

Materials to the Faunistic Study of the White and Barents seas sponges.**6. The origin of the White and Barents seas sponge faunas.**

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Abstract: The history and origin of the White and Barents Seas sponge faunas is probably connected with the end of the Pliocene (about 4 Ma ago). In that time the native-atlantic species of the subtropical-boreal near-Europe distribution might appear forced by the forming of the atlantic boreal region and fall in the surface water temperature. During the Pliocene transgression (about 3.5 Ma ago) some Pacific boreal sponge species had intruded into the North Atlantic established the base to the appearance of the secondary-atlantic wide spread boreal sponges species. About 2.5 Ma ago in the North Bering Sea and North-Eastern Atlantic regions due to the rise in temperature the boreal-arctic species were formed which later have created the background of the sponges faunas of the White and Barents Seas. The history of the modern White and Barents Seas sponge faunas starts at the beginning of the Vurm glacier thawing (10-12 Ka ago) when into the shelf shoal-water regions filled with the cold waters the arctic species could have penetrated. Later on during the rise in temperature widespread boreal-arctic species dispersed from the depths of Polar Basin into the White and Barents Seas. The most intensive penetration of the eurybiont boreal-arctic species began about 8-9 Ka ago connected with the rise in temperature in the White and Barents Seas. During the Littorine Transgression (about 5 Ka ago) boreal and subtropical-boreal sponge species distributed in the investigated areas. The following fall in temperature brought the sponge faunas of the White and Barents Seas to their present condition. The spicule analysis from the Pleistocene deposits in different parts of the Barents Sea revealed that time, direction and itineraries of sponges penetration on its shelf are similar with those of the others benthic groups immigrants. The main sources of the White and Barents Seas sponges faunas are the Norwegian and Greenland basins and the Atlantic district of the Arctic Basin.

Zusammenfassung: Der Beginn der Schwamm-Besiedlung im Weißen Meer und der Barents See fällt vermutlich mit dem späten Pliozän (vor etwa 4 Millionen Jahren) zusammen. In dieser Zeit wanderte wohl begünstigt durch die Etablierung der borealen Atlantik-Region und dem damit verbundenen Temperatur-Sturz des Oberflächenwassers die primäre Poriferen-Assoziation ein, bestehend aus ursprünglich atlantischen Arten (native-atlantic species), die im subtropisch-borealen Bereich vor Europa verbreitet waren. Etwa vor 3,5 Mill. Jahren konnten infolge der Pliozän-Transgression einige Poriferen-Arten der borealen Pazifik-Provinz in den Nordatlantik vorstoßen. Sie bilden die Basis für die weit verbreitete, sekundäre Assoziation borealer Atlantik-Poriferen (secondary-atlantic species). Mit dem Temperaturanstieg vor circa 2,5 Mill. Jahren ändert sich in der nördlichen Bering See und dem NE-Atlantik die Zusammensetzung der boreal-arktischen Poriferen-Fauna. Sie stellt die Basis für die Poriferen-Assoziation des Weißen Meeres und der Barents See. Die Geschichte der modernen Spongienfaunen des Weißen Meeres und der Barents See beginnt mit dem Rückgang der Würm-Vereisung vor etwa 12 000 bis 10 000 Jahren. Durch das Auffüllen der flachen Schelfregionen mit kalten Schmelzwässern konnten die arktischen Poriferen-Arten in dieses Gebiet einwandern. Mit dem nachfolgenden Temperaturanstieg breitete sich, ausgehend von den tiefen Polarbecken, beginnend vor 9000 bis 8000 Jahren eine eurybionte boreal-arktische Poriferen-Assoziation großflächig im Weißen Meer und der Barents See aus. Im Zuge der Littorina-Transgression vor circa 5000 Jahren können boreale und subtropisch-boreale Poriferen-Arten in das Untersuchungsgebiet einwandern. Mit dem darauf wieder einsetzenden Temperaturrückgang gestaltet sich die Poriferen-Vergesellschaftung in ihrer heutigen Zusammensetzung aus. Die Skleren-Analyse pleistozäner Sedimente von verschiedenen Stellen der Barents See belegt, daß zeitliche Abfolgen und Einwanderungsrichtungen der Poriferen-Besiedlung mit denen der übrigen Benthos-Organismen übereinstimmen. So sind die bevorzugten Ausgangsgebiete für die Poriferen-Besiedlung des Weißen Meeres und der Barents See die Becken von Norwegen und Grönland sowie des atlantisch-beeinflußten Arktischen Beckens.

Keywords: Barents Sea, White Sea, Porifera, Fauna origin, Quaternary Period.

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1. Introduction

The White and Barents Seas faunas investigations for more than 100-years, many geological and palaeontological data and palaeogeographical Neogene reconstructions made possible to reassemble the history of population and development of the biocoenoses in these areas (Derjugin, 1928; Gurjanova, 1948; Lavrova, 1960; Strauch, 1972; Golikov, 1976, 1985; Govberg, 1974; Herman & Hopkins, 1980; Babkov & Golikov, 1985; Fedyakov, 1986; Thomson & Vorren, 1986; Barash, 1988; Golikov & Scarlato, 1988). It is revealed that the process of forming the White and Barents Seas ecosystems is closely related with the evolutionary history of the Arctic Ocean and adjacent regions of the Atlantic and Pacific Oceans.

One of the leading positions in the palaeoecological and stratigraphical reconstructions belongs to the micropalaeontological investigations including foraminifera, diatoms and spore-pollen analysis. However, the spicule analysis in such reconstructions play a less significant role. At the same time the spicule analysis is comparatively perspective and promising method. The study of physical, chemical and biocoenotic environmental and distributional conditions of the modern sponges fauna and its species diversity, circumstances of the spicule sediments origin and revealing the variety of the skeleton elements in them (Koltun, 1960, 1966b) are the base of this method. This knowledge using the character of spicules in different sediment layers enable to judge about the sponges inhabiting the investigated areas during the corresponding geological periods. At the same time the data on fossil sponge species composition, ecology and biogeographical peculiarities of species permit to reconstruct the hydrological, physical, chemical, and biocoenotic characteristics of their contemporary environment. Successful use of the spicule method is based on the perfect preservation of spicules. As was shown with the special study of the Mediterranean Sea sediments, the sponge spicules are the most slowly dissolved siliceous skeleton elements (Emelianov, 1966). However, some spicule types are selectively dissolved. Fossil spicule assemblages are therefore changed compared with the living fauna.

In the authors previous publications the results of the taxonomical, comparative-faunistic, biogeographical and ecological analysis of the White and Barents Seas sponge faunas were represented (Ereskovsky, 1993, 1994a, 1994b, 1995a, 1995b). This work is an attempt to reconstruct with the use of spicule analysis elements and literature data the history and the itineraries of the sponges colonizing the White and Barents Seas.

2. Material and methods

Sponge spicules from the samples of Holocene deposits collected in different parts of the Barents Sea were obtained from already processed sediment

powders containing sponge skeleton elements. These powders were acquired from geological sediment cores collected during the cruises of R/V "Dalnie Zelency" in 1983-1986 and courteously placed in our disposal by the researches of the Murmansk Marine Biological Institute Russian Academy of Sciences I.A. Sacharova and A.J. Sharapova. The sediment cores from 13 stations were examined (Fig. 1, Table I).

The Simpson equation was used for the comparison of the fauna similarity in the comparative-faunistic analysis of the sponges faunas of different Arctic and North Atlantic regions (Simpson, 1943). These parameter permit to measure the level of the small fauna inclusion into the greatest one:

$$I_s = \frac{C}{D_{\min}} \times 100\% ,$$

where D_{\min} - the smallest number of species in two compared extractions, C - the number of common species in these extractions. More than 50% similarity was used as a criteria to join extractions.

The biogeographical characteristics of sponge species are the same as in our previous publication (Ereskovsky, 1994a).

3. Results

In the region of the southern part of the Spitzbergen shoals and the mouth of Zuidcap Through all sediment thickness correlated with Holocene is segregated in three layers (Matishov et al., 1989). Sediments attached to Preboreal include both arctic and boreal and boreal-arctic species. A great number of Tetractinomorpha sponge spicules are found in this layer in the Spitzbergen region (St. 391); the most abundant among them are the spicules of atlantic highboreal species *Geodia macandrewii* (Fig. 2a).

In the Zuidcap Through mouth (St. 666) in the same layer the great number of spicules of atlantic boreal-arctic species *Thenea muricata* (Tetractinomorpha) and the oxea of the representatives of wide spread genus *Halichondria* (Ceractinomorpha) (Fig. 2b) are found. This region in Preboreal probably was washed with warm atlantic waters, however the presence of arctic Foraminifera species is indicative of the sufficiently severe environmental conditions. The next layer is attached to the Atlantic Subboreal Period. Here boreal and boreal-arctic species are prevailing. In the Spitzbergen region together with *G. macandrewii* the spicules of atlantic highboreal species *Striphnus ponderosus* appear and in the Zuidcap Through region remain the great number of *T. muricata* spicules. At last in sediments connected with the Subatlantic Period (St. 391) only some macroscleres fragments of Tetractinomorpha sponges are recorded

Table I. Localities of the stations. Compare with Fig. 1.

Station	Depth, m	Latitude, N	Longitude, E
111	166	70°57.0'	35°14.0'
146	285	73°20.0'	34°00.0'
147	230	72°44.2'	35°54.0'
151	200	69°30.0'	35°50.0'
152	150	69°30.0'	34°37.0'
205	410	73°35.0'	29°30.0'
262	236	70°13.0'	32°28.0'
391	225	76°51.0'	13°14.0'
396	130	76°10.2'	28°12.1'
397	240	77°00.0'	31°18.0'
399	240	76°32.3'	38°39.4'
610	980	71°32.8'	15°44.2'
666	380	75°55.0'	15°54.0'

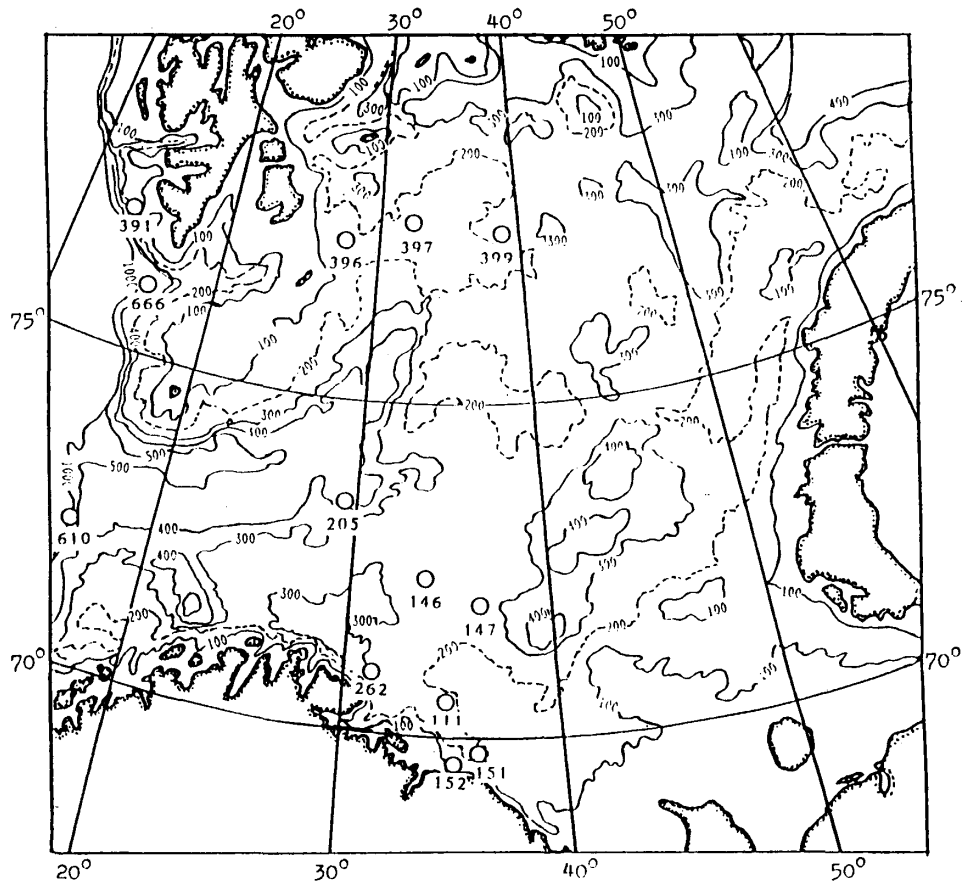


Fig. 1. Map-scheme of the sediment stations location in the Barents Sea used for the micropalaeontological analysis based on sponges spicules.

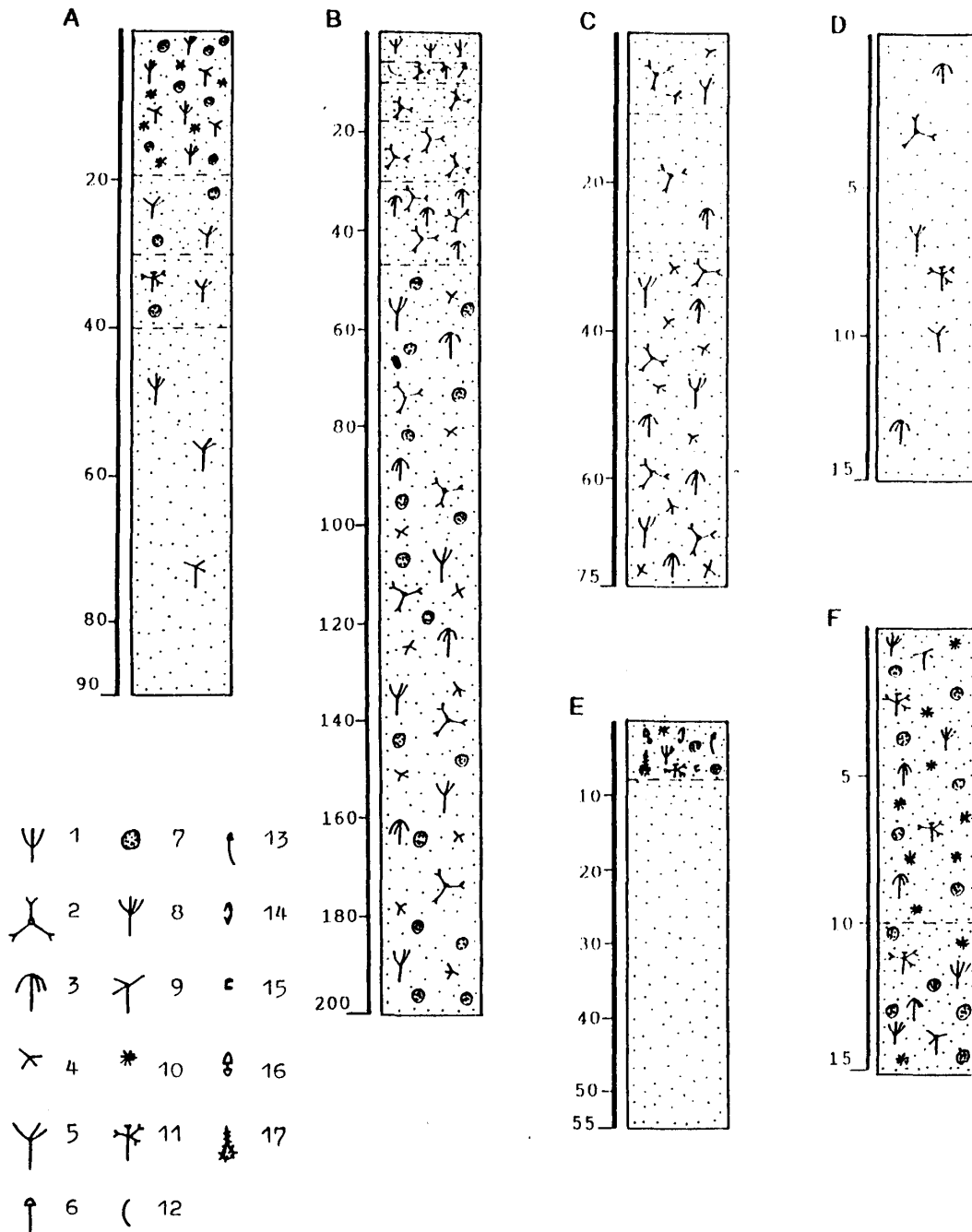


Fig. 2. The sponges spicules distribution in sediments in different regions of the Barents Sea.

a) St. 391; b) St. 666; c) St. 397; d) St. 399; e) St. 262; f) St. 152.

Conventional signs: 1 - plagiotriaene of *Thenea muricata*; 2 - dichotriaene of *T. muricata*; 3 - anatriaene of *T. muricata*; 4 - tylasters of *T. muricata*; 5 - plagiotryaene of *Striphnus*; 6 - sphaerotyle of *Sphaerotylus*; 7 - sterrasters of *Geodia*; 8 - mesotriaene of *Geodia*; 9 - ortotriaene of *Geodia*; 10 - oxyaster of *Geodia*; 11 - dichotriaene of *Geodia*; 12 - oxea of *Halichondria*; 13 - tylostyle of *Suberites*; 14 - diancistra of *Hamacantha implicans*; 15 - bipocilae of *Iophon piceus*; 16 - palmate anisochela of *I. piceus*; 17 - acanthotylostyle of *Hymedesmia*.

and on St. 666 the same spicule composition remains up to the end of sediment core. The data obtained from the sponge analysis are indicative of relatively stable conditions remained in the Late Postglacial Period in the southern Spitzbergen and

Zuidcap Through regions - because the spicules indicated throughout the sediment cores belong to the species flourishing in these areas up to now.

The late Quaternary sediments were exposed on St. 397 and 399 in the Persei Plateau region.

Sedimentation conditions in different sides of the plateau according to the spicules found differed to some extent. Thus in the south-eastern slope (St. 399) rare spicules fragments belonging to indetermined Tetractinomorph sponges are indicated only in the uppermost parts of the sediment core - 0-15 cm (Fig. 2d), whereas in the north-western slope (St. 397) spicules belonging probably to *Thenea muricata* are traced in great number in the layer from 0 up to 30 cm (Fig. 2c). However according to the character of sediments and foraminifera composition both these layers belong to the same period - early Holocene (Matishov et al., 1989). Gradual rise in temperature and the increase of the boreal macrobenthic species number did not reflect significantly the sponges composition in the area. Thus the Persei Plateau was populated with eurybiont sponges species in the early Holocene.

In the northern part of the Bear depression (St. 396) spicules of Tetractinomorph sponges are indicated only in the upper layer of the compressed aleurite (0-9 cm). These deposits are attached to the Atlantic Holocene Period.

In the Demidov Bank region we have checked two stations: 205 and 146. In the north-western extremity of the Bank (St. 205) skeleton elements of Tetractinomorph sponges were found only in the deep layers of sediment cores (183-198 cm) belonging to the end of Boreal - beginning of the Atlantic Period. In the north-eastern extremity of the Bank (St. 146) sponge spicules are in great number traced through the whole core; in the layer from 69 up to 96 cm many sterrasters are present that prove the presence in this region during the Atlantic Period of highboreal or boreal-arctic sponge species of Atlantic origin belonging to genus *Geodia*. It is essential to emphasize that representatives of this genus inhabit only areas with increased activity of waters with oceanic salinity.

In the Central Plateau region (St. 147) aleurite-clayey silt contains numerous sponges spicules in the layer from 42 up to 87 cm. The presence of sterrasters in the macrosclere fragments indicates that here in the Atlantic Period to which this layer belongs representatives of genus *Geodia* were flourishing. Sharp increase of reophyle foraminifera species number in these sediments that is indicative of the Atlantic waters intrusion forcing the rise in temperature and salinity (Polyak et al., 1987), and the presence of *Geodia* indicate high mobility of near-bottom waters.

Similar conditions in the late Holocene can be observed also in the south-western slope region of the Murmansk Bank (St. 111) where analogous skeleton elements complex is traced in sediment cores layer from 9 up to 36 cm. The presence of *Geodia* species here is indicative of the hydrological conditions stability from the Atlantic Period up to now. However in the coastal Murmansk Bank regions (St. 151) spicules are found only in the uppermost (0-6 cm) and lower (90-165 cm) layers. The uppermost one contains the complex of the

siliceous spicules of the species living here up to nowadays. In the middle layer (10-90 cm) remains of benthic organisms are absent. Rare spicules found in the layers 24-27 cm and 54-57 cm might have been brought here with currents. The absence of fossils in the middle layer should be supposed as a result of sediment instability in hilly shallow-water areas and high hydrodynamic activity (Zamilatskaya & Sacharova, 1985; Polyak et al., 1987). In deeper layers not older than 8-9 Ka sterrasters of *Geodia* sp. are found in large amount.

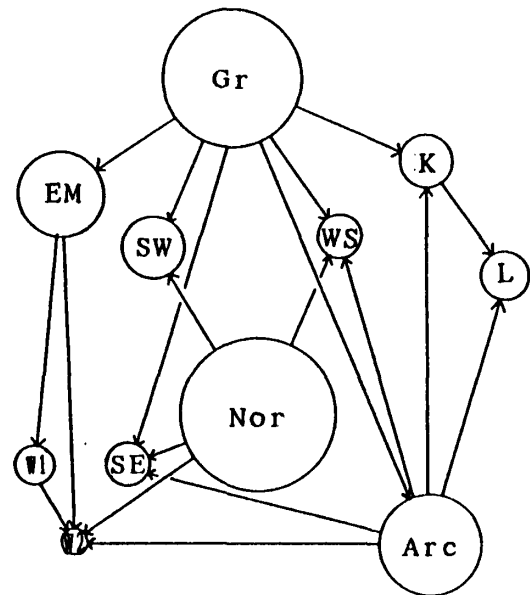


Fig. 3. Graph of 75% pair inclusion of sponges in different regions of the Barents Sea and adjacent aquatoriums (equation (1)).

Conventional signs: Gr - Greenland Sea; Nor - Norwegian Sea; L - Laptev Sea; K - Kara Sea; Arc - Atlantic Sector of the Arctic; SE - south-eastern region of the Barents Sea; EM - East Murman region of the Barents Sea; SW - south-western region of the Barents Sea; WS - west Spitzbergen region; W1 - the first region of the White Sea (include the Onega Bay, Gorlo of the White Sea, west regions of the Dvina Bay and upper sublittoral zone of the Kandalaksha Bay); W2 - the second region of the White Sea (include central depression, Terskiy Coast, south-eastern part of the Gorlo of the White Sea, and north-eastern part of the Dvina Bay).

Diameters of the circles are in proportion with the number of species in the areas.

In the region of the Rybachja (St. 262) and Kildin (St. 152) Banks the abundance of spicules is indicated only from the upper layers of Holocene

deposits up to the Littorine Transgression deposits approximately. The microscopical analysis permit to attribute the spicules found to either sponge species or genus inhabiting these regions in recent times as well. In the Kildin Bank region these are the atlantic highboreal species *Geodia barretti*, *G. macandrewii* and the highboreal species *G. phlegraei* (Fig. 2f). The surface layer of the Rybachja Bank sediments due to the strongly developed sponges community is covered with a thick felt of spicules. They can be found only in the uppermost sediment layer (0-10 cm) (Fig. 2e). This indicates that dense sponges settlements promoting preservation and accumulation of spicules in sediments had developed relatively not long ago during the last several Ka. It goes without saying that before that time from the beginning of the Littorine Transgression sponges were existing here. But due to the strong Murmansk Coastal Current (Ruppin Branch of the Nordcap Current) and active drift of terrigenous material from land spicules were not preserved in the corresponding layers. In the discussed one on the base of skeleton elements were successfully determined *Geodia macandrewii*, *Hamacantha implicans*, *Iophon piceus*, *Hymedesmia* sp., *Suberites* sp., *Thenea muricata*, *Halichondria* sp. In order to make more precise the expansion sources of the contemporary White and Barents Seas sponges faunas the graphs of inclusion according to the equation (1) were assembled (Fig. 3). It is evident from our data that the main source centers from which the two discussed faunas were installed are the Norwegian and Greenland basins and the Atlantic District of the Arctic Ocean.

4. Discussion

It is usual to originate the history of the Barents Sea fauna from the Pliocene Transgression about 3.3-4 Ma ago (Golikov, 1976; Golikov & Scarlato, 1988; Barash, 1988). In its early period when the water temperature was relatively high eurybiont boreal species had penetrated from the Pacific Ocean together with its warm waters via covered with sea north of Canada into the North Atlantic (Gurjanova, 1951; Nesis, 1961; Golikov, 1976; Gladenkov, 1975). Pacific immigrants transformed by the atlantic waters and native-atlantic species of the Tethys origin composed the base of the fauna that populated the Barents Sea shelf.

However about 2.5-3 Ma ago the active fall in sea temperature began forced by the climate changes that caused the forming of the Greenland and Iceland continental glaciers (Einarsson et al., 1967). Continuing cooling of sea waters in that time provoked the origin of boreal-arctic species in the northern part of the Bering Sea and near-atlantic waters of the Arctic Ocean (Golikov, 1976). They could have penetrated into the Barents Sea both from the North-East and West.

In the beginning of the Pleistocene the mighty regression began coupled with the strong climate

cooling. The decrease of the sea level on 56-750 m below the contemporary caused the isolation of the Arctic Ocean both from the Pacific and Atlantic Oceans (Saks, 1953; Panov, 1946; Kotenev, 1970; and others). The termination of the North-Atlantic Current flow to the European coasts should be supposed one of the main causes of the Pleistocene glaciation. Fall in water temperature in the Arctic Ocean below zero all year round could be endured only by eurybiont boreal-arctic species both of the Pacific and Atlantic origin. These species could have survived in the Polar Basin depressions. Here from them the arctic species have originated - endemic to the Arctic Ocean. Among sponges inhabiting now bathyal and pseudoabyssal zones of the Polar Basin such species should be supposed the following ones (Koltun, 1970): A) in bathyal - Tetractinomorpha sponges: *Geodia mesotriaena*, *Polymastia thielei*, *P. sol sol*; Ceractinomorpha sponges: *Raphydotheca arctica*; B) in pseudoabyssal - Tetractinomorpha sponges: *Thenea abyssorum*; Ceractinomorpha sponges: *Cladorhiza gelida*, *Cl. arctica*, *Forcepia topsenti*; Hexactinellid sponges: *Caulophacus arcticus*. The closest relatives of these species (except *Cl. gelida*, *Cl. arctica*, *C. arcticus*) should be supposed correspondingly (Koltun, 1966, 1970): *Geodia barretti*, *Polymastia ueberima*, *P. hemisphaericum*, *Raphydotheca marshalli*, *Thenea muricata*, *Forcepia fabricans*.

As a result of the following Sicilian Transgression when the temperature increased by 2-3° C the new phase of colonizing the Polar seas by the boreal species began. The subsequent queue of Quaternary glaciations and interglacial transgressions play an important role in forming the contemporary bottom relief in the Barents Sea although the most ancient morphostructures have been developing from Paleozoic Period (Matishov, 1977, 1984; Grosvald, 1983). The character and position of macrostructures of the Barents Sea shelf relief reflected in the peculiarities of hydrology and sedimentation here. And these in its turn affected the itineraries and features of the Barents Sea bottom fauna immigration.

The palaeogeographic reconstructions of the Barents Sea glaciations carried out with some authors revealed that during the last glaciations shelf glaciers have crushed nearly the whole shelf fauna of the Sea (Grosvald, 1983; Matishov, 1984). However, many of the cold-water species were retained in bathyal and pseudoabyssal arctic zones while more thermophile ones refuged in the southern and south-western regions of the North Atlantic. In shelf deposits of the pre-Holocene period the remainings of the sea fauna found in the primary bedding are absent. There are no chlorophyll here and the organic carbon concentration is extremely low. These facts permit to suppose that the origin of these sediments occurred in freshwater environment (Lapina et al., 1970; Blajchishin & Linkova, 1977; Kotenev, 1979; and others). About 15 Ka ago the gradual melting of the Vurm glacier began and near

the Alered Time the Barents Sea shelf became free from ice, continental ice remained only in the coastal zone (Lavrova, 1960; Grosvald, 1983). As a result of thawing the cold strongly refreshed waters were produced which are correspondent to the contemporary estuary-arctic water mass. Because of this the first immigrants directed towards the Barents Sea shelf were the estuary-arctic species. However, species connected with the estuary-arctic complexes are absent among the sponges contemporary living here. This is why during the last Barents Sea immigration phase sponges appeared here later than other more eurytherm benthic groups (such as crustaceans, mollusks, polychaetes and others).

During the Yoldia Transgression (about 10-12 Ka ago) the Surface Arctic water mass was recreated on the Barents Sea shelf. In the shoals and later on in more deep-water parts of the Sea the atlantic highboreal conditions appeared that enabled expansion of the eurybiont boreal species (Golikov, 1976; Golikov & Scarlato, 1988).

About 6 Ka ago the Atlantic Transgression began followed with the rise in water temperature by 2-3° C. Such conditions allowed atlantic subtropical-boreal species to settle down in the Barents Sea. Arctic species were pressed away into the deeper and more cold-water northern and eastern parts of the Sea. They might be preserved in fjords and barred basins as a relicts.

The following oscillations of climate and sea level were not significant and did not force essential changes in the Barents Sea ecosystems. However the alternation of rising and falling of temperature constrained the displacements of the cold- and warm-water complexes either to North or South in dependence of climate changes occurring in the corresponding time interval (Galkin, 1986, 1988). Thus the Barents Sea sponge fauna assumed its present appearance approximately 4-5 Ka ago, however its most archaic elements traced their history from Pliocene-Pleistocene period, i.e. are about 2-3 Ma old.

The history of the White Sea sponge fauna development have its beginning only in Holocene, i.e. in the time of the Vurm glacier melting. About 15 Ka ago all the White Sea depression was filled with ice that have crushed the basin inhabitants. The release from ice began in early Drias (12-14 Ka ago). Due to the glacier melting in the regions of contemporary Dvina and Onega Bays the postglacial lakes were formed (Avilov, 1956; Lavrova, 1960). Active residual glaciers melting occurred in this period (about 12 Ka ago) caused partly with the intensifying of the warm North Atlantic Current inflow along the Scandinavian and Murman shores. Also in this period the entering of the cold waters from the Barents Sea began that produced the brackish-water basin with the salinity of about 7-17 ‰ (Babkov & Golikov, 1984). Conditions suitable for the development of the estuary-arctic complex appeared as a result of the Basin and branching bays water mixtion. The first arctic immigrants from the Barents

Sea invaded into these refreshed waters. About 10 Ka ago arctic species have their most intensive penetration into the White Sea coupled with the cold and salt marine waters. It is obvious that these waters represented the Surface Arctic water mass (Babkov & Golikov, 1984). The arctic species penetration period was not long - about 2 Ka.

Conditions promoting the arctic species implanting were of short duration. That, together with the severe Gorto of the White Sea regime and low salinity of its waters probably served as a barrier for the arctic species penetration into the White Sea. According to our data the arctic sponges species are absent in the White Sea (Ereskovsky, 1993). The study of the sponges attitude to the salinity revealed that nearly all arctic species inhabiting adjacent to the discussed area aquatoriums are stenohaline ones and are not indicated at the salinity lower than 32 ‰ (Ereskovsky, 1994a, 1994b).

About 8-9 Ka ago warming up in summer of deeper and deeper water layers permitted eurybiont boreal-arctic species which are able to inhabit both arctic and cooled boreal waters to get over the Gorto of the White Sea. Now boreal-arctic species compose 52.5% of the White Sea sponge fauna (Ereskovsky, 1994a). This is why it may be supposed that from this period up to the end of the Atlantic Transgression penetration of sponges into the discussed Sea was most intensive. Further rise in temperature and salinity (up to 20-24 ‰) of the surface White Sea waters favoured the thermophile boreal species to penetrate into it. The White Sea modification of the Atlantic Highboreal water mass formed up to that time initially was located along the coasts and this is why the first boreal immigrants were shallow-water species (Babkov & Golikov, 1984). In the same time boreal-arctic species continue to intrude in more deeper layers. The population of the White Sea continued approximately up to the end of the Atlantic Transgression. The sponges species observed earlier as thermophile littorine relicts (Gurjanova, 1948) occurred to be synonymous of wide spread boreal-arctic species inhabiting nearly all of the northern and far-eastern Russian seas (Koltun, 1959; Ereskovsky, 1993).

In the following periods conditions in the regions of the Barents Sea adjacent to the White Sea have changed and species potentially able to inhabit the White Sea disappeared from them. Eurybiont species inhabiting now the east-murmansk and south-eastern regions of the Barents Sea can't penetrate into the refreshed White Sea because of their stenohalinity. Relatively more euryhaline from them *Polymastia ueberrima* and *Phakellia bowerbanki* are indicated up to the northern part of the Gorto of the White Sea and *Mycale lingua*, *Lissodendoryx diversichela* and *Tedania suctorica* - only in the Voronka of the White Sea (Ereskovsky, 1994b).

Thus the results of the preliminary investigation of the skeletal sponge elements in

Holocene deposits in the Barents Sea indicate that itineraries, direction and time of sponges immigration into the Barents Sea shelf are similar to those of the others benthic groups immigrants. Due to the absence of long living pelagic or planktonic larvae in sponges the speed of their settling down in the shelf released from glaciers was somewhat lower than in animals having pelagic larvae. However attached in favorable conditions some species due to the good developed asexual reproduction (mainly budding) could develop the vast thickets and supplant many inhabitants of these biotops. Such regions with powerful sponge communities are indicated in the areas of the Kopytov Plateau, west Spitzbergen, to the north from the Rybatchiy Peninsula and along the west margin of the Barents Sea shelf (Ereskovsky, 1995, in press). The results of the mathematical analysis (based on Simpson equation) of the contemporary sponges inhabitants of the Atlantic Sector of the Arctic are in full concordance with data obtained on the base of micropalaeontological reconstructions.

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Appendix: List of Sponges species occurred in various regions of the Barents and White Seas.

Regions of the Barents (No. 1-5) and White (No. 6-12) Seas: 1: South-Western; 2: North-Western; 3: East-Murman; 4: South-Eastern; 5: Northern and North-Eastern; 6: The Kandalakscha Bay; 7: The Onega Bay; 8: The Dvina Bay; 9: The Bassin; 10: The Gorlo; 11: The Mezen Bay; 12: The Funnel.

Taxon	Regions of the Barents Sea					Regions of the White Sea						
	1	2	3	4	5	6	7	8	9	10	11	12

Class Hyalospongiae SCHMIDT, 1860

Ord. Hexasterophora SCHULZE, 1886
 Suborder Lyssacinosa ZITTEL, 1877
 Fam. Rossellidae SCHULZE, 1875

Genus *Asconema* KENT, 1870

<i>Asconema setubalense</i> KENT, 1870	+	+	-	-	+	-	-	-	-	-	-	-
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Genus *Trichasterina* SCHULZE, 1900

<i>Trichasterina borealis</i> SCHULZE, 1900	-	+	+	-	+	-	-	-	-	-	-	-
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Class Demospongiae SOLLAS, 1884

Subclass Homoscleromorpha LEVI, 1953

Ord. Homosclerophorida DENDY, 1905
 Fam. Oscarellidae LENDENFELD, 1887

Genus *Oscarella* VOSMAER, 1887

<i>Oscarella lobularis</i> (SCHMIDT, 1862)	-	-	-	-	+	-	-	-	-	-	-	-
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Subclass Tetractinomorpha LEVI, 1953

Ord. Hadromerida TOPSENT, 1894
 Fam. Clionidae GRAY, 1867

Genus *Cliona* GRANT, 1826

<i>Cliona vastifica</i> HANCOCK, 1849	+	-	+	-	-	+	+	-	-	+	-	-
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Fam. Latrunciliidae BOCAGE, 1869

Genus *Latrunculia* BOCAGE, 1869

<i>Latrunculia triloba</i> (SCHMIDT, 1875)	+	+	-	-	-	-	-	-	-	-	-	-
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Fam. Polymastiidae GRAY, 1867

Genus *Polymastia* BOWERBANK, 1866

<i>Polymastia mamillaris</i> (MULLER, 1806)	-	+	+	+	+	+	+	-	+	+	-	+
<i>Polymastia grimmaldi</i> (TOPSENT, 1913)	+	-	+	+	+	+	+	-	+	+	-	-
<i>Polymastia robusta</i> (BOWERBANK 1861)	+	-	+	-	-	+	-	+	+	-	-	-
<i>Polymastia bursa</i> (MULLER, 1806)	+	+	+	+	+	-	-	-	-	-	-	-
<i>Polymastia hemisphaericum</i> (SARS, 1872)	+	-	+	+	+	-	-	-	-	-	-	-
<i>Polymastia ueberrima</i> (SCHMIDT, 1870)	+	+	+	+	+	-	-	-	-	+	-	+

Taxon	Regions of the Barents Sea					Regions of the White Sea						
	1	2	3	4	5	6	7	8	9	10	11	12
Genus <i>Sphaerotylus</i> TOPSENT, 1898												
<i>Sphaerotylus borealis</i> (SWARCZEWSKY, 1906)	+	-	+	-	+	+	+	+	+	-	-	-
<i>Sphaerotylus schoenus</i> (SOLLAS, 1882)	+	-	+	-	+	-	-	-	-	-	-	-
Genus <i>Tentorium</i> VOSMAER, 1885												
<i>Tentorium semisuberites</i> (SCHMIDT, 1870)	+	+	+	+	+	-	-	-	-	-	-	-
Genus <i>Quasilina</i> NORMAN, 1868												
<i>Quasilina brevis</i> (BOWERBANK, 1861)	+	+	+	+	+	-	-	-	-	-	-	-
Genus <i>Vosmaeria</i> FRISTEDT, 1885												
<i>Vosmaeria crustacea</i> FRISTEDT, 1885	+	-	+	+	-	+	+	-	+	-	-	-
Fam. Suberitidae SCHMIDT, 1870												
Genus <i>Suberites</i> NARDO, 1833												
<i>Suberites domuncula ficus</i> (JOHNSTON, 1842)	+	-	+	+	+	+	+	-	+	-	-	-
<i>Suberites domuncula spermatozoon</i> (SCHMIDT, 1872)	-	-	+	+	+	-	-	-	+	-	-	-
<i>Suberites carnosus</i> (JOHNSTON, 1842)	+	+	+	-	+	+	+	-	-	+	-	-
<i>Suberites montiniger</i> CARTER, 1870	+	+	+	+	+	+	+	-	+	-	-	-
Genus <i>Pseudosuberites</i> TOPSENT, 1896												
<i>Pseudosuberites hyalinus</i> (RIDLEY & DENDY, 1887)	-	-	-	-	+	-	-	-	-	-	-	-
Genus <i>Terpios</i> DUCHASSAING & MICHELOTTI, 1864												
<i>Terpios fugax</i> DUCHASSAING & MICHELOTTI, 1864	-	-	+	-	-	+	+	+	+	+	-	-
Fam. Stylocordylidae TOPSENT, 1928												
Genus <i>Stylocordia</i> THOMSON, 1873												
<i>Stylocordia typica</i> BURTON, 1928	+	+	+	-	+	-	-	-	-	-	-	-
Fam. Tethyidae GRAY, 1867												
Genus <i>Tethya</i> LAMARCK, 1815												
<i>Tethya aurantium</i> (PALLAS, 1766)	+	+	+	+	+	+	+	-	-	-	-	-
Ord. Choristida SOLLAS, 1886												
Fam. Pachastrellidae CARTER, 1875												
Genus <i>Pachastrella</i> SCHMIDT, 1868												
<i>Pachastrella montilifera</i> SCHMIDT, 1868	+	-	-	-	-	-	-	-	-	-	-	-
Fam. Theneidae SOLLAS, 1886												
Genus <i>Thenea</i> GRAY, 1867												
<i>Thenea muricata</i> (BOWERBANK, 1858)	+	+	+	+	+	-	-	-	-	-	-	-
Fam. Stellettidae CARTER, 1875												
Genus <i>Stelletta</i> SCHMIDT, 1862												
<i>Stelletta normani</i> SOLLAS, 1880	+	+	+	-	+	-	-	-	-	-	-	-

Taxon	Regions of the Barents Sea						Regions of the White Sea					
	1	2	3	4	5	6	7	8	9	10	11	12

Genus *Stryphnus* SOLLAS, 1886

<i>Stryphnus ponderosus</i> (BOWERBANK, 1866)	+	+	+	-	+	-	-	-	-	-	-	-
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Fam. Geodiidae GRAY, 1867

Genus *Geodia* LAMARCK, 1815

<i>Geodia macandrewii</i> (BOWERBANK, 1858)	+	+	+	-	+	-	-	-	-	-	-	-
<i>Geodia barretti</i> BOWERBANK, 1858	+	+	+	-	+	-	-	-	-	-	-	-

Ord. Spirophorida LEVI, 1955

Fam. Tetillidae SOLLAS, 1886

Genus *Tetilla* SCHMIDT, 1868

<i>Tetilla polyura</i> SCHMIDT, 1870	+	+	+	+	+	-	-	-	-	-	-	-
<i>Tetilla sibirica</i> (FRISTEDT, 1887)	-	-	+	-	+	-	-	-	-	-	-	-
<i>Tetilla cranium</i> (MULLER, 1776)	+	+	+	+	+	-	-	-	-	-	-	-
<i>Tetilla infrequens</i> (CARTER, 1876)	+	+	-	-	+	-	-	-	-	-	-	-

Ord. Axinellida (LEVI, 1955)

Fam. Axinellidae (CARTER, 1875)

Genus *Axinella* SCHMIDT, 1862

<i>Axinella rugosa</i> (BOWERBANK, 1866)	+	+	+	+	+	-	-	-	-	-	-	-
<i>Axinella ventillabrum</i> (JOHNSTON, 1842)	+	-	-	-	-	-	-	-	-	-	-	-
<i>Axinella vermiculata</i> (BOWERBANK, 1866)	+	+	-	-	+	-	-	-	-	-	-	-

Genus *Phakellia* BOWERBANK, 1864

<i>Phakellia arctica</i> (VOSMAER, 1885)	+	-	+	-	-	-	-	-	-	-	-	-
<i>Phakellia bowerbanki</i> (VOSMAER, 1885)	+	+	+	+	+	-	-	-	-	+	-	+
<i>Phakellia cribrata</i> (MIKLUCHO-MACLAY, 1870)	-	+	+	+	+	+	+	+	+	+	-	+

Subclass Ceractinomorpha LEVI, 1956

Ord. Halichondrida VOSMAER, 1885

Fam. Halichondriidae VOSMAER, 1887

Genus *Halichondria* FLEMING, 1828

<i>Halichondria panicea</i> (PALLAS, 1766)	+	+	+	+	+	+	+	+	+	+	+	+
<i>Halichondria sitiens</i> (SCHMIDT, 1870)	-	-	+	+	+	+	+	+	+	+	+	+

Genus *Hymeniacion* BOWERBANK, 1864

<i>Hymeniacion assimilis</i> (LEVINSEN, 1886)	-	-	+	-	-	-	-	-	-	-	-	-
<i>Hymeniacion caruncula</i> (BOWERBANK, 1866)	-	-	+	+	-	-	-	-	-	-	-	-

Ord. Poecilosclerida TOPSENT, 1828

Fam. Mycalidae LUNDBECK, 1905

Genus *Mycale* LUNDBECK, 1905

<i>Mycale lobata</i> (BOWERBANK, 1866)	-	-	+	+	-	+	+	+	-	+	+	+
<i>Mycale lingua</i> (BOWERBANK, 1866)	+	+	+	+	+	-	-	-	-	-	-	-
<i>Mycale thumatochela</i> LUNDBECK, 1905	-	-	+	-	-	+	+	-	-	-	-	-

Taxon	Regions of the Barents Sea					Regions of the White Sea						
	1	2	3	4	5	6	7	8	9	10	11	12
Genus <i>Rhaphidotheca</i> KENT, 1870												
<i>Rhaphidotheca arctica</i> HENTSCHEL, 1929	-	-	-	-	+	-	-	-	-	-	-	-
Genus <i>Oxymycale</i> HENTSCHEL, 1929												
<i>Oxymycale intermedia</i> (SCHMIDT, 1874)	-	-	+	-	+	-	-	-	-	-	-	-
Fam. Cladorhizidae LAUBENFELS, 1936												
Genus <i>Asbestopluma</i> NORMAN, 1882												
<i>Asbestopluma bichamatifera</i> (CARTER, 1876)	+	-	+	-	-	-	-	-	-	-	-	-
<i>Asbestopluma cupressiformis</i> (CARTER, 1874)	+	-	+	-	+	-	-	-	-	-	-	-
<i>Asbestopluma infundibulum</i> (LEVINSEN, 1886)	-	-	+	-	-	-	-	-	-	-	-	-
<i>Asbestopluma lycopodium</i> (LEVINSEN, 1886)	+	+	+	-	+	-	-	-	-	-	-	-
<i>Asbestopluma pennatula</i> (SCHMIDT, 1875)	+	+	+	-	+	-	-	-	-	-	-	-
Genus <i>Chondracladia</i> THOMSON, 1873												
<i>Chondracladia congregens</i> (HANSEN, 1885)	+	-	+	-	-	-	-	-	-	-	-	-
Fam. Esperiopsidae HENTSCHEL, 1923												
Genus <i>Esperiopsis</i> CARTER, 1882												
<i>Esperiopsis typichela</i> LUNDBECK, 1905	-	-	+	+	+	-	+	-	+	-	-	-
<i>Esperiopsis forcipula</i> LUNDBECK, 1905	-	-	+	-	+	-	-	-	-	-	-	-
<i>Esperiopsis villosa</i> (CARTER, 1874)	+	-	+	-	-	-	-	-	-	-	-	-
Genus <i>Isodictya</i> (BOWERBANK, 1864)												
<i>Isodictya flabelliformis</i> (HANSEN, 1885)	-	-	+	+	-	-	-	-	-	-	-	-
<i>Isodictya palmata</i> (JOHNSTON, 1842)	-	-	-	+	-	+	+	+	+	+	+	+
Fam. Biemnidae HENTSCHEL, 1923												
Genus <i>Biemna</i> GRAY, 1867												
<i>Biemna variantia</i> (BOWERBANK, 1861)	+	+	+	-	+	-	-	-	-	-	-	-
Genus <i>Hamacantha</i> GRAY, 1867												
<i>Hamacantha implicans</i> LUNDBECK, 1902	+	-	+	-	+	-	-	-	-	-	-	-
Genus <i>Tylodesma</i> THIELEI, 1903												
<i>Tylodesma rosea</i> (FRISTEDT, 1887)	+	+	+	-	+	-	-	-	-	-	-	-
Fam. Coelosphaeridae HENTSCHEL, 1923												
Genus <i>Coelosphaera</i> THOMSON, 1873												
<i>Coelosphaera appendiculata</i> CARTER, 1874	+	-	-	-	+	-	-	-	-	-	-	-
<i>Coelosphaera physo</i> (SCHMIDT, 1875)	+	+	+	-	+	-	-	-	-	-	-	-
Genus <i>Cornulum</i> CARTER, 1876												
<i>Cornulum textile</i> CARTER, 1876	+	+	-	-	+	-	-	-	-	-	-	-

Taxon	Regions of the Barents Sea						Regions of the White Sea					
	1	2	3	4	5	6	7	8	9	10	11	12
Genus <i>Plocamionida</i> TOPSENT, 1928												
<i>Plocamionida ambigua</i> (BOWERBANK, 1866)	-	+	+	-	-	+	+	+	+	+	-	-
Fam. Anchinoidae TOPSENT, 1928												
Genus <i>Anchinoe</i> GRAY, 1867												
<i>Anchinoe arneseni</i> TOPSENT, 1913	+	-	-	-	+	-	-	-	-	-	-	-
<i>Anchinoe roemeri</i> HENTSCHEL, 1929	-	-	-	-	+	-	-	-	-	-	-	-
Fam. Hymedesmiidae TOPSENT, 1928												
Genus <i>Hymedesmia</i> BOWERBANK, 1864												
<i>Hymedesmia dermatata</i> LUNDBECK, 1910	-	-	+	-	-	-	-	-	-	-	-	-
<i>Hymedesmia irregularis</i> (LUNDBECK, 1910)	-	-	+	-	-	+	+	+	+	-	-	-
<i>Hymedesmia longurius</i> LUNDBECK, 1910	-	-	+	-	-	+	-	-	-	-	-	-
<i>Hymedesmia occulta</i> BOWERBANK, 1874	-	+	+	-	+	-	-	-	-	-	-	-
<i>Hymedesmia paupertas</i> (BOWERBANK, 1866)	+	-	+	-	-	-	-	-	-	-	-	-
<i>Hymedesmia procumbens</i> LUNDBECK, 1910	-	-	+	-	-	-	-	-	-	-	-	-
<i>Hymedesmia similis</i> LUNDBECK, 1910	+	+	-	+	-	-	-	-	-	-	-	-
<i>Hymedesmia trichoma</i> LUNDBECK, 1910	+	-	-	-	-	-	-	-	-	-	-	-
<i>Hymedesmia truncata</i> LUNDBECK, 1910	-	-	-	-	+	-	-	-	-	-	-	-
<i>Hymedesmia verrucosa</i> LUNDBECK, 1910	-	-	+	-	-	-	-	-	-	-	-	-
Genus <i>Hymenaphia</i> BOWERBANK, 1866												
<i>Hymenaphia stellifera</i> BOWERBANK, 1866	-	-	+	-	-	+	+	-	+	+	+	-
Genus <i>Crellomima</i> REZVOJ, 1925												
<i>Crellomima imparidens</i> (REZVOJ, 1925)	-	-	+	-	-	+	+	-	-	+	-	-
Ord. Haplosclerida TOPSENT 1928												
Fam. Halicionidae LAUBENFELS, 1932												
Genus <i>Haliclona</i> GRANT, 1841												
<i>Haliclona aqueductus</i> (SCHMIDT, 1862)	-	-	+	+	-	+	+	-	-	+	-	-
<i>Haliclona gracilis</i> (MIKLUCHO-MACLAY, 1870)	-	-	+	+	-	+	+	-	+	-	+	-
<i>Haliclona cinerea</i> (GRANT, 1841)	+	+	+	-	-	+	+	-	-	-	-	-
<i>Haliclona schmidtii</i> (LUNDBECK, 1902)	+	-	-	+	-	+	-	-	-	-	-	-
<i>Haliclona ventilabrum</i> (FRISTEDT, 1887)	-	-	+	+	-	-	-	-	-	-	-	-
Genus <i>Gellius</i> GRAY, 1867												
<i>Gellius angulatus</i> LUNDBECK, 1902	-	-	+	-	-	+	+	-	-	-	-	-
<i>Gellius flagellifer</i> (RIDLEY & DENDY, 1886)	-	-	+	-	-	-	-	-	-	-	-	-
<i>Gellius jugosus</i> (BOWERBANK, 1866)	-	-	+	+	+	-	+	-	-	-	-	-
<i>Gellius porosus</i> (FRISTEDT, 1867)	-	+	+	-	+	-	-	-	-	-	-	-
<i>Gellius primitivus</i> LUNDBECK, 1902	-	-	+	-	-	+	+	-	-	+	-	-
Ord. Dictyoceratida MINCHIN, 1900												
Fam. Dysideidae GRAY, 1867												
Genus <i>Dysidea</i> JOHNSTON, 1842												
<i>Dysidea fragilis</i> (MONTAGU, 1818)	+	+	+	+	+	-	+	-	-	+	-	-

Taxon	Regions of the Barents Sea						Regions of the White Sea					
	1	2	3	4	5	6	7	8	9	10	11	12

Fam. Spongiidae GRAY, 1867

Genus *Spongionella* BOWERBANK, 1864

<i>Spongionella carteri</i> (BURTON, 1930)	+	+	+	-	+	-	-	-	-	-	-	-
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Ord. Dendroceratida MINCHIN, 1900
Fam. Halisarciidae VOSMAER, 1885

Genus *Halisarca* JOHNSTON, 1842

<i>Halisarca dujardini</i> JOHNSTON, 1842	-	-	+	-	-	+	+	-	-	+	-	-
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Fam. Aplysillidae VOSMAER, 1883

Genus *Aplysilla* SCHULZE, 1870

<i>Aplysilla glacialis</i> MEREJKOWSKY, 1879	-	-	+	-	-	+	+	-	-	-	-	-
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Class Calcarea BOWERBANK 1864

Subclass Calcaronea BIDDER, 1898

Ord. Leucosoleniida HARTMAN, 1958
Fam. Leucosoleniidae MINCHIN, 1900

Genus *Leucosolenia* (BOWERBANK, 1864)

<i>Leucosolenia complicata</i> (MONTAGU, 1818)	+	+	+	+	-	+	+	-	-	-	-	-
<i>Leucosolenia variabilis</i> (HAECKEL, 1870)	+	-	+	-	-	+	+	-	-	-	-	-

Ord. Sycettida BIDDER, 1898
Fam. Sycettidae DENDY, 1892

Genus *Sycon* (RISSE, 1828)

<i>Sycon ciliatum</i> (FABRICIUS, 1780)	-	+	+	+	-	+	+	-	-	+	-	-
<i>Sycon utriculus</i> (SCHMIDT, 1870)	+	+	+	+	-	-	-	-	-	-	-	-
<i>Sycon arcticum</i> (HAECKEL, 1870)	-	-	+	+	+	-	-	-	-	-	-	-

Fam. Amphoriscidae DENDY, 1892

Genus *Grantessa* (LENDENFELD, 1885)

<i>Grantessa kuekenthali</i> (BREITFUSS, 1898)	+	+	+	+	+	+	+	-	-	-	-	-
<i>Grantessa gracilis</i> (HAECKEL, 1870)	-	+	+	+	+	-	-	-	-	-	-	-

Fam. Grantiidae DENDY, 1892

Genus *Leucandra* (HAECKEL, 1872)

<i>L. valida</i> (LAMBE, 1900)	-	-	+	+	+	-	+	-	+	-	-	-
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Subclass Calcinea BIDDER, 1898

Ord. Clathrinida HARTMAN, 1958
Fam. Clathrinidae MINCHIN, 1900

Genus *Clathrina* (GRAY, 1867)

<i>Clathrina blanca</i> (MIKLUCHO-MACLAY, 1868)	+	+	+	+	+	+	+	-	-	-	-	-
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