>Rezvoi, 1924<br>Koltun, 1959<br>Koltun, 1959 |
| Family Halichondriidae Gray, 1867                                 | <i>Halichondria</i><br>( <i>Halichondria</i> ) | <i>panicea</i><br>(Pallas, 1766)     | WPD 2015                       | <i>Halichondria</i>   | <i>panicea</i> (Pallas, 1766)<br><i>panicea</i><br>(Pallas, 1766)<br><i>oblonga</i>   | Rezvoi, 1924<br>Koltun, 1959<br>Koltun, 1959   |

|  |                          |                          |               |  |                      |  |  |  |   |
|--|--------------------------|--------------------------|---------------|--|----------------------|--|--|--|---|
|  | (Hansen, 1885)           |                          |               |  | <i>Haltichondria</i> |  |  |  | (Hansen, 1885)                          |
|  | <i>Haltichondria</i>     | <i>sitiens</i>           | WPD 2015      |  | <i>Haltichondria</i> |  |  |  | <i>sitiens</i>                          |
|  | ( <i>Eumastia</i> )      | (Schmidt, 1870)          |               |  | <i>Haltichondria</i> |  |  |  | (Schmidt, 1870)                         |
|  | <i>Hymeniacion</i>       | <i>assimilis</i>         | WPD 2015      |  | <i>Hymeniacion</i>   |  |  |  | <i>assimilis</i>                        |
|  | (Levinsen, 1887)         |                          |               |  |                      |  |  |  | Levinsen, 1887                          |
|  | <i>Hymeniacion</i>       | <i>perlevis</i>          | WPD 2015      |  | <i>Hymeniacion</i>   |  |  |  | Levinsen, 1887                          |
|  |                          | (Montagu, 1814)          |               |  |                      |  |  |  | Levinsen, 1887                          |
|  | <i>Suberites</i>         | <i>montalbidus</i>       | WPD 2015      |  | <i>Suberites</i>     |  |  |  | (Bowerbank, 1866)                       |
|  |                          | Carter, 1880             |               |  |                      |  |  |  | <i>montalbidus</i>                      |
|  | <i>Suberites</i>         | <i>spermatozoon</i>      | WPD 2015      |  | <i>Suberites</i>     |  |  |  | Carter, 1880                            |
|  |                          | (Schmidt, 1875)          |               |  |                      |  |  |  | <i>spermatozoon</i>                     |
|  | <i>Isodictya</i>         | <i>palmata</i>           | WPD 2015      |  | <i>Isodictya</i>     |  |  |  | (Schmidt, 1875)                         |
|  |                          | (Ellis & Solander, 1786) |               |  |                      |  |  |  | <i>caulifera</i>                        |
|  | <i>Semisuberites</i>     | <i>cribrosa</i>          | present study |  | <i>Semisuberites</i> |  |  |  | Vosmaer, 1882                           |
|  |                          | (Miklucho-Maclay, 1870)  |               |  |                      |  |  |  | <i>compressa</i>                        |
|  | <i>Mycale</i>            | <i>lingua</i>            | WPD 2015      |  | <i>Mycale</i>        |  |  |  | Schmidt, 1870                           |
|  | ( <i>Mycale</i> )        | (Bowerbank, 1866)        |               |  |                      |  |  |  | <i>sluiteri</i>                         |
|  | <i>Mycale</i>            | <i>arctica</i>           | WPD 2015      |  | <i>Mycale</i>        |  |  |  | Vosmaer, 1882                           |
|  | ( <i>Rhaphidotheca</i> ) | (Hentschel, 1929)        |               |  |                      |  |  |  | <i>sluiteri</i>                         |
|  | <i>Mycale</i>            | <i>strelnikovi</i>       | WPD 2015      |  | <i>Mycale</i>        |  |  |  | (Vosmaer, 1882)                         |
|  |                          | Rezvoi, 1924             |               |  |                      |  |  |  | <i>variabilis</i>                       |
|  | <i>Iophon</i>            | <i>picum</i>             | WPD 2015      |  | <i>Iophon</i>        |  |  |  | (Vosmaer, 1882)                         |
|  | (Vosmaer, 1882)          |                          |               |  |                      |  |  |  | <i>cribrosa</i> (Miklucho-Maclay, 1870) |
|  | <i>Iophon</i>            | <i>picca</i>             | WPD 2015      |  | <i>Iophon</i>        |  |  |  | Maclay, 1870)                           |
|  |                          | (Vosmaer, 1882)          |               |  |                      |  |  |  | <i>vosmaeri</i>                         |
|  | <i>Iophon</i>            | <i>piceus</i>            | WPD 2015      |  | <i>Iophon</i>        |  |  |  | Levinsen, 1887                          |
|  |                          | (Vosmaer, 1882)          |               |  |                      |  |  |  | Levinsen, 1887                          |
|  | <i>Iophon</i>            | <i>frigidus</i>          | WPD 2015      |  | <i>Iophon</i>        |  |  |  | Rezvoi, 1924                            |
|  |                          | Lundbeck, 1909           |               |  |                      |  |  |  | Hentschel, 1929                         |
|  | <i>Iophon</i>            | <i>lingua</i>            | WPD 2015      |  | <i>Iophon</i>        |  |  |  | Koltun, 1959                            |
|  |                          | (Bowerbank, 1866)        |               |  |                      |  |  |  | Levinsen, 1887                          |
|  | <i>Iophon</i>            | <i>arctica</i>           | WPD 2015      |  | <i>Iophon</i>        |  |  |  | Rezvoi, 1924                            |
|  |                          | (Hentschel, 1929)        |               |  |                      |  |  |  | Koltun, 1959                            |
|  | <i>Iophon</i>            | <i>strelnikovi</i>       | WPD 2015      |  | <i>Iophon</i>        |  |  |  | Koltun, 1959                            |
|  |                          | Rezvoi, 1924             |               |  |                      |  |  |  | Koltun, 1959                            |
|  | <i>Iophon</i>            | <i>piceum</i>            | WPD 2015      |  | <i>Iophon</i>        |  |  |  | Fristedt, 1887                          |
|  |                          | (Vosmaer, 1882)          |               |  |                      |  |  |  | Fristedt, 1887                          |
|  | <i>Iophon</i>            | <i>piceus</i>            | WPD 2015      |  | <i>Iophon</i>        |  |  |  | Fristedt, 1887                          |
|  |                          | (Vosmaer, 1882)          |               |  |                      |  |  |  | Fristedt, 1887                          |
|  | <i>Iophon</i>            | <i>frigidus</i>          | WPD 2015      |  | <i>Iophon</i>        |  |  |  | Fristedt, 1887                          |
|  |                          | Lundbeck, 1909           |               |  |                      |  |  |  | Fristedt, 1887                          |
|  | <i>Iophon</i>            | <i>lingua</i>            | WPD 2015      |  | <i>Iophon</i>        |  |  |  | Hentschel, 1929                         |
|  |                          | (Bowerbank, 1866)        |               |  |                      |  |  |  | Hentschel, 1929                         |
|  | <i>Iophon</i>            | <i>arctica</i>           | WPD 2015      |  | <i>Iophon</i>        |  |  |  | Koltun, 1959                            |
|  |                          | (Hentschel, 1929)        |               |  |                      |  |  |  | Levinsen, 1887                          |
|  | <i>Iophon</i>            | <i>strelnikovi</i>       | WPD 2015      |  | <i>Iophon</i>        |  |  |  | Levinsen, 1887                          |
|  |                          | Rezvoi, 1924             |               |  |                      |  |  |  | Levinsen, 1887                          |
|  | <i>Iophon</i>            | <i>piceum</i>            | WPD 2015      |  | <i>Iophon</i>        |  |  |  | Rezvoi, 1924                            |
|  |                          | (Vosmaer, 1882)          |               |  |                      |  |  |  | Hentschel, 1929                         |
|  | <i>Iophon</i>            | <i>piceus</i>            | WPD 2015      |  | <i>Iophon</i>        |  |  |  | Koltun, 1959                            |
|  |                          | (Vosmaer, 1882)          |               |  |                      |  |  |  | Lundbeck, 1905                          |
|  | <i>Iophon</i>            | <i>frigidus</i>          | WPD 2015      |  | <i>Iophon</i>        |  |  |  | Lundbeck, 1905                          |
|  |                          | Lundbeck, 1909           |               |  |                      |  |  |  | Lundbeck, 1905                          |

Family Suberitidae Schmidt, 1870

Order Poecilosclerida Topsent, 1928

Family Isodictyidae Dendy, 1924

Family Esperioptidae Hentschel, 1923

Family Mycalidae Lundbeck, 1905

Family Acarnidae Dendy, 1922

Table 3. cont.

| Higher taxa                        | Accepted genus       | Accepted species                    | Reference accepted combination | Original genus record      | Original species record  | Reference for Kara Sea occurrence |
|------------------------------------|----------------------|-------------------------------------|--------------------------------|----------------------------|--|-----------------------------------|
| Family Microcionidae Carter, 1875  | <i>Iophon</i>        | <i>dubium</i> (Hansen, 1885)        | WPD 2015                       | <i>Iophon</i>              | <i>frigidus</i> Lundbeck, 1909                                       | Hentschel, 1929                   |
|                                    |                      | <i>arcigera</i> Schmidt, 1870       | WPD 2015                       | <i>Artemisina</i>          | <i>piceus dubius</i> (Hansen, 1885)                                  | Koltun, 1959                      |
|                                    |                      |                                     | present study                  | <i>Artemisina</i>          | <i>arcigera</i> Schmidt, 1870  | Koltun, 1959                      |
| Family Hymedesmiidae Topsent, 1928 | <i>Phorbas</i>       | <i>claviger</i> (Levinsen, 1887)    | present study                  | <i>Artemisina</i>          | <i>apollinis</i> (Ridley & Dendy, 1886)                              | Koltun, 1959                      |
|                                    |                      |                                     | WPD 2015                       | <i>Esperella</i> (Myxilla) | <i>clavigera</i> Levinsen, 1887                                      | Levinsen, 1887                    |
|                                    |                      |                                     | WPD 2015                       | <i>Ectyodoryx</i>          | <i>clavigera</i> (Levinsen, 1887)                                    | Koltun, 1959                      |
|                                    |                      |                                     | WPD 2015                       | <i>Hymedesmia</i>          | <i>occulta</i> Bowerbank, 1869                                       | Koltun, 1959                      |
|                                    |                      |                                     | WPD 2015                       | <i>Hymedesmia</i>          | <i>platychela</i> Lundbeck, 1910                                     | Koltun, 1959                      |
|                                    |                      |                                     | WPD 2015                       | <i>Hymedesmia</i>          | <i>peachii</i> Bowerbank, 1882                                       | Koltun, 1959                      |
|                                    |                      |                                     | WPD 2015                       | <i>Hymedesmia</i>          | <i>nummulus</i> Lundbeck, 1910                                       | Koltun, 1959                      |
|                                    |                      |                                     | WPD 2015                       | <i>Hymedesmia</i>          | <i>rhodus</i> (Hentschel, 1929)                                      | Koltun, 1959                      |
|                                    |                      |                                     | WPD 2015                       | <i>Coelosphaera</i>        | <i>tubifex</i> Thomson, 1873   | Koltun, 1959                      |
|                                    |                      |                                     | WPD 2015                       | <i>Coelosphaera</i>        | <i>fragilis</i> (Fristedt, 1885)                                     | Koltun, 1959                      |
| Family Coelosphaeridae Dendy, 1922 | <i>Lissodendoryx</i> | <i>indistincta</i> (Fristedt, 1887) | WPD 2015                       | <i>Lissodendoryx</i>       | <i>indistincta</i> (Fristedt, 1887)                                  | Koltun, 1959                      |
|                                    |                      |                                     | WPD 2015                       | <i>Lissodendoryx</i>       | <i>topsenti</i> Lundbeck, 1905                                       | Koltun, 1959                      |
|                                    |                      |                                     | WPD 2015                       | <i>Forcepia</i>            | <i>topsenti</i> Lundbeck, 1905                                       | Koltun, 1959                      |
|                                    |                      |                                     | WPD 2015                       | <i>Cladorhiza</i>          | <i>arctica</i> Koltun, 1959  | Koltun, 1959                      |
|                                    |                      |                                     | WPD 2015                       | <i>Coelosphaera</i>        | <i>appendiculata</i> (Carter, 1874)                                  | Koltun, 1959                      |
|                                    |                      |                                     | WPD 2015                       | <i>Coelosphaera</i>        | <i>fragilis</i> (Fristedt, 1885)                                     | Koltun, 1959                      |
|                                    |                      |                                     | WPD 2015                       | <i>Lissodendoryx</i>       | <i>indistincta</i> (Fristedt, 1887)                                  | Koltun, 1959                      |
|                                    |                      |                                     | WPD 2015                       | <i>Lissodendoryx</i>       | <i>topsenti</i> Lundbeck, 1905                                       | Koltun, 1959                      |
|                                    |                      |                                     | WPD 2015                       | <i>Forcepia</i>            | <i>topsenti</i> Lundbeck, 1905                                       | Koltun, 1959                      |
|                                    |                      |                                     | WPD 2015                       | <i>Cladorhiza</i>          | <i>arctica</i> Koltun, 1959  | Koltun, 1959                      |
| Family Cladorhizidae Dendy, 1922   | <i>Lycopodina</i>    | <i>robusta</i> (Levinsen, 1887)     | present study                  | <i>Esperella</i>           | <i>cupressiformis</i> var. <i>ro-</i><br><i>busta</i> Levinsen, 1887 | Levinsen, 1887                    |
|                                    |                      |                                     | present study                  | <i>Asbestopluma</i>        | <i>cupressiformis</i> (Carter, 1874)                                 | Koltun, 1959                      |
|                                    |                      |                                     | present study                  | <i>Esperella</i>           | <i>cupressiformis</i> var. <i>cupressiformis</i>                     | Levinsen, 1887                    |
|                                    |                      |                                     | present study                  | <i>Asbestopluma</i>        | <i>lycopodium</i> Levinsen, 1887                                     | Koltun, 1959                      |
|                                    |                      |                                     | present study                  | <i>Esperella</i>           | <i>lycopodium</i> Levinsen, 1887                                     | Koltun, 1959                      |
|                                    |                      |                                     | present study                  | <i>Esperella</i>           | <i>infundibulum</i> Levinsen, 1887                                   | Levinsen, 1887                    |
|                                    |                      |                                     | present study                  | <i>Asbestopluma</i>        | <i>infundibulum</i> Levinsen, 1887                                   | Koltun, 1959                      |
|                                    |                      |                                     | present study                  | <i>Esperella</i>           | <i>infundibulum</i> Levinsen, 1887                                   | Levinsen, 1887                    |
|                                    |                      |                                     | present study                  | <i>Asbestopluma</i>        | <i>infundibulum</i> Levinsen, 1887                                   | Koltun, 1959                      |
|                                    |                      |                                     | present study                  | <i>Esperella</i>           | <i>infundibulum</i> Levinsen, 1887                                   | Levinsen, 1887                    |





Table 3. cont.

| Higher taxa  | Accepted genus                          | Accepted species                         | Reference accepted combination | Original genus record                   | Original species record  | Reference for Kara Sea occurrence                                 |
|--|---|--|--------------------------------|---|--|---|
| Order Biemnida Morrow, 2013<br>Family Biemnidae Hentschel, 1923  | <i>Biemna</i>                           | <i>variantia</i><br>(Bowerbank, 1858)    | WPD 2015                       | <i>Gellius</i>                          | <i>capilliferus</i><br>Levinsen, 1887<br><i>capillifera</i><br>(Levinsen, 1887)<br><i>variantia capillifera</i><br>(Levinsen, 1887)<br><i>variantia hamifera</i><br>(Lundbeck, 1902) | Levinsen, 1887<br>Hentschel, 1929<br>Koltun, 1959<br>Koltun, 1959 |
| Subclass Keratosa Grant, 1861<br>Order Dictyoceratida Minchin, 1900<br>Family Dysideidae Gray, 1867                                      | <i>Dysidea</i>                          | <i>fragilis</i><br>(Montagu, 1814)       | WPD 2015                       | <i>Dysidea</i>                          | <i>fragilis</i><br>(Montagu, 1814)   | Koltun, 1959  |
| Order Dendroceratida Minchin, 1900<br>Family Dictyodendrillidae Bergquist, 1980  | <i>Spongionella</i>                     | <i>pulchella</i><br>(Sowerby, 1804)      | WPD 2015                       | <i>Spongionella</i>                     | <i>carteri</i><br>(Burton, 1930)   | Koltun, 1959  |
| Class Calcareo Bowerbank, 1862<br>Subclass Calcinea Bidder, 1898<br>Order Clathrinida Hartman, 1958<br>Family Clathrinidae Minchin, 1900 | <i>Clathrina</i>                        | <i>blanca</i><br>(Miklucho-Maclay, 1870) | WPD 2015                       | <i>Leucosolenia</i>                     | <i>blanca</i><br>(Miklucho-Maclay, 1870)   | Levinsen, 1887  |
| Subclass Calcaronea Bidder, 1898<br>Order Leucosolenida Hartman, 1958<br>Family Leucosoleniidae Minchin, 1900                            | <i>Leucosolenia</i>                     | <i>complicata</i><br>(Montagu, 1814)     | WPD 2015                       | <i>Leucosolenia</i>                     | <i>fabricii</i><br>(Schmidt, 1869)   | Levinsen, 1887  |
| Family Syceetidae Dendy, 1893  | <i>Sycon</i>                            | <i>arcticum</i><br>(Haeckel, 1870)       | WPD 2015                       | <i>Sycon</i>                            | <i>arcticum</i><br>(Haeckel, 1870)<br><i>coronatum</i><br>(Ellis & Solander, 1786)   | Levinsen, 1887<br>Rezvoi, 1931                                    |
| Family Jenkinidae Borojevic, Boury-Esnault & Vacelet, 2000   | <i>Breitfussia</i><br>(Breitfuss, 1896) | <i>schulzei</i>                          | WPD 2015                       | <i>Achramorpha</i><br>(Breitfuss, 1896) | <i>schulzei</i>  | Rezvoi, 1931  |