THE ARCTIC SEAS

Climatology, Oceanography, Geology, and Biology

Edited by

Yvonne Herman

VAN NOSTRAND REINHOLD COMPANY
New York

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Library of Congress Catalog Card Number 88-33800
ISBN-13:978-1-4612-8022-4 e-ISBN-13:978-1-4613-0677-1
DOI: 10.1007/978-1-4613-0677-1

Designed by Beehive Production Services

Van Nostrand Reinhold
115 Fifth Avenue
New York, New York 10003

Van Nostrand Reinhold (International) Limited
11 New Fetter Lane
London EC4P 4EE, England

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480 La Trobe Street
Melbourne, Victoria 3000, Australia

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1120 Birchmount Road
Scarborough, Ontario M1K 5G4, Canada

16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

Library of Congress Cataloging in Publication Data
The Arctic Seas.
Includes index.
1. Oceanography—Arctic Ocean. 2. Geology—Arctic Ocean. I. Herman, Yvonne.
GC401.A76 1989 551.46'8 88—33800
ISBN-13:978-1-4612-8022-4

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Contents

14: Arctic Ocean Bryozoa

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INTRODUCTION

Bryozoans (Bryozoa, Polyzoa, Ectoprocta) are aquatic colonial animals. A few kinds live in fresh water (class Phylactolaemata) while the majority are marine (class Gymnolaemata and Stenolaemata). The phylum contains over 4,000 living species and about 15,000 extinct species. The colonies are formed by asexual reproduction from one individual, the ancestrula, that arises through metamorphosis of the larva developed by sexual reproduction. The bryozoan colony, the zoarium, is almost always firmly attached to the substratum and can be ramified, lobed, fan-shaped, and very frequently have the appearance of crusts covering the substratum. The size of colonies vary from several millimeters to several decimeters. The colonies consist of individuals, the zooids. Bryozoans are bilaterally symmetrical, coelomic, protostomian animals. As a result of their sessile and colonial way of life, their organization has undergone profound changes in different subclasses.

Note: This chapter has been reviewed, edited, and rewritten by the Editor, Yvonne Herman.

The structure of bryozoans is as follows: Every zooid bears a circlet of tentacles. The mouth is surrounded by tentacles. The anus is located near the mouth, but outside the crown of tentacles. In marine bryozoans, the lophophore, a fleshy structure that surrounds the mouth, is ring-shaped. When the anterior part of the body is withdrawn, the tentacles are also retracted into the body known as the tentacle sheath.

Marine bryozoans have neither heart nor vascular system. The inner zooidal cavity is a coelom that is separated from the lophophore cavity by an incomplete partition. The nervous system comprises a nerve ganglion that lies between the mouth and the anus and a plexus in the body wall. From the nerve ganglion, nerves radiate to the tentacles and other organs. The muscular system consists of circular and longitudinal muscles, namely, circular sphincter muscles, transverse parietal muscles, and strong retractor muscles. Reproduction can be both asexual and sexual; colonies are formed mainly by asexual

reproduction. Most bryozoans are hermaphrodites.

The zooidal body cavity contains gonads of both sexes that develop simultaneously, although some species show a tendency for protandry (functional male gonad maturation precedes female gonad maturation). Spermatozoa are released from the zooidal cavity either through the terminal pores of tentacles, or through the supraneural pore coelomopore situated at the vertex of the funnel between tentacles. In some species, the coelomopore is transformed into an intertentacular organ in which fertilization occurs. Fertilized eggs can be discharged into the sea, although in many marine taxa their development up to larval stage occurs either in the coelom or the zooid in a special brooding chamber (ovicell). The larvae are close to the trochophore and according to some authors may be significant as a dispersal mechanism. After being set free, the larvae swim for a few hours and eventually settle on a suitable substratum, producing through metamorphosis and budding a primary zooid, the ancestrula, which subsequently initiates a colony.

The above-described complex of organs is termed the polypide; it is encased in the exoskeleton of various shapes, called the zooecium or cystid. It is secreted by the body wall, which consists of cellular layers. The zooidal skeleton can be separated, but its walls are usually in touch with other zooecia or zooecia may have common proximal and distal walls. Connection between separate zooids is through single pores or more complex structures (porous lamellae or septa, porous chamber or dietalia) in the cystid walls. The zooecium bears an orifice through which the anterior end of the polypide is protruded. It can be provided with an operculum. The space between the tips of tentacles withdrawn into the tentacle sheath and the orifice is the atrium or vestibulum. The zooecium can be chitinous, jellylike (other polymer of chitin of Insecta), or calcareous.

In bryozoan colonies the zooids are usually polymorphic, that is, there are in addition to the zooids' typical structures: the autozooids, morphologically modified and physiologically specialized zooids such as the heterozooids, including gonozoids (where maturation of sperm and ooecia occurs), the kenozooids (performing supporting function), the avicularia (defense function), the vibracula (apparently providing water current beneath the colony), and other structures (*Treatise on Invertebrate Paleontology*, 1983). The phylum Bryozoa is divided into three classes.

Class Stenolaemata with 6 orders:

Order Cyclostomata (Paleozoic–Recent)
Order Trepostomata (Paleozoic–Triassic)
Order Cystoporata (Paleozoic)
Order Rhabdomesonata (Paleozoic)
Order Cryptostomata (Paleozoic)
Order Fenestrata (Paleozoic)

Class Gymnolaemata with 2 orders:

Order Ctenostomata (Paleozoic–Recent)
Order Cheilostomata (Jurassic–Recent)

Class Phylactolaemata (Carboniferous–Recent)

Bryozoa are known to have been widespread in the Paleozoic seas (7 orders) and are valuable in stratigraphy; their ancestry and early evolutionary relationships are difficult to infer. Skeleton-bearing bryozoans are believed to have evolved during the lower Ordovician (Baltic province), although the high level of organization of the early Ordovician bryozoans suggests that they might have evolved during the early Cambrian. The evolutionary development of skeleton-bearing Bryozoa is divided into large stages, their boundaries corresponding to boundaries of geologic epochs defined by major evolutionary changes that led to a change in the rank of orders (Morosova and Viskova, 1977). The first stage encompasses the period from

early Ordovician up to late Permian; the second stage occurred during the Mesozoic–Cenozoic. During the first stage, 7 orders evolved simultaneously with an abrupt change of genera and families at three boundaries: The first boundary corresponds to the end of the Silurian; the second, to the end of the Devonian; and the third, to the end of the Permian. The second stage covers the Mesozoic–Cenozoic eras. It is noteworthy that the currently accepted systematics of the Bryozoa is far from being adequate, as the paleontological classification is based only on the morphology of skeletal elements.

The Permian is the final period of evolution of Paleozoic bryozoans. Permian taxa were widespread in the World Ocean. However, the Arctic region was rich in bryozoans between the Ordovician and Permian (Astrova, 1965; Morosova, 1981; Morosova and Kruchinina, 1986; Nekchorosheva, 1965, 1966, 1970, 1976). About 300 species described by these authors are used for the stratigraphic division of Paleozoic deposits of this region as well as for dividing the Paleozoic Arctic seas into biogeographic regions.

During the Dzchulphinian and Dorosham times, the bryozoan faunas were declining. They survived only in the Tethys Sea. Nearly all bryozoans had disappeared by the end of the Permian. Only 4 genera (Discritella, Reptonodicava, Paralioclema, and Pseudobatostomella) with few species characterized by simple morphological organization continued to evolve in the Triassic seas (known from the Primorsky Territory and the northeastern USSR) together with a small number of Cyclostomata. The Mesozoic–Cenozoic stage commences in Triassic and is characterized by a different type of bryozoans, which must have given rise to all the younger taxa. Favorable environmental conditions in the Middle Jurassic seas, where the Cyclostomata were probably the only bryozoans, may have triggered their rapid speciation. During the Late Jurassic and throughout the entire Cretaceous period, the Cyclostomata, which were the dominant bryozoans, became ubiquitous in the World Ocean. The penetration of the Cyclostomata to relatively great depths in Campanian and Maestrichtian seas must have been related not only to extensive marine transgressions but also to the rapid development of the Cheilostomata that had evolved in early Jurrasic time (*Pyriporopsis portlandensis*). The Cyclostomata are represented today by relicts of Mesozoic seas.

Another order of recent bryozoans is the Ctenostomata. The fossil record of this group is very scanty because they lack calcareous skeleton; to date 55 genera have been described. They belong to 23 families, 3 of which are Paleozoic while 15 are recent. Most recent species belong to the order Cheilostomata (80 percent of the total number of recent species). In the Early Cretaceous, only the Anasca suborder was represented. Two other suborders, Ascophora and Cribrimorpha, evolved at the beginning of the Late Cretaceous. The end of the Late Cretaceous and the beginning of the Cenozoic are characterized by the extinction of most cribrimorphs and by the diversification of the Anasca and Ascophora. The evolution of bryozoans suggests a parallel evolution of colonies of different phylogenetic branches of the phylum owing to polymorphism. This provided bryozoans with a high degree of adaptation to environmental factors with evolutionary plasticity and led to their flourishing in modern oceans and seas.

Bryozoans, represented by three orders in the World Ocean—the Cyclostomata, Ctenostomata, and Cheilostomata—are a ubiquitous group of aquatic invertebrates. They occur in every climatic zone and inhabit depths ranging from the littoral to the abyssal zones. Bryozoans constitute a part of many marine bottom biocenoses and play an important role in the total economy of the sea. Colonies live on rocks, algae, hydroids, worm tubes, mollusk shells, crab tests, ascidians, corals,

colonies of other bryozoans, fragments of sea urchins' skeletons, and also on various sunken objects such as buoys and nets.

ARCTIC BRYOZOA

The distributional pattern of various biogeographic groups shows that all Arctic seas are dominated by boreal–Arctic* species. The western part of the Barents Sea and areas of the Atlantic Ocean adjoining the Arctic Basin are dominated by Atlantic boreal† species. Boreal species† are replaced by the Arctic taxa‡ in the eastern Barents, Kara, Laptev, and East Siberian seas. Arctic species‡ are replaced by boreal Pacific taxa in the eastern Chukchi Sea and adjoining part of the Bering Sea. North American Arctic waters are dominated by Arctic species. Most species are confined to the Eurasian and Amerasian subbasins with the boundary in the area of the New Siberian Islands. Eurybathyal species are predominant in the western Barents, and the Chukchi Sea fauna exhibits the lowest degree of similarity with the fauna of Siberian seas and the Arctic–American waters.

The majority of bryozoans inhabit rocky substrates. They comprise many marine benthic biocenoses and play an important part in the overall trophic relations of the sea. They are well preserved in sediments of different geological age and are very important in biostratigraphic zonation. There are numerous reviews dealing with the bryozoan fauna of the Arctic Basin (Packard, 1867; Smitt, 1878, 1879; Vigelius, 1882, 1884; Waters, 1900, 1904; Nordgaard, 1906, 1912, 1918, 1923, 1929; Norman, 1906; Osburn, 1913, 1932, 1936; Kluge, 1962; Gostilovskayja, 1978). While the faunal composition in this region has been adequately studied, knowledge of their ecology remains incomplete. Nevertheless, the literature and material collected during the last 250 years and deposited at the Zoological Institute of the USSR Academy of Sciences allows us to summarize their distribution in the Arctic Ocean.

Here we follow the classification of Kluge (1962) with several additions based on recent investigations of Soviet and foreign scientists. In the Arctic Ocean, the phylum is represented by 3 orders, 11 suborders, 41 families, 89 genera, 340 species including 40 varieties and 1 form.

Variations in species composition in different seas of the Arctic Ocean have been analyzed using cluster analysis and estimating the degree of similarity according to Jaccard (1901),

$$j = \frac{c \times 100\%}{D_1 + D_2 - c}$$

and with the inclusion method

$$j = \frac{c \times 100\%}{D_{\min}}$$

Results are presented in Tables 14-1 and 14-2 (see pages 349–363) and Figure 14-1. As shown in Table 14-1, the decline in number of species occurs from boreal Atlantic waters to the Arctic proper. There is a significant difference between the bryozoan fauna of the western Barents Sea of boreal character, and faunas of eastern Barents Sea and adjoining seas. The groups showing the closest affinity are from the eastern Barents, Kara, and Lap-

*Boreal–Arctic species (for their boundaries see map) occur in the boreal and Arctic biogeographic regions.
†Boreal species including amphiboreal, widespread boreal, low boreal, and high boreal taxa are distributed within the boreal biogeographic regions.
‡Arctic species include Eurasian species distributed in the Arctic Ocean off the European and Asian coasts; Euroamerican or Amereuropean species distributed in the Arctic Ocean off the Asian and North American coasts. Circumpolar species are distributed in the Arctic Ocean off the coasts of Europe, Asia, North America, Greenland, Iceland, and Arctic Ocean islands. Amerasian species are distributed in the Arctic Ocean off the Asian and North American coasts. American species are distributed in the Arctic Ocean off the North American coasts.

tev seas. The fauna of these seas contain a larger proportion of Atlantic taxa than of Pacific elements. There is a significant difference in composition between the fauna of the East Siberian Sea, comprising species of Atlantic and Pacific origin, and the fauna of the Eurasian sector of the Arctic and Chukchi seas.

D_I	D_2	D_3	D_4	D_5	D_6	
I93	68	63	60	64	62	D_I
47	2II	93	80	76	84	D_2
45	78	I86	90	85	94	D_3
30	40	55	II9	72	68	D_4
3I	35	46	53	II0	56	D_5
25	35	45	53	34	93	D_6

Correlation of different biogeographic groups in the Arctic seas (Fig. 14-2) shows that the boreal–Arctic species are the most abundant group in all seas. Boreal species predominate in the North Atlantic and western Barents Sea as well as in the eastern Chukchi Sea. The number of Arctic species exceeds that of boreal species in the eastern Barents Sea and western Chukchi Sea, delineating the boundaries of the Arctic region. Major faunal differences exist between the Eurasian and the American sectors of the Arctic Basin; the boundary between the two regions is the New Siberian shoals. Boreal–Arctic species are predominant here; however, there is a decline in species numbers in this region. The western part of the Barents and eastern part of the Chukchi seas may be considered a transitional zone between the Atlantic and the Pacific boreal biogeographic regions and the Arctic region (Fig. 14-3).

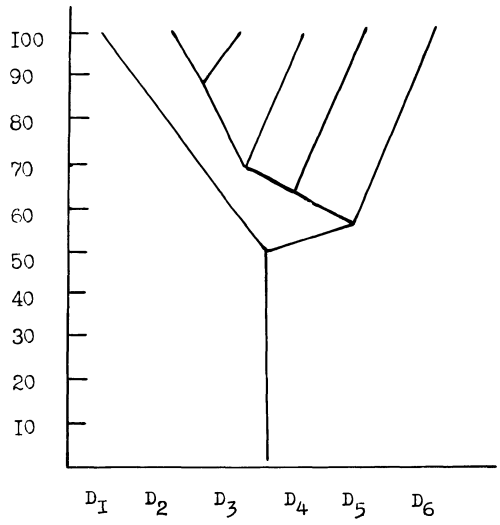

Figure 14-1. Dendrogram expressing similarities; similarities (bottom) and degree of inclusion (top) of bryozoan fauna (%) in Arctic seas. D_1, western part of the Barents Sea; D_2, eastern part of the Barents Sea; D_3, Kara Sea; D_4, Laptev Sea; D_5, Eastern Siberian Sea; D_6, Chukchi Sea.

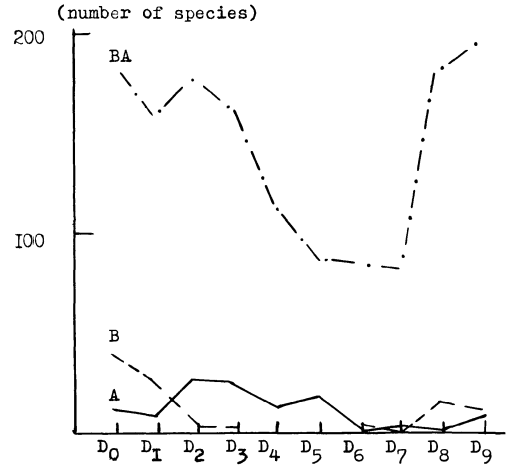

Figure 14-2. Depth distribution of different biogeographic groups of bryozoan species in the Arctic Seas. Legend as in Figure 14-1. D_0, northern part of the Atlantic Ocean; D_6, eastern part of the Chukchi Sea; D_7, western part of the Chukchi Sea; D_8, northern part of the Pacific Ocean; D_9, Arctic coastal waters of North America; BA, boreal–Arctic species; B, boreal species; A, Arctic species.

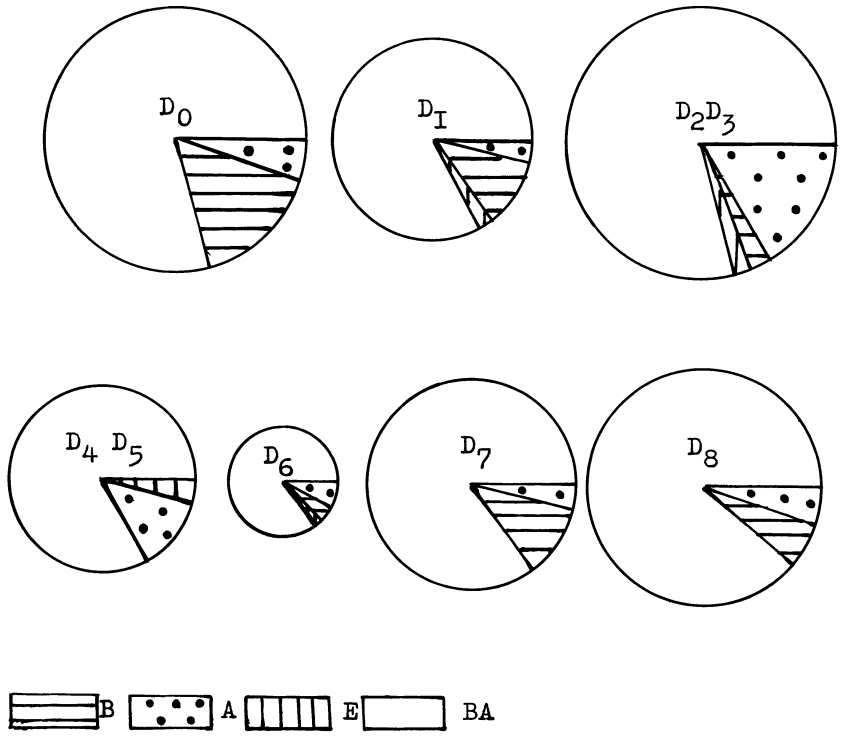

Figure 14-3. Biogeographic distribution of the bryozoan fauna in the Arctic Seas. Legend as in Figures 14-1 and 14-2 except D_7, northern part of the Pacific Ocean; D_8, Arctic coastal waters of North America; E, endemic species.

The distribution of bryozoans in the Arctic region (Fig. 14-4) indicates that species number is highest between 50 m and 100 m depths. Valuable information concerning the vertical distribution of water masses is provided by analyses of various biogeographic groups (Fig. 14-5). Boreal-Arctic species are predominant to a depth of 500 m with a maximum at 50–100 m depths. The number of boreal species gradually declines with increasing depth, increasing slightly at 50–100 m depths. Species endemic to the Arctic region occur between 0 m and 250 m depths, reaching maximum diversity between 50 m and 100 m depths. The number of Arctic species exceeds that of boreal taxa between 40 m and 450 m depths.

Bryozoa colonies live on a variety of substrates (Fig. 14-6). It should be emphasized that although the number of Bryozoa in different facies depends on various factors, including temperature and currents, generally the most important factor is believed to be the substrate (Hayward and Ryland, 1979). In our opinion, the low number of species on rocky substrates and their relatively high number on sandy and argillaceous facies is principally due to the total area occupied by these types of facies in the Arctic seas.

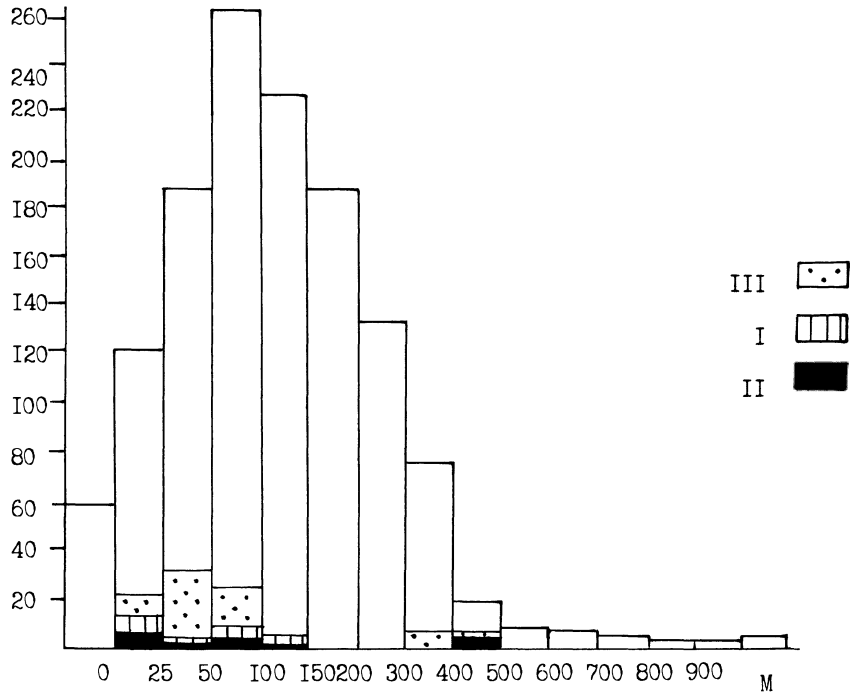

Figure 14-4. Depth distribution of species. Patterns indicate species confined to certain depth ranges. I, Barents Sea; II, western part of the Barents Sea; III, other Arctic seas. Ordinate: number of species; abscissa: water depth in meters.

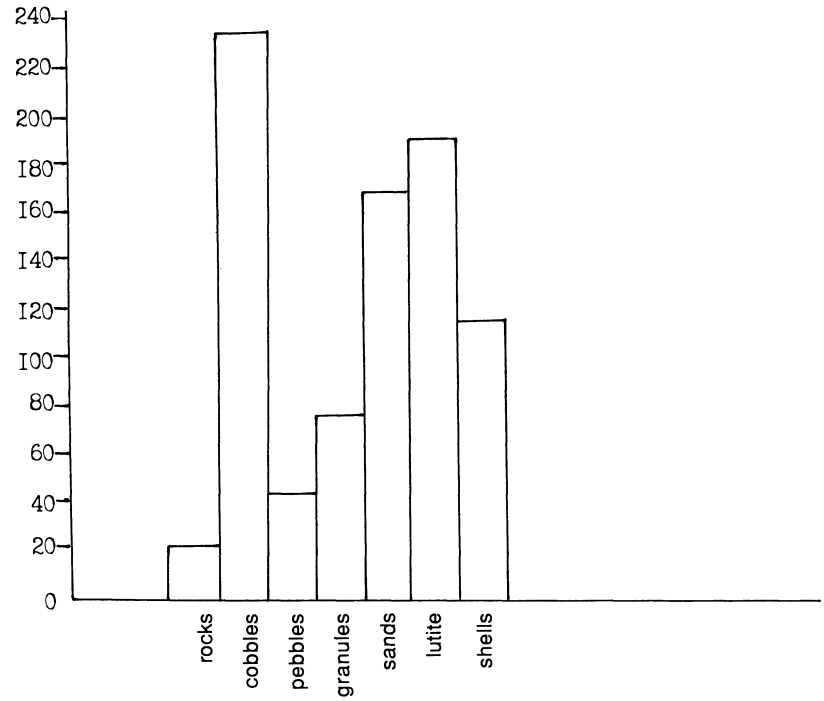

Figure 14-5. Distribution of bryozoans on various substrates. Ordinate: number of species.

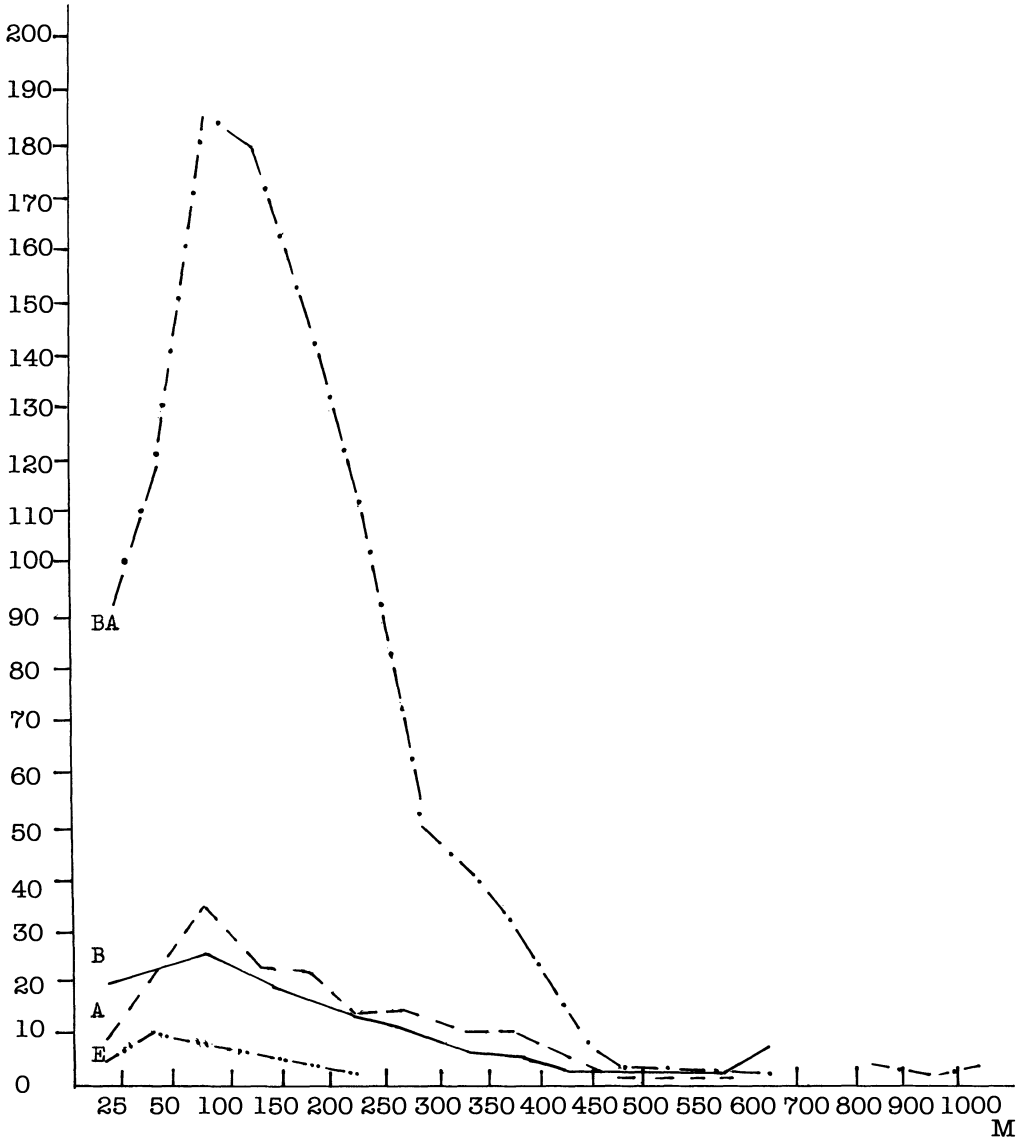

Figure 14-6. Depth distribution of species belonging to different biogeographic groups. Ordinate: number of species. Legend as in Figure 14-2.

Table 14-1. Distribution of Bryozoa in the Arctic Ocean

Species	Biogeography	Species Presence																						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Parasmittina trispinosa (Johnston)	sub.-b.							+		+										+		+		+	
Schizomavella auriculata (Hassall)	sub.-b.				+		+	+	+	+	+	+		+				+							
Proboscina major (Johnston)	atl.sub.-b.					+														+					
Tubulipora dilatans (Johnston)	atl.sub.-b.								+						+				+	+	+				
Tubulipora liliacea (Pallas)	atl.sub.-b.							+		+	+							+		+					
Crisidia cornuta (Linnaeus)	atl.sub.-b.									+				+						+	+				
Diplosolen obelia (Johnston)	atl.sub.-b.				+		+	+		+	+	+								+					
Stegohornera violacea (M. Sars)	atl.sub.-b.									+							+			+					
Bowerbankia pustulosa (Ellis et Solander)	atl.sub.-b.																+			+					
Bowerbankia imbricata (Adams)	atl.sub.-b.																		+	+					
Callopora aurita (Hincks)	atl.sub.-b.						+										+		+	+					
Tessarodoma boreale (Busk)	atl.sub.-b.										+									+	+	+			
Tubulipora penicillata (Fabricius)	atl.b.		+	+							+									+					
Bowerbankia gracilis Leidy	atl.b.																		+	+					
Valkeria uva (Linnaeus)	atl.b.																		+	+					
Amphiblestrum flemingii (Busk))	atl.b.						+													+					
Amphiblestrum solidum (Packard)	atl.b.																			+					
Chartella barleei (Busk)	atl.b.																			+					

Note: sub.-b., subtropical boreal; atl.b., Atlantic boreal widespread; atl.sub.-b., Atlantic subtropical boreal; atl.h.-b., Atlantic high boreal; amph.b., amphiboreal; b.-a., boreal–Arctic widespread; b.-a.atl.circ.-p., boreal–Arctic Atlantic circumpolar; b.-a.atl.eurasian, boreal–Arctic Atlantic Eurasian; b.-a.atl.am.-eur., boreal–Arctic Atlantic American–European; b.-a.pac.circ.-p., boreal–arctic Pacific circumpolar; b.-a-pac.amer.-as, boreal–Arctic Pacific Amerasian; b.-a.pac.eur.-as., boreal–Arctic Pacific Eurasian; arc.circ.-p., Arctic circumpolar; arc.eur.-as., Arctic Eurasian; arc.amer.-as., Arctic Amerasian; arc.eur.-am., Arctic Euroamerican; arc.amer., Arctic American; pac.b., Pacific boreal.

+ = species in: 1, northwestern coast of Alaska; 2, northern coast of North America; 3, the Archipelago of Canadian Islands; 4, Baffin Bay; 5, Davis Strait; 6, Hudson Bay; 7, Gulf of Labrador; 8, Newfoundland; 9, St. Lawrence Gulf; 10, western Greenland; 11, eastern Greenland; 12, Greenland Sea; 13, Iceland; 14, Jan Mayen; 15, Norwegian Sea; 16, North Sea; 17, northern Norway; 18, White Sea; 19, Barents Sea; 20, Kara Sea; 21, Laptev Sea; 22, East Siberian Sea; 23, Chukchi Sea; 24, Bering Strait.

This table is based on the authors' present data and the literature listed.

Table 14-1. *(continued)*

Species	Biogeography	Species Presence																						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Membraniporella nitida (Johnston)	atl.b.																+			+					
Cribrilina punctata (Hassall)	atl.b.		+							+	+						+		+	+					
Cribrilina cryptooecium Norman	atl.b.																			+					
Escharella laqueata (Norman)	atl.b.																	+		+					
Fenestrulina malusii (Audouin)	atl.b.																+								
Cellepora pumicosa (Linnaeus)	atl.b.																			+					
Turbicellepora avicularis (Hincks)	atl.b.																			+					
Proboscina gracilis (Kluge)	atl.h.-b																			+					
Tubulipora marisalbi Gostilovskaja	atl.h.-b.																		+						
Tubulipora fructuosa Gostilovskaja	atl.h.-b.																		+						
Tubulipora smitti Gostilovskaja	atl.h.-b.																			+					
Tubulipora uniformis Gostilovskaja	atl.h.-b.																			+	+				
Tubulipora aperta Harmer	atl.h.-b.																		+						
Tubulipora murmanica Kluge	atl.h.-b.																			+					
Defrancia lucernaria var. prolifera Kluge	atl.h.-b.																		+	+					
Alcyonidium excavatum Hincks	atl.h.-b.																			+					
Alcyonidium irregulare Kluge	atl.h.-b.																			+					
Alcyonidium proboscideum Kluge	atl.h.-b.																			+					
Arachnidium simplex Hincks	atl.h.-b.																			+					
Arachnoidea barentsia Kluge	atl.h.-b.																			+					
Electra crustulenta var. *catenulariasimilis* Kluge	atl.h.-b.																	+							
Tegella kildinensis Kluge	atl.h.-b.																			+					
Callopora derjugeni (Kluge)	atl.h.-b.																			+					
Ramphonotus minax (Busk)	atl.h.-b.									+				+						+					
Larnacicus corniger (Busk)	atl.h.-b.											+								+					
Megapora ringens (Busk)	atl.h.-b.																			+					

Reussina impressa (Reuss)	atl.h.-b.																	+						
Dendrobeania murmanica Kluge	atl.h.-b.																	+						
Bicellarina alderi (Busk)	atl.h.-b.											+						+						
Notoplites jeffreysii Norman	atl.h.-b.																	+						
Scrupocellaria intermedia Norman	atl.h.-b.																	+						
Gephyrotes nitidopunctata (Smitt)	atl.h.-b.									+								+						
Escharella octodentata Hincks	atl.h.-b.																	+						
Escharella latodonta Kluge	atl.h.-b.																	+						
Schizoporella hexagona Nordgaard	atl.h.-b.																	+						
Schizoporella smitti Kluge	atl.h.-b.															+		+						
Schizoporella thompsoni Kluge	atl.h.-b.											+												
Turbicellepora smitti Kluge	atl.h.-b.									+						+		+						
Berenicea meandrina (S. Wood)	amph.-b.							+		+														
Filicrisia geniculata (Milne-Edwards)	amph.b.																+	+						
Lichenopora radiata (Audouin)	amph.b.																							+
Flustrellidra hispida (Fabricius)	amph.b.								+	+					+		+	+						
Bowerbankia composita (Kluge)	amph.b.														+			+						
Triticella pedicellata (Alder)	amph.b.														+			+						
Membranipora membranacea (Linnaeus)	amph.b.														+			+						
Tegella unicornis (Fleming)	amph.b.		+		+				+	+								+						
Cauloramphus spiniferum (Johnston)	amph.b.																+	+						
Flustra foliacea (Linnaeus)	amph.b.											+				+		+	+	+				
Corynoporella tenuis Hincks	amph.b.								+									+						
Tricellaria peachii var. *beringia* Kluge	amph.b.																+							

Note: sub.-b., subtropical boreal; atl.b., Atlantic boreal widespread; atl.sub.-b., Atlantic subtropical boreal; atl.h.-b., Atlantic high boreal; amph.b., amphiboreal; b.-a., boreal–Arctic widespread; b.-a.atl.circ.-p., boreal–Arctic Atlantic circumpolar; b.-a.atl.eurasian, boreal–Arctic Atlantic Eurasian; b.-a.atl.am.-eur., boreal–Arctic Atlantic American–European; b.-a.pac.circ.-p., boreal–arctic Pacific circumpolar; b.-a-pac.amer.-as, boreal–Arctic Pacific Amerasian; b.-a.pac.eur.-as., boreal–Arctic Pacific Eurasian; arc.circ.-p., Arctic circumpolar; arc.eur.-as., Arctic Eurasian; arc.amer.-as., Arctic Amerasian; arc.eur.-am., Arctic Euroamerican; arc.amer., Arctic American; pac.b., Pacific boreal.

+ = species in: 1, northwestern coast of Alaska; 2, northern coast of North America; 3, the Archipelago of Canadian Islands; 4, Baffin Bay; 5, Davis Strait; 6, Hudson Bay; 7, Gulf of Labrador; 8, Newfoundland; 9, St. Lawrence Gulf; 10, western Greenland; 11, eastern Greenland; 12, Greenland Sea; 13, Iceland; 14, Jan Mayen; 15, Norwegian Sea; 16, North Sea; 17, northern Norway; 18, White Sea; 19, Barents Sea; 20, Kara Sea; 21, Laptev Sea; 22, East Siberian Sea; 23, Chukchi Sea; 24, Bering Strait.

This table is based on the authors' present data and the literature listed.

Table 14-1. *(continued)*

Species	Biogeography	Species Presence																						
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*
Smittoidea reticulata (Mac Gillivray)	amph.b.																			+					
Stomachetosella magniporata (Nordgaard)	amph.b.		+																	+					
Microporella ciliata (Pallas)	amph.b.	+	+				+	+		+	+							+	+	+				+	
Retepora beaniana King	amph.b.									+	+		+							+					
Tubulipora lobulifera Hastings	amph.b.									+															
Tubulipora flabellaris (Flabricius)	b.-a.	+	+	+															+	+	+	+	+	+	
Diplosolen obelia var. *arctica* (Waters)	b.-a.		+	+				+		+	+			+					+	+	+	+	+	+	
Crisia eburnea (Linnaeus)	b.-a.			+				+		+	+			+				+	+	+	+	+	+	+	
Crisia klugei (Ryland)	b.-a.		+								+										+			+	
Lichenopora verrucaria (Fabricius)	b.-a.		+	+	+			+		+	+	+			+		+	+	+	+	+	+	+	+	
Lichenopora hispida (Fleming)	b.-a.		+	+			+	+		+	+	+			+		+		+	+	+				
Alcyonidium gelatinosum (Linnaeus)	b.-a.		+			+	+			+	+	+			+		+	+	+	+	+	+			
Alcyonidium mytili Dalyell	b.-a.		+								+	+			+		+		+	+	+	+	+	+	
Buskia nitens Alder	b.-a.																		+	+	+		+		
Eucratea loricata (Linnaeus)	b.-a.		+	+	+		+	+		+	+	+		+				+	+	+	+	+	+	+	
Electra arctica (Borg)	b.-a.		+	+	+	+	+			+	+								+	+	+	+		+	
Tegella armifera (Hincks)	b.-a.		+	+	+		+	+		+	+	+			+				+	+	+	+	+	+	
Tegella spitzbergensis (Bidenkap)	b.-a.	+	+				+				+	+							+	+	+		+	+	
Tegella arctica (d'Orbigny)	b.-a.		+	+	+		+	+		+	+	+							+	+	+			+	
Tegella nigrans (Hincks)	b.-a.		+	+	+		+				+	+							+	+	+	+	+	+	
Callopora lineata (Linnaeus)	b.-a.	+	+	+			+	+		+	+	+			+			+	+	+	+	+	+	+	
Callopora craticula (Alder)	b.-a.		+	+	+		+	+	+	+	+	+		+	+			+	+	+	+	+	+	+	
Cauloramphus cymbaeformis (Hincks)	b.-a.		+	+	+		+	+		+	+	+			+				+	+	+	+	+	+	
Doryporella spatulifera (Smitt)	b.-a.		+	+	+	+			+	+	+	+		+	+			+	+	+	+			+	
Carbasea carbasea (Ellis et Solander)	b.-a.		+	+			+	+		+	+				+			+		+	+	+	+	+	
Terminoflustra membranaceotruncata (Smitt)	b.-a.			+	+					+	+	+							+	+	+	+	+	+	
Dendrobeania murrayana (Bean in Johnston)	b.-a.	+	+	+	+		+	+		+	+								+	+	+			+	

Dendrobeania pseudomurrayana Kluge	b.-a.				+							+	+						+			+							+	
Dendrobeania pseudomurrayana var. *fessa* Kluge	b.-a.						+			+		+	+			+				+		+	+	+	+				+	
Dendrobeania fruticosa (Packard)	b.-a.			+	+					+		+	+	+		+	+					+	+	+	+	+			+	
Dendrobeania fruticosa var. *quadridentata* (Lowen)	b.-a.				+		+					+	+											+	+	+				
Tricellaria peachii (Busk)	b.-a.				+	+			+	+			+	+		+						+	+	+	+	+	+	+		
Tricellaria ternata (Ellis et Solander)	b.-a.			+	+				+	+	+	+	+	+		+	+					+		+	+	+				
Tricellaria gracilis (Van Beneden)	b.-a.				+	+	+		+	+			+	+		+	+					+		+	+	+	+	+		
Scrupocellaria scabra (Van Beneden)	b.-a.			+	+	+			+	+	+	+	+	+		+	+			+				+	+	+				+
Scrupocellaria scabra var. *paenulata* (Van Beneden)	b.-a.			+	+					+			+	+								+		+	+	+	+			+
Scrupocellaria elongata (Smitt)	b.-a.				+				+				+											+	+	+				
Caberea ellisii (Fleming)	b.-a.			+	+				+	+			+			+				+				+	+					
Cribrilina annulata (Fabricius)	b.-a.		+	+	+	+			+	+			+	+	+		+			+				+	+	+				+
Escharella immersa (Fleming)	b.-a.								+	+			+	+	+		+			+				+	+	+			+	+
Escharella ventricosa (Hassall)	b.-a.			+	+	+			+	+			+	+	+	+	+							+	+	+	+	+	+	+
Smittina majuscula (Smitt)	b.-a.			+		+			+	+			+	+	+							+		+	+	+	+	+	+	+
Smittina bella (Busk)	b.-a.			+	+	+							+	+	+	+									+					
Smittina minuscula (Smitt)	b.-a.				+				+	+				+	+	+								+	+	+	+			+
Smittina rigida Lorenz	b.-a.						+		+	+				+	+		+							+	+	+	+			+
Porella concinna (Busk)	b.-a.		+	+	+	+	+		+	+	+		+	+	+		+			+				+	+	+	+			+
Porella concinna var. *belli* (Dawson)	b.-a.									+			+	+	+								+	+	+					+
Parasmittina jeffreysii (Norman)			+	+	+					+			+	+	+					+			+	+	+	+	+	+		
Porella compressa (Sowerby)	b.-a.			+	+	+			+	+				+	+		+	+						+	+	+	+	+	+	+
Porella acutirostris Smitt	b.-a.			+	+	+						+	+	+			+								+	+	+	+	+	+
Porella smitti Kluge																															

Note: sub.-b., subtropical boreal; atl.b., Atlantic boreal widespread; atl.sub.-b., Atlantic subtropical boreal; atl.h.-b., Atlantic high boreal; amph.b., amphiboreal; b.-a., boreal–Arctic widespread; b.-a.atl.circ.-p., boreal–Arctic Atlantic circumpolar; b.-a.atl.eurasian, boreal–Arctic Atlantic Eurasian; b.-a.atl.am.-eur., boreal–Arctic Atlantic American–European; b.-a.pac.circ.-p., boreal–arctic Pacific circumpolar; b.-a-pac.amer.-as, boreal–Arctic Pacific Amerasian; b.-a.pac.eur.-as., boreal–Arctic Pacific Eurasian; arc.circ.-p., Arctic circumpolar; arc.eur.-as., Arctic Eurasian; arc.amer.-as., Arctic Amerasian; arc.eur.-am., Arctic Euroamerican; arc.amer., Arctic American; pac.b., Pacific boreal.

+ = species in: 1, northwestern coast of Alaska; 2, northern coast of North America; 3, the Archipelago of Canadian Islands; 4, Baffin Bay; 5, Davis Strait; 6, Hudson Bay; 7, Gulf of Labrador; 8, Newfoundland; 9, St. Lawrence Gulf; 10, western Greenland; 11, eastern Greenland; 12, Greenland Sea; 13, Iceland; 14, Jan Mayen; 15, Norwegian Sea; 16, North Sea; 17, northern Norway; 18, White Sea; 19, Barents Sea; 20, Kara Sea; 21, Laptev Sea; 22, East Siberian Sea; 23, Chukchi Sea; 24, Bering Strait.

This table is based on the authors' present data and the literature listed.

Table 14-1. *(continued)*

Species	Biogeography	Species Presence																						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Cystisella saccata (Busk)	b.-a.		+	+	+			+	+	+	+	+		+	+			+	+	+	+	+	+	+	
Umbonula patens (Smitt)	b.-a.									+	+									+				+	
Buffonellaria biaperta Michelin	b.-a.		+	+	+					+	+			+	+				+	+	+	+		+	
Myriozoella crustacea (Smitt)	b.-a.		+	+	+		+	+		+	+	+		+	+			+	+	+	+	+	+	+	
Schizomavella auriculata var. *lineata* (Nordgaard)	b.-a.				+					+	+			+				+	+	+	+				
Schizomavella porifera (Smitt)	b.-a.		+	+	+		+	+		+	+	+		+	+			+	+	+	+	+			
Stomachetosella incerta (Kluge)	b.-a.							+			+								+	+	+	+			
Stomachetosella sinuosa (Busk)	b.-a.	+	+			+	+			+	+	+		+	+			+	+	+					
Stomachetosella cruenta (Busk)	b.-a.		+		+					+	+				+			+	+	+	+	+	+	+	
Hippoporina propinqua (Smitt)	b.-a.							+			+	+		+				+	+	+	+				
Myriapora coarctata (M. Sars)	b.-a.					+		+		+	+	+		+	+			+	+	+	+				
Hippothoa divaricata var. *arctica* Kluge	b.-a.				+			+		+	+	+						+	+	+	+	+		+	
Hippothoa hyalina (Linnaeus)	b.-a.		+	+	+			+		+	+	+		+	+			+	+	+	+	+	+	+	
Hippoponella hippopus (Smitt)	b.-a.		+	+	+			+		+	+	+						+	+	+	+			+	
Rhamphostomella scabra (Fabricius)	b.-a.			+	+	+		+		+	+	+						+	+	+	+	+	+	+	
Rhamphostomella costata Lorenz	b.-a.			+	+		+	+		+	+	+			+			+	+	+	+	+	+	+	
Rhamphostomella ovata (Smitt)	b.-a.	+	+	+	+	+	+	+		+	+	+						+	+	+	+	+	+	+	
Rhamphostomella radiatula (Hincks)	b.-a.		+	+		+		+		+	+	+		+	+			+	+	+	+				
Ragionula rosacea (Busk)	b.-a.									+	+			+	+			+	+	+	+		+		
Stomatopora granulata (Milne-Edwards)	b.-a.atl.circ.-p.																		+	+	+				
Proboscina incrassata (Smitt)	b.-a.atl.circ.-p.									+										+	+	+			
Oncousoecia diastoporoides (Norman)	b.-a.atl.circ.-p.							+		+				+					+	+	+			+	
Tubulipora ventricosa Busk	b.-a.atl.circ.-p.			+							+								+	+	+	+	+		
Idmonea atlantica Forbes MSS	b.-a.atl.circ.-p.		+	+	+			+	+	+	+	+		+	+					+	+	+			
Entalophora clavata (Busk)	b.-a.atl.circ.-p.		+									+			+					+	+	+	+		
Entalophora harmeri (Osburn)	b.-a.atl.circ.-p.		+	+						+	+									+	+				
Defrancia lucernaria M. Sars	b.-a.atl.circ.-p.									+	+	+			+					+	+	+	+		
Fasciculiporoides americana (d'Orbigny)	b.-a.atl.circ.-p.								+	+	+											+	+	+	

Stegohornera lichenoides (Linnaeus)	b.-a.atl.circ.-p.								+	+	+		+	+					+	+	+	+			
Alcyonidium mammilatum Alder	b.-a.atl.circ.-p.		+							+	+			+				+	+	+		+	+		
Nolella dilatata (Hincks)	b.-a.atl.circ.-p.	+								+				+					+						
Electra pilosa (Linnaeus)	b.-a.atl.circ.-p.	+			+				+	+			+				+		+	+	+				
Amphiblestrum septentrionalis (Kluge)	b.-a.atl.circ.-p.		+						+	+	+			+				+	+			+			
Amphiblestrum trifolium var. *quadrata* (Hincks)	b.-a.atl.circ.-p.		+						+	+	+			+			+		+				+		
Securiflustra securifrons (Pallas)	b.-a.atl.circ.-p.		+			+	+	+		+	+			+		+	+	+	+	+	+		+		
Sarsiflustra abyssicola (G.O. Sars)	b.-a.atl.circ.-p.									+	+		+	+				+	+	+	+				
Bugula elongata (Nordgaard)	b.-a.atl.circ.-p.								+										+	+	+				
Kinetoskias arborescens Daniellsen	b.-a.atl.circ.-p.		+			+			+	+									+	+	+	+			
Kinetoskias smitti Daniellsen	b.-a.atl.circ.-p.																		+	+		+			
Lepralioides nordlandica (Nordgaard)	b.-a.atl.circ.-p.		+						+	+				+					+	+		+	+		
Pachyegis groenlandica Norman	b.-a.atl.circ.-p.		+	+					+	+	+						+	+	+	+			+		
Retepora cellulosa (Linnaeus)	b.-a.atl.circ.-p.									+	+			+					+	+	+				
Idmonea atlantica var. *gracillima* Busk	b.-a.atl.circ.-p.	+	+				+		+	+	+		+	+					+	+	+	+			
Alcyonidium hirsutum (Fleming)	b.-a.atl.eur.-as.																	+	+						
Alcyonidium gelatinosum var. *diaphanum* (Farre)	b.-a.atl.eur.-as.																		+						
Alcyonidium albidum Alder	b.-a.atl.eur.-as.																		+	+					
Arachnidium clavatum Hincks	b.-a.atl.eur.-as.																		+						
Arachnidium hippothoides Hincks	b.-a.atl.eur.-as.																		+						

Note: sub.-b., subtropical boreal; atl.b., Atlantic boreal widespread; atl.sub.-b., Atlantic subtropical boreal; atl.h.-b., Atlantic high boreal; amph.b., amphiboreal; b.-a., boreal–Arctic widespread; b.-a.atl.circ.-p., boreal–Arctic Atlantic circumpolar; b.-a.atl.eurasian, boreal–Arctic Atlantic Eurasian; b.-a.atl.am.-eur., boreal–Arctic Atlantic American–European; b.-a.pac.circ.-p., boreal–arctic Pacific circumpolar; b.-a-pac.amer.-as, boreal–Arctic Pacific Amerasian; b.-a.pac.eur.-as., boreal–Arctic Pacific Eurasian; arc.circ.-p., Arctic circumpolar; arc.eur.-as., Arctic Eurasian; arc.amer.-as., Arctic Amerasian; arc.eur.-am., Arctic Euroamerican; arc.amer., Arctic American; pac.b., Pacific boreal.

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This table is based on the authors' present data and the literature listed.

Table 14-1. *(continued)*

Species	Biogeography	Species Presence																					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Electra pilosa var. *dentata* Ellis et Solander	b.-a.atl.eur.-as.																		+	+	+				
Electra pilosa var. *baltica* Borg	b.-a.atl.eur.-as.																+								
Bugula purpurotincta Norman	b.-a.atl.eur.-as.													+											
Smittina peristomata (Nordgaard)	b.-a.atl.eur.-as.													+				+	+	+	+				
Smittina pseudoacutirostris Gostilovskaja	b.-a.atl.eur.-as.																		+	+					
Haplopoma impressum (Audouin)	b.-a.atl.eur.-as.																			+					
Bicellariella ciliata (Linnaeus)	b.-a.atl.am.-eur.		+							+								+							
Cribrilina watersi Andersson	b.-a.atl.am.-eur.										+	+		+	+			+		+	+	+	+		
Escharella microstoma (Norman)	b.-a.atl.am.-eur.			+							+	+							+	+	+		+		
Phylactella labiata (Boeck in MS. Smitt)	b.-a.atl.am.-eur.										+	+		+				+		+	+	+			
Porelloides struma (Norman)	b.-a.atl.am.-eur.				+		+	+		+	+			+					+	+	+				
Porelloides laevis (Fleming)	b.-a.atl.am.-eur.		+			+		+												+					
Porella minuta (Norman)	b.-a.atl.am.-eur.		+	+	+			+										+	+	+					
Palmicellaria skenei (Ellis et Solander)	b.-a.atl.am.-eur.					+														+	+	+			
Palmicellaria skenei var. *bicornis* (Busk)	b.-a.atl.am.-as.																			+					
Escharina alderi (Busk)	b.-a.atl.am.-eur.									+										+					
Schizoporella pachystega Kluge	b.-a.atl.am.-eur.									+	+									+	+		+		
Microporina articulata (Fabricius)	b.-a.pac.circ.-p.	+	+	+	+		+				+									+					
Smittina mucronata (Smitt)	b.-a.pac.circ.-p.						+											+	+	+	+				+
Umbonula arctica (M. Sars)	b.-a.pac.circ.-p.	+	+		+					+	+	+		+	+			+	+	+	+	+	+	+	+
Porella fragilis Levinsen	b.-a.pac.circ.-p.			+				+		+	+	+							+	+	+	+	+	+	+
Stomachetosella limbata (Lorenz)	b.-a.pac.circ.-p.			+	+					+	+				+			+	+	+	+	+			
Schizobrachiella stylifera (Levinsen)	b.-a.pac.circ.-p.		+	+	+					+	+	+								+	+	+		+	
Hippoporina reticulatopunctata (Hincks)	b.-a.pac.circ.-p.		+	+	+	+		+		+	+	+							+	+	+	+	+	+	

Porella obesa Waters	b.-a.pac.circ.-p.						+			+											+	+	+	+		+					
Hippothoa expansa Dawson	b.-a.pac.circ.-p.	+	+	+	+	+	+	+		+	+	+			+						+	+	+			+					
Cylindroporella tubulosa (Norman)	b.-a.pac.circ.-p.		+	+	+					+	+	+			+					+	+	+	+			+					
Phydolopora elongata (Smitt)	b.-a.pac.circ.-p.		+	+	+	+		+		+	+	+								+		+	+	+	+						
Lepraliella contigua (Smitt)	b.-a.pac.circ.-p.		+	+	+		+			+	+	+		+	+					+	+	+				+					
Rhamphostomella hinksi Nordgaard	b.-a.pac.circ.-p.		+	+	+	+	+			+	+	+		+	+							+	+	+		+					
Rhamphostomella plicata (Smitt)	b.-a.pac.circ.-p.			+	+	+				+	+	+		+						+	+	+	+	+		+					
Escharopsis lobata (Lamouroux)	b.-a.pac.circ.-p.		+	+	+			+	+	+	+	+	+	+	+					+	+	+	+	+	+	+					
Celleporina incrassata Lamarck	b.-a.pac.circ.-p.		+	+	+		+	+	+	+	+			+						+	+	+	+		+	+					
Celleporina ventricosa Lorenz	b.-a.pac.circ.-p.	+	+	+	+	+		+		+	+	+		+	+					+		+	+	+	+	+					
Filicrisia smitti (Kluge)	b.-a.pac.am.-as.									+	+											+	+		+						
Crisiella producta (Smitt)	b.-a.pac.am.-as.										+										+	+	+								
Smittina thompsoni Kluge	b.-a.pac.am.-as.				+	+				+	+																				
Myriapora orientalis (Kluge)	b.-a.pac.am.-as.				+																			+	+	+					
Myriapora subgracilis (d'Orbigny)	b.-a.pac.am.-as.	+	+	+	+	+	+	+	+	+	+	+										+	+	+	+	+					
Eucratea loricata var. *macrostoma* (Ortmann)	b.-a.pac.eur.-as.																						+	+							
Tegella arctica var. *retroversa* Kluge	b.-a.pac.eur.-as.																					+	+		+	+					
Cheiloporina sincera Smitt	b.-a.pac.circ.-p.	+	+	+	+	+		+		+	+	+		+	+					+		+	+	+	+	+					
Cauloramphus intermedius Kluge	b.-a.pac.eur.-as.	+																			+	+	+			+					
Flustra nordenskjoldi Kluge	b.-a.pac.eur.-as.																							+	+	+					
Dendrobeania pseudomurrayana var. *tenuis* Kluge	b.-a.pac.eur.-as.																					+									
Dendrobeania flustroides Levinsen	b.-a.pac.eur.-as.																						+								

Note: sub.-b., subtropical boreal; atl.b., Atlantic boreal widespread; atl.sub.-b., Atlantic subtropical boreal; atl.h.-b., Atlantic high boreal; amph.b., amphiboreal; b.-a., boreal–Arctic widespread; b.-a.atl.circ.-p., boreal–Arctic Atlantic circumpolar; b.-a.atl.eurasian, boreal–Arctic Atlantic Eurasian; b.-a.atl.am.-eur., boreal–Arctic Atlantic American–European; b.-a.pac.circ.-p., boreal–arctic Pacific circumpolar; b.-a-pac.amer.-as, boreal–Arctic Pacific Amerasian; b.-a.pac.eur.-as., boreal–Arctic Pacific Eurasian; arc.circ.-p., Arctic circumpolar; arc.eur.-as., Arctic Eurasian; arc.amer.-as., Arctic Amerasian; arc.eur.-am., Arctic Euroamerican; arc.amer., Arctic American; pac.b., Pacific boreal.

+ = species in: 1, northwestern coast of Alaska; 2, northern coast of North America; 3, the Archipelago of Canadian Islands; 4, Baffin Bay; 5, Davis Strait; 6, Hudson Bay; 7, Gulf of Labrador; 8, Newfoundland; 9, St. Lawrence Gulf; 10, western Greenland; 11, eastern Greenland; 12, Greenland Sea; 13, Iceland; 14, Jan Mayen; 15, Norwegian Sea; 16, North Sea; 17, northern Norway; 18, White Sea; 19, Barents Sea; 20, Kara Sea; 21, Laptev Sea; 22, East Siberian Sea; 23, Chukchi Sea; 24, Bering Strait.

This table is based on the authors' present data and the literature listed.

Table 14-1. *(continued)*

Species	Biogeography	Species Presence																					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Semibugula birulai Kluge	b.-a.pac.eur.-as.																			+	+	+			
Scrupocellaria scabra var. *paenulata forma orientalis* Kluge	b.-a.pac.eur.-as.																						+		
Schizoporella costata Kluge	b.-a.pac.eur.-as.																			+					
Hippoporina ussowi (Kluge)	b.-a.pac.eur.-as.										+								+	+	+				
Stomachetosella hincksi Powell	b.-a.pac.circ.-p.			+	+					+	+				+			+	+	+	+	+			+
Rhamphostomella bilaminata var. *sibirica* Kluge	b.-a.pac.eur.-as.-am.									+	+	+							+	+	+	+	+	+	
Celleporina nordenskjoldi (Kluge)	b.-a.pac.eur.-as.																				+	+	+		
Cheloporina inermis (Busk)	b.-a.pac.circ.-p.				+					+	+									+	+			+	
Oncousoecia canadensis (Osburn)	arc.circ.-p.			+	+					+	+	+							+	+		+		+	
Oncousoecia polygonalis (Kluge)	arc.circ.-p.									+										+				+	
Diplosolen intricarius (Smitt)	arc.circ.-p.				+						+			+						+	+	+			
Crisia eburneodenticulata Smitt	arc.circ.-p.									+	+				+				+	+	+	+	+		
Crisia denticulata var. *borgi* Kluge	arc.circ.-p.										+				+				+	+	+	+	+		
Lichenopora crassiuscula (Smitt)	arc.circ.-p.			+							+	+								+	+	+		+	
Crisia denticulata var. *arctica* M. Sars	arc.circ.-p.										+		+							+	+	+		+	
Alcyonidium mammilatum var. *erectum* Andersson	arc.circ.-p.		+								+	+							+	+	+	+	+		
Alcyonidium disciforme Smitt	arc.circ.-p.			+		+					+	+						+		+	+	+	+	+	
Flustrellidra corniculata (Smitt)	arc.circ.-p.			+							+				+					+					
Bowerbankia arctica Busk	arc.circ.-p.			+							+	+							+	+	+	+	+		
Eucratea loricata var. *cornuta* (Osburn)	arc.circ.-p.						+															+	+	+	
Eucratea loricata var. *arctica* (Kluge)	arc.circ.-p.									+										+	+	+	+	+	
Callopora smitti Kluge	arc.circ.-p.		+				+				+									+	+	+	+		
Callopora whiteavesi Norman	arc.circ.-p.									+	+	+							+	+	+	+	+	+	
Callopora lata (Kluge)	arc.circ.-p.										+				+				+	+	+	+	+		
Flustra serrulata Busk	arc.circ.-p.		+	+	+			+	+	+	+									+	+	+	+	+	

Notoplites smitti (Norman)	arc.circ.-p.			+	+	+						+	+						+			+	+	+						
Tricellaria gracilis var. *inermis* Kluge	arc.circ.-p.											+					+					+	+							+
Escharella abyssicola (Norman)	arc.circ.-p.			+		+					+	+	+				+			+			+							
Smittina smitti (Kirchenpauer)	arc.circ.-p.			+	+						+	+	+				+			+			+	+	+	+				
Pseudoflustra solida (Stimpson)	arc.circ.-p.			+			+	+			+	+	+	+	+	+	+						+	+	+	+				
Pseudoflustra hincksi Kluge	arc.circ.-p.												+										+	+	+	+				
Pseudoflustra anderssoni Kluge	arc.circ.-p.													+									+	+	+	+				
Pseudoflustra sinuosa (Andersson)	arc.circ.-p.									+			+										+	+	+	+				
Porella aperta (Boeck)	arc.circ.-p.			+			+				+	+	+										+	+	+					
Pachyegis producta (Packard)	arc.circ.-p.				+						+	+	+							+	+	+	+	+						+
Porella proboscidea Hincks	arc.circ.-p.				+						+	+	+				+				+	+	+	+	+	+				
Porella plana Hincks	arc.circ.-p.				+			+				+	+		+								+	+	+	+				
Palmicellaria skenei var. *tridens* (Busk)	arc.circ.-p.							+			+	+	+		+					+			+	+						
Hippoporina harmsworthi (Waters)	arc.circ.-p.										+	+	+								+	+	+	+	+	+	+			
Harmeria scutulata (Busk)	arc.circ.-p.			+	+	+		+				+									+	+	+							
Microporella ciliata var. *arctica* Norman	arc.circ.-p.			+					+			+	+							+	+	+	+							
Rhamphostomella costata var. *cristata* Hincks	arc.circ.-p.							+	+		+		+										+							
Rhamphostomella spinigera Lorenz	arc.circ.-p.			+	+			+				+	+				+				+	+	+							
Rhamphostomella bilaminata (Hincks)	arc.circ.-p.		+	+		+	+	+	+		+	+	+				+				+	+	+							+
Celleporina nodulosa (Lorenz)	arc.circ.-p.			+	+		+					+	+				+				+	+	+	+	+	+				
Escharoides jacksoni (Waters)	arc.circ.-p.			+	+							+	+											+	+	+				
Proboscina fecunda Kluge	arc.eur.-as.																									+				
Tubulipora minuta Kluge	arc.eur.-as.																					+	+			+				

Note: sub.-b., subtropical boreal; atl.b., Atlantic boreal widespread; atl.sub.-b., Atlantic subtropical boreal; atl.h.-b., Atlantic high boreal; amph.b., amphiboreal; b.-a., boreal–Arctic widespread; b.-a.atl.circ.-p., boreal–Arctic Atlantic circumpolar; b.-a.atl.eurasian, boreal–Arctic Atlantic Eurasian; b.-a.atl.am.-eur., boreal–Arctic Atlantic American–European; b.-a.pac.circ.-p., boreal–arctic Pacific circumpolar; b.-a-pac.amer.-as, boreal–Arctic Pacific Amerasian; b.-a.pac.eur.-as., boreal–Arctic Pacific Eurasian; arc.circ.-p., Arctic circumpolar; arc.eur.-as., Arctic Eurasian; arc.amer.-as., Arctic Amerasian; arc.eur.-am., Arctic Euroamerican; arc.amer., Arctic American; pac.b., Pacific boreal.

+ = species in: 1, northwestern coast of Alaska; 2, northern coast of North America; 3, the Archipelago of Canadian Islands; 4, Baffin Bay; 5, Davis Strait; 6, Hudson Bay; 7, Gulf of Labrador; 8, Newfoundland; 9, St. Lawrence Gulf; 10, western Greenland; 11, eastern Greenland; 12, Greenland Sea; 13, Iceland; 14, Jan Mayen; 15, Norwegian Sea; 16, North Sea; 17, northern Norway; 18, White Sea; 19, Barents Sea; 20, Kara Sea; 21, Laptev Sea; 22, East Siberian Sea; 23, Chukchi Sea; 24, Bering Strait.

This table is based on the authors' present data and the literature listed.

Table 14-1. *(continued)*

Species	Biogeography	Species Presence																						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Tubulipora eminens Kluge	arc.eur.-as.																						+		
Tubulipora borgi Kluge	arc.eur.-as.																		+						
Tubulipora soluta Kluge	arc.eur.-as.																			+	+	+	+		
Tubulipora nordgaardi Kluge	arc.eur.-as.																						+		
Tubulipora fruticosa Kluge	arc.eur.-as.																		+	+	+		+		
Idmonea tumida (Smitt)	arc.eur.-as.																			+	+		+		
Idmonea bidenkapi Kluge	arc.eur.-as.																			+					
Idmoneoides arctoflabellaris (Kluge)	arc.eur.-as.																			+	+	+	+		
Idmoneoides simplex Kluge	arc.eur.-as.																			+					
Berenicea arctica Kluge	arc.eur.-as.																			+	+				
Berenicea oblonga Kluge	arc.eur.-as.																			+	+				
Crisiella diversa (Kluge)	arc.eur.-as.																			+	+				
Crisiella complecta (Kluge)	arc.eur.-as.																			+	+				
Crisis aculeata var. *bathyalis* Kluge	arc.eur.-as.																				+				
Crisia constans Kluge	arc.eur.-as.																				+				
Stegohornera arctica (Kluge)	arc.eur.-as.																			+	+				
Lichenopora multicentra Kluge	arc.eur.-as.																					+			
Lichenopora sibirica Kluge	arc.eur.-as.																					+			
Fungella dalli Kluge	arc.eur.-as.																							+	
Alcyonidium gelatinosum var. *anderssoni Abrikosov*	arc.eur.-as.																			+	+	+	+	+	
Alcyonidium gelatinosum var. *pachydermatum* Kluge	arc.eur.-as.																			+	+				
Alcyonidium radicellatum Kluge	arc.eur.-as.																			+	+	+	+		
Tegella armiferoides Kluge	arc.eur.-as.																						+		
Callopora craticula var. *sedovi* Kluge	arc.eur.-as.																			+					
Rhamphonotus gorbunovi Kluge	arc.eur.-as.																						+		
Dendrobeania fruticosa var. *frigida* (Waters)	arc.eur.-as.																			+					
Bugula tricuspis Kluge	arc.eur.-as.																			+					
Uschakovia gorbunovi Kluge	arc.eur.-as.																				+		+		
Notoplites sibirica (Kluge)	arc.eur.-as.																			+	+	+		+	

Notoplites normani (Nordgaard)	arc.eur.-as.														+				+	+					
Cribrilina spitzbergensis Norman	arc.eur.-as.									+	+							+	+	+	+	+	+		
Cribrilina spiculifera Kluge	arc.eur.-as.																					+			
Escharella ventricosa var. *peristomata* Kluge	arc.eur.-as.																	+	+						
Escharelloides cancellatum (Smitt)	arc.circ.-p.	+				+													+						
Escharelloides simplex Kluge	arc.eur.-as.																			+					
Smittina glaciata (Waters)	arc.eur.-as.																		+	+					
Smittina muliebris Kluge	arc.eur.-as.																			+					
Pseudoflustra birulai Kluge	arc.eur.-as.																		+	+		+			
Umbonula inarmata Kluge	arc.eur.-as.																				+				
Schizoporella elmwoodia var. *mammilata* Kluge	arc.eur.-as.																		+						
Hippoporina borealis (Waters)	arc.eur.-as.																		+	+					
Stomachetosella collaris (Kluge)	arc.eur.-as.																				+				
Retepora beaniana var. *watersi* Nordgaard	arc.eur.-as.												+						+						
Echaroides bidenkapi (Kluge)	arc.eur.-as.																+		+	+	+	+			
Echaroides jacksoni var. *rostrata* (Kluge)	arc.eur.-as.																					+			
Escharoides monstruosa (Kluge)	arc.amer.-as.																						+		
Idmonea fenestrata Busk	arc.amer.-as.										+								+	+	+				
Bugula harmsworthi Waters	arc.amer.-as.		+		+					+	+			+											
Escharella diimphnae (Kluge)	arc.amer.-as.										+														
Escharella indivisa Levinsen	arc.circ.-p.		+	+	+	+				+	+								+	+	+	+			
Hippoporina tschukotkensis Kluge	arc.amer.-as.																						+		
Escharelloides spinulifera (Hincks)	arc.circ.-p.	+		+	+		+		+	+								+	+	+					
Esharelloides stenostoma (Smitt)	arc.eur.-am.										+								+						

Note: sub.-b., subtropical boreal; atl.b., Atlantic boreal widespread; atl.sub.-b., Atlantic subtropical boreal; atl.h.-b., Atlantic high boreal; amph.b., amphiboreal; b.-a., boreal–Arctic widespread; b.-a.atl.circ.-p., boreal–Arctic Atlantic circumpolar; b.-a.atl.eurasian, boreal–Arctic Atlantic Eurasian; b.-a.atl.am.-eur., boreal–Arctic Atlantic American–European; b.-a.pac.circ.-p., boreal–arctic Pacific circumpolar; b.-a-pac.amer.-as, boreal–Arctic Pacific Amerasian; b.-a.pac.eur.-as., boreal–Arctic Pacific Eurasian; arc.circ.-p., Arctic circumpolar; arc.eur.-as., Arctic Eurasian; arc.amer.-as., Arctic Amerasian; arc.eur.-am., Arctic Euroamerican; arc.amer., Arctic American; pac.b., Pacific boreal.

+ = species in: 1, northwestern coast of Alaska; 2, northern coast of North America; 3, the Archipelago of Canadian Islands; 4, Baffin Bay; 5, Davis Strait; 6, Hudson Bay; 7, Gulf of Labrador; 8, Newfoundland; 9, St. Lawrence Gulf; 10, western Greenland; 11, eastern Greenland; 12, Greenland Sea; 13, Iceland; 14, Jan Mayen; 15, Norwegian Sea; 16, North Sea; 17, northern Norway; 18, White Sea; 19, Barents Sea; 20, Kara Sea; 21, Laptev Sea; 22, East Siberian Sea; 23, Chukchi Sea; 24, Bering Strait.

This table is based on the authors' present data and the literature listed.

Table 14-1. *(continued)*

Species	Biogeography	Species Presence																						
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*
Hemicyclopora emucronata (Smitt)	arc.eur.-am.				+	+														+	+				
Schizoporella bispinosa Nordgaard	arc.eur.-am.			+																+	+				
Schizoporella elmwoodiae Waters	arc.eur.-am.			+															+	+	+				
Cellepora canaliculata Busk	arc.circ.-p.					+				+	+	+		+				+	+	+	+	+	+		
Escharella macrodonta Levinsen	arc.amer.											+													
Smittina tuberosa Kluge	arc.amer.	+																							
Cystisella elegantula (d'Orbigny)	arc.amer.				+	+	+	+	+	+	+														
Membraniporella crassicosta Hincks	arc.amer.					+	+			+															
Hippoporina murdochi Kluge	arc.amer.	+																							
Schizoporella ortmanni Kluge	arc.amer.				+			+																	
Cheiloporina sincera var. *praelucida* (Hincks)	arc.amer.		+	+				+		+	+														
Vesicularia fasciculata Soule	arc.amer.		+																						
Alcyonidium vermiculare Okada	pac.b																							+	
Tegella anguloavicularis Kluge	pac.b																							+	
Tegella inermis Kluge	pac.b																								+
Tegella amissavicularis (Kluge)	pac.b																								+
Callopora obesa Kluge	pac.b																								+
Dendrobeania pseudolevinseni Kluge	pac.b																							+	
Bugula tschukotkensis (Kluge)	pac.b																							+	
Cystisella saccata var. *beringia* Kluge	pac.b																							+	
Porella tumida (Kluge)	pac.b																								+
Schizobrachiella stylifera var. *perforata* (Kluge)	pac.b																								+

Hippoponella fastigatoavicularis (Kluge)	pac.b																								+
Adeonellopsis tuberculata (Busk)	pac.b																							+	
Smittina beringia (Kluge)	arc.am.			+																					
Scrupocellaria minor Kluge	amer.										+							+	+			+	+		

Note: sub.-b., subtropical boreal; atl.b., Atlantic boreal widespread; atl.sub.-b., Atlantic subtropical boreal; atl.h.-b., Atlantic high boreal; amph.b., amphiboreal; b.-a., boreal-Arctic widespread; b.-a.atl.circ.-p., boreal-Arctic Atlantic circumpolar; b.-a.atl.eurasian, boreal-Arctic Atlantic Eurasian; b.-a.atl.am.-eur., boreal-Arctic Atlantic American-European; b.-a.pac.circ.-p., boreal-arctic Pacific circumpolar; b.-a-pac.amer.-as, boreal-Arctic Pacific Amerasian; b.-a.pac.eur.-as., boreal-Arctic Pacific Eurasian; arc.circ.-p., Arctic circumpolar; arc.eur.-as., Arctic Eurasian; arc.amer.-as., Arctic Amerasian; arc.eur.-am., Arctic Euroamerican; arc.amer., Arctic American; pac.b., Pacific boreal.

+ = species in: 1, northwestern coast of Alaska; 2, northern coast of North America; 3, the Archipelago of Canadian Islands; 4, Baffin Bay; 5, Davis Strait; 6, Hudson Bay; 7, Gulf of Labrador; 8, Newfoundland; 9, St. Lawrence Gulf; 10, western Greenland; 11, eastern Greenland; 12, Greenland Sea; 13, Iceland; 14, Jan Mayen; 15, Norwegian Sea; 16, North Sea; 17, northern Norway; 18, White Sea; 19, Barents Sea; 20, Kara Sea; 21, Laptev Sea; 22, East Siberian Sea; 23, Chukchi Sea; 24, Bering Strait.

This table is based on the authors' present data and the literature listed.

Table 14-2. Biogeographic Distribution of the Bryozoan Fauna of the Arctic Ocean (%)

Biogeographic Groups	*Entire Arctic Ocean*	*Regions*																							
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*
sub.-b.	0.6	0	0	0	1.4	0	1.6	2.6	5.9	1.65	0	0.8	0	1.8	0	0	0	1.4	0	0.3	0	0.85	0	0.9	0
atl.sub.-b.	2.9	0	0	0	1.4	2.6	3.2	2.6	5.9	2.5	2.5	0.8	0	1.8	1.4	0	14.3	1.4	2.3	3.8	1.6	0.85	0	0	0
atl.b. widespread	3.9	0	2.3	1	0	0	1.6	0	0	0.8	1.2	0	0	0	0	0	14.3	1.4	2.3	4.4	0	0	0	0	0
atl.h.-b.	9.2	0	0	0	0	0	0	0	0	0.8	1.2	2.6	0	1.8	0	0	0	4.1	3.1	9.5	0.5	0	0	0	0
amph.-b.	5.0	0	2.3	2.0	0	0	3.2	1.3	5.9	4.1	3.1	0.8	0	1.8	0	0	9.5	5.5	4.6	4.8	0.5	0	0	3.6	0
b.-a. widespread	19.2	47	47.1	48.5	47.9	31.6	53.3	59.3	35	40.6	38.9	41	0	46.4	46.5	0	47.7	43.7	44.2	23.5	32.1	33.3	31.4	43.6	0
b.-a.atl.circ.-p.	7.1	0	5.8	10.1	2.8	2.6	3.2	3.9	11.8	11.6	10.5	9.4	0	8.9	16.4	0	9.5	4.1	6.2	8.1	10.3	10.2	10.8	6.4	0
b.-a.atl.eur.-as.	3.5	0	1.2	1.0	0	0	0	1.3	0.8	0.5	0.5	0.8	0	5.3	1.4	0	4.7	1.4	3.1	3.7	2.2	0.85	0.9	0	0
b.-a.atl.am.-eur.	29	0	3.4	2.0	2.8	5.3	1.6	3.9	0	3.3	3.1	2.5	0	5.3	1.4	0	0	5.5	2.3	3.7	3.3	2.6	2.0	0.9	0
b.-a.pac.circ.-p.	5.9	29.4	17.2	16.2	23.9	18.4	12.9	11.6	11.8	14	11.1	11.9	0	16.2	15.1	0	0	17.8	11	7.3	9.8	9.4	6.9	14.6	0
b.-a.pac.am.-as.	1.5	5.9	1.2	1.0	4.2	5.3	1.6	1.3	5.9	11.65	2.5	1.6	0	0	0	0	0	0	0.8	1.1	1.6	1.7	2.9	1.8	0
b.-a.pac.eur.-as.	3.5	5.9	0	0	0	0	0	0	0	0.8	1.2	0.8	0	0	0	0	0	0	2.3	2.6	3.8	4.3	4.9	4.6	0
arc.circ.-p.	12.4	5.9	17.2	14.2	11.4	23.7	14.6	9.3	11.8	14.9	20.9	22.2	100	8.9	16.4	50	0	12.3	13.1	15.1	19.6	25.6	22.6	12.7	0
arc.eur.-as.	13.6	0	0	0	0	0	0	0	0	0	0.5	0.8	0	1.8	0	50	0	1.4	3.9	10.3	12.6	9.4	17.6	3.6	0
arc.am.as.	0.9	0	0	0	0	0	0	0	0	0	0.5	0.8	0	0	0	0	0	0	0	0.3	0.5	0.85	0	1.8	0
arc.eur.-am.	1.2	0	0	2.0	1.4	2.6	0	0	0	0	0.5	1.6	0	0	0	0	0	0	0.8	1.5	1.6	0	0	0	0
arc.amer.	3.2	11.8	2.3	2.0	2.8	7.9	3.2	3.9	0	2.5	1.8	1.6	0	0	1.4	0	0	0	0	0	0	0	0	0	0
pac.b.	3.5	0	0	0	0	0	0	0	5.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.5	100

Note: Legend of biogeographic groups appears in footnote to Table 14-1.

APPENDIX

Plate 14-I

1. Proboscina sp., × 21, Barents Sea, incrusting kelp.
2. Tubulipora sp., × 35, Barents Sea, incrusting kelp.
3. Tubulipora sp., × 21, Barents Sea, incrusting kelp.
4. *Tubulipora soluta* Kluge, × 21, Barents Sea, incrusting kelp.
5. Idmoneoides sp., × 5, Barents Sea, on polychaetes tubes.

5*a*. Idmoneoides sp., fragment of zoarium with oecistome.

6. *Entalophora clavata* (Busk), × 3.5, Barents Sea, on rock.
7. Tubulipora sp., × 14, Barents Sea, incrusting kelp.
8. *Tubulipora eminens* Kluge, × 3.5, East Siberian Sea, on rock and argillaceous sand.

Plate 14-II

1. Berenicea sp., × 10.5, Chukchi Sea, on rocks.
2. Fasciculiporoides sp., × 10.5, East Siberian Sea, on a hydrozoa.
3. Berenicea sp., × 7, Barents Sea, on polychaetes tubes.
4. *Lichenopora multicentra* Kluge, solitary zoarium, × 3.5, substratum: argillaceous sand with rocks, Laptev Sea.
5. *Lichenopora multicentra* Kluge, compound zoarium, × 6, Laptev Sea, on the legs of sea spiders.
6. *Lichenopora sibirica* Kluge, × 6, Laptev Sea, on hydrozoa, on argillaceous substratum.

Plate 14-III

1. *Eucratea loricata* var. *arctica* (Kluge), × 17.5, Kara Sea, on rocks; argillaceous rocky substratum.
2. *Notoplires smitti* (Norman), × 14, Barents Sea, on shells; on argillaceous rocky substratum.
3. *Semibugula birulai* Kluge, × 28, Barents Sea, on rocks; on argillaceous rocky substratum.
4. *Dendrobeania fruticosa* (Packard), × 17.5, Barents Sea, on rocks; substratum: rocks, shells, clays.
   a. marginal avicularium side view, × 42.
   b, c. middle avicularium view from above, × 52.5.
5. *Dendrobeania levinseni* (Kluge), × 17.5, Kara Sea, on rocks.
   a. marginal avicularium side view, × 28.
   b. middle avicularium side view, × 28.
   c. middle avicularium frontal view, × 28.
6. *Flustra serrulata* Busk, Chukchi Sea, × 17.5, on hydrozoa; on argillaceous rocky substratum.

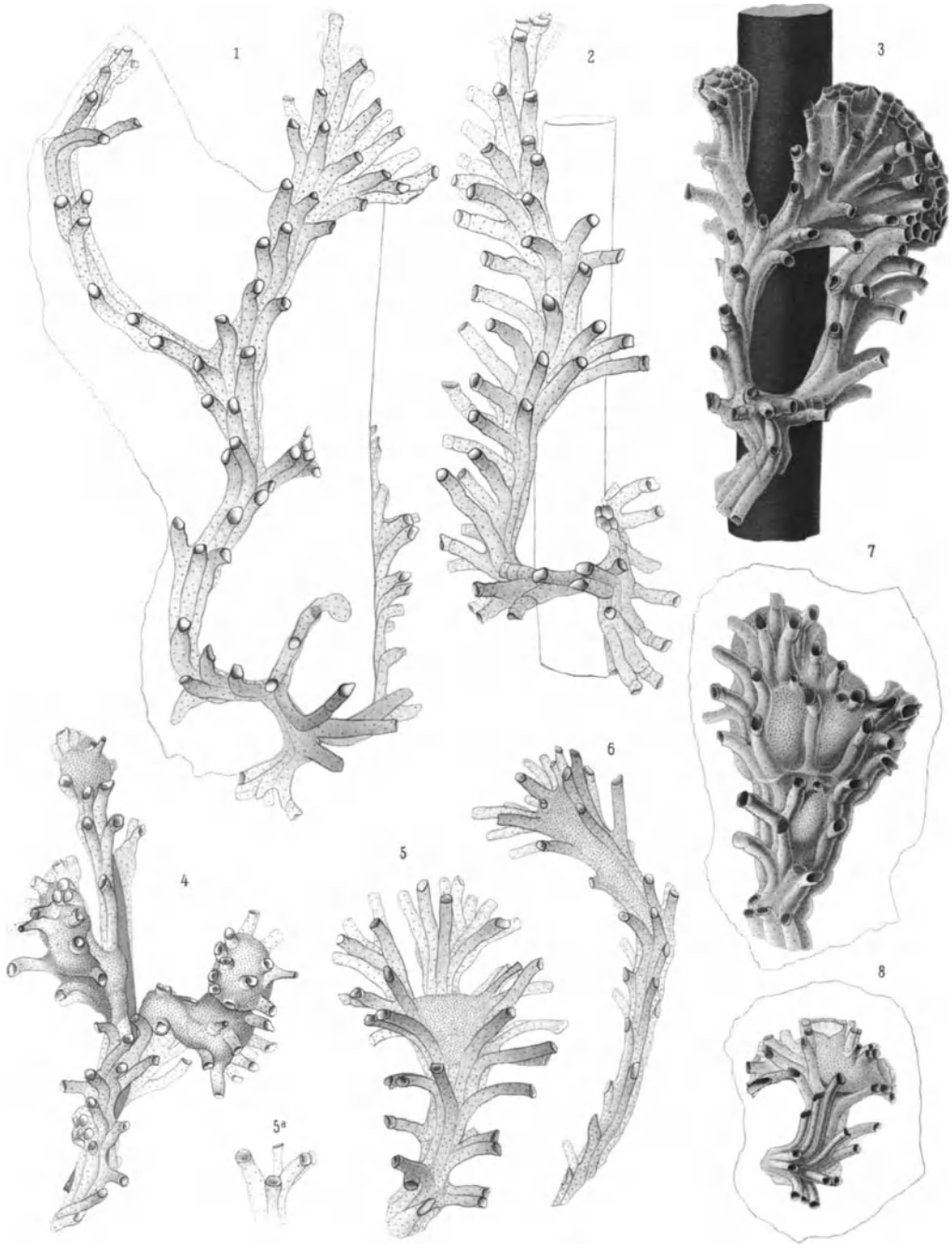


PLATE 14-I

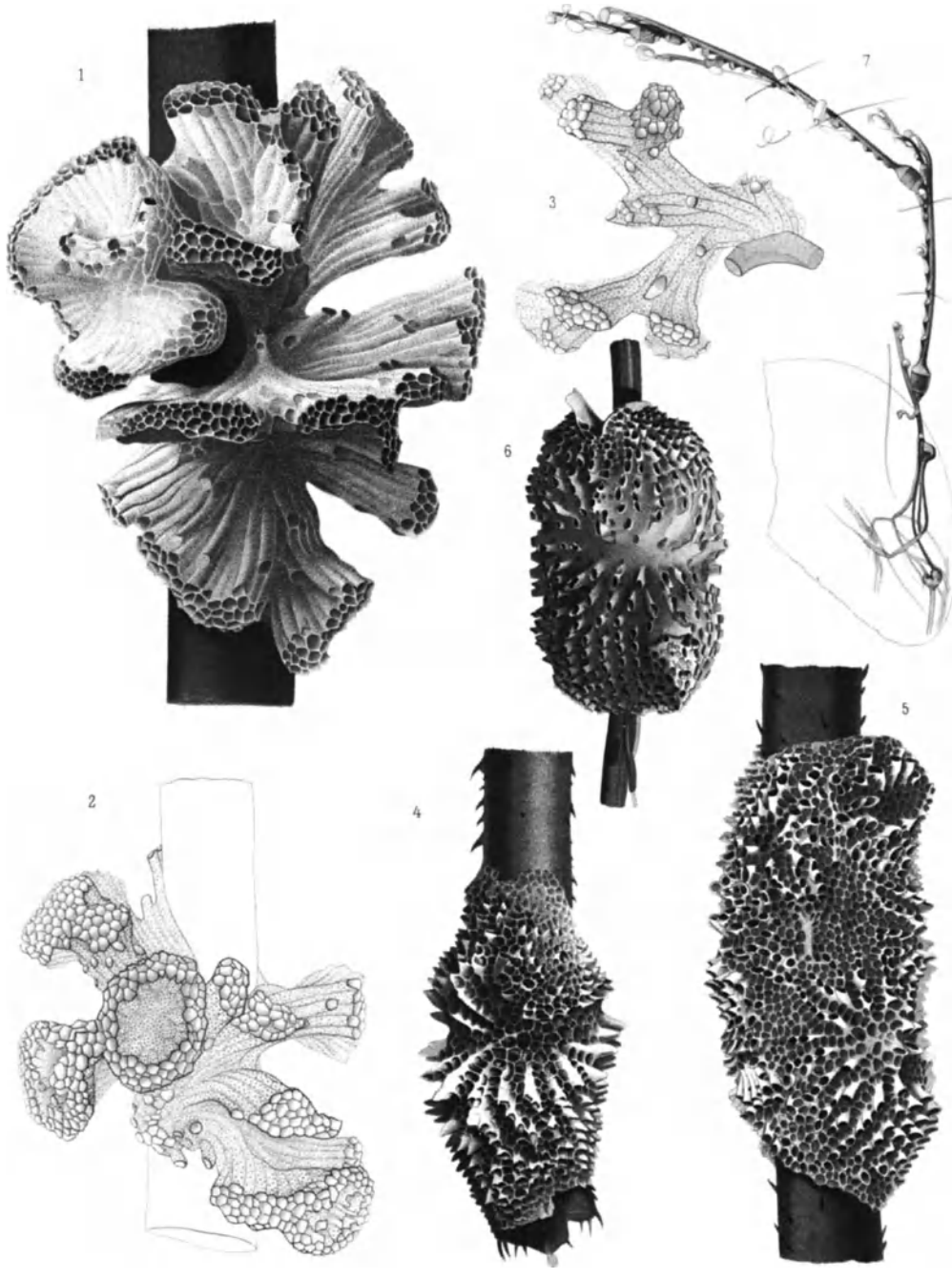


PLATE 14-II

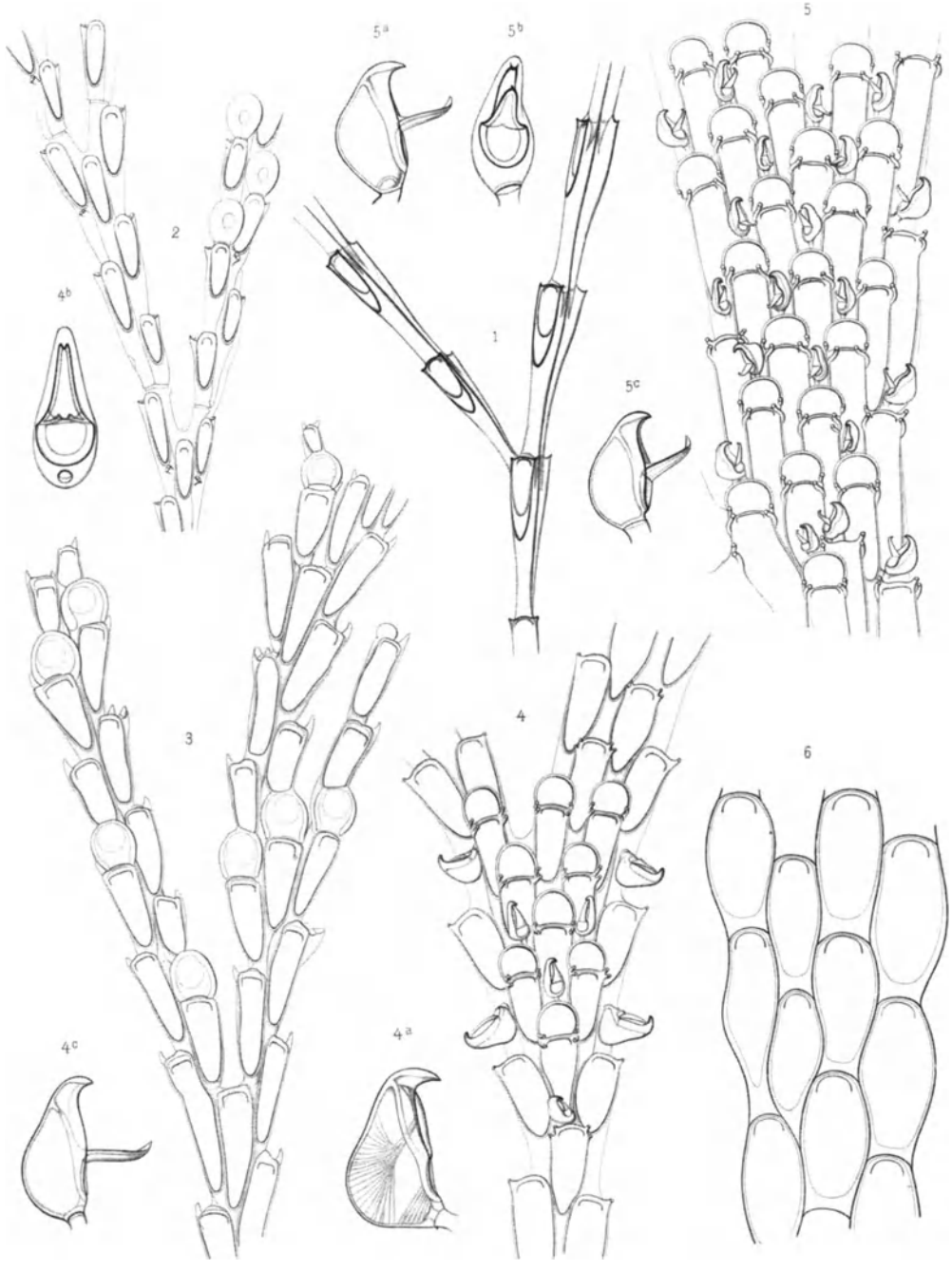


PLATE 14-III

Plate 14-IV

1. *Callopora smitti* (Kluge), × 21, Kara Sea, on shells; on argillaceous-rocky-sandy substratum.
2. *Stomachetosella incerta* (Kluge), × 21, Barents Sea, on rocks.
3. *Schizoporella pachystega* (Kluge), × 21, Barents Sea, on shells, on argillaceous-rocky-sandy substratum.
4. *Pseudoflustra solida* (Stimpson), × 21, Laptev Sea, on rocks.
5. *Pseudoflustra birulai* (Kluge), × 21, Barents Sea, on rocks, on argillaceous rocky substratum.
6. *Rhamphostomella bilaminata* var. *sibirica* (Kluge), × 21, on shells, Chukchi Sea, on rocky argillaceous substratum.
7. *Rhamphostomella ovata* (Smitt), × 21, Barents Sea, on algae, on rocky argillaceous substratum.
8. *Cellepora canaliculata* Busk, × 28, on shells, Kara Sea.
9. *Celleporina nordenskjoldi* (Kluge), × 17.5, East Siberian Sea, on algae.

All illustrations were drawn by Kluge in 1916 but were never published.

Map 14-1

Map of the seas of the Northern Hemisphere divided into biogeographic regions, subregions, and provinces.

I. Arctic subregion, Arc–Atlantic region.
II–IV. Atlantic boreal subregion, Arc–Atlantic region.
II. Celtic high boreal province.
III. Delaware low boreal province.
IV. Scandinavian low boreal province.
V. Aleutian high boreal subregion, Pacific boreal region.
VI. Ainian low boreal subregion, Pacific boreal region.
VII. Oregonian low boreal subregion, Pacific boreal region.

Map 14-2

Distribution of the three Arctic species:

● *Dendrobeania fruticosa* (Packard)
■ *Semibugula birulai* Kluge
▲ *Rhamphostomella ovata* (Smitt)

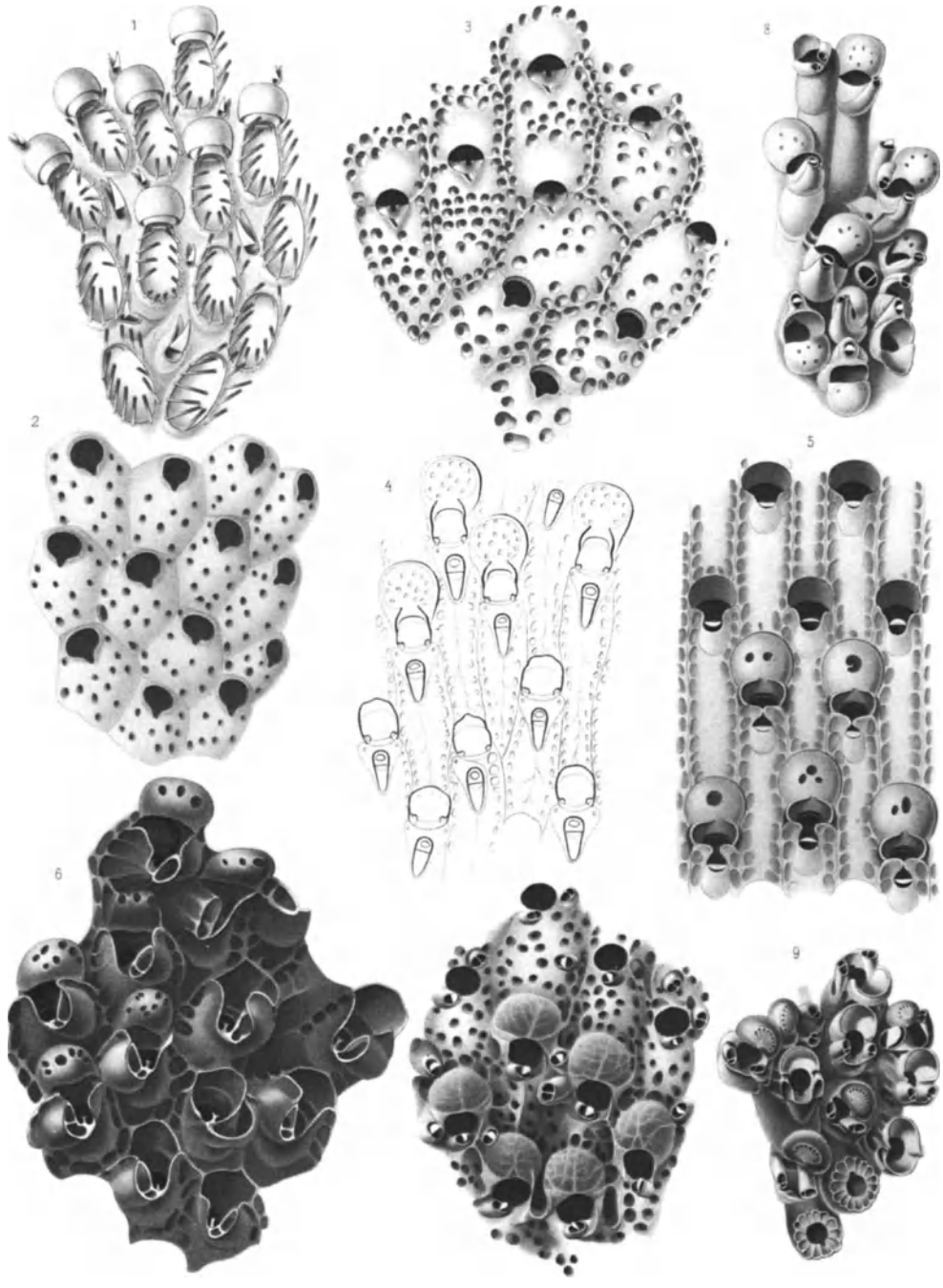
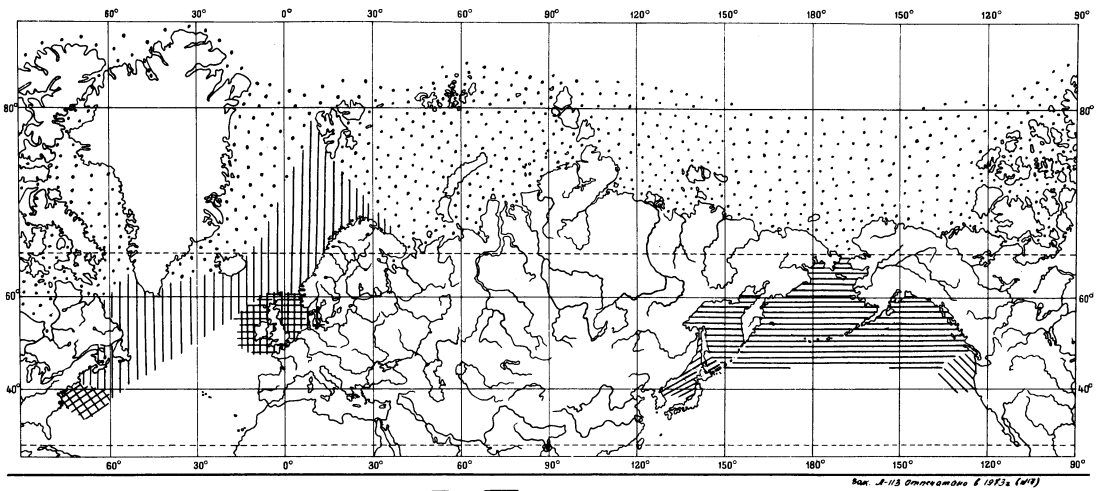
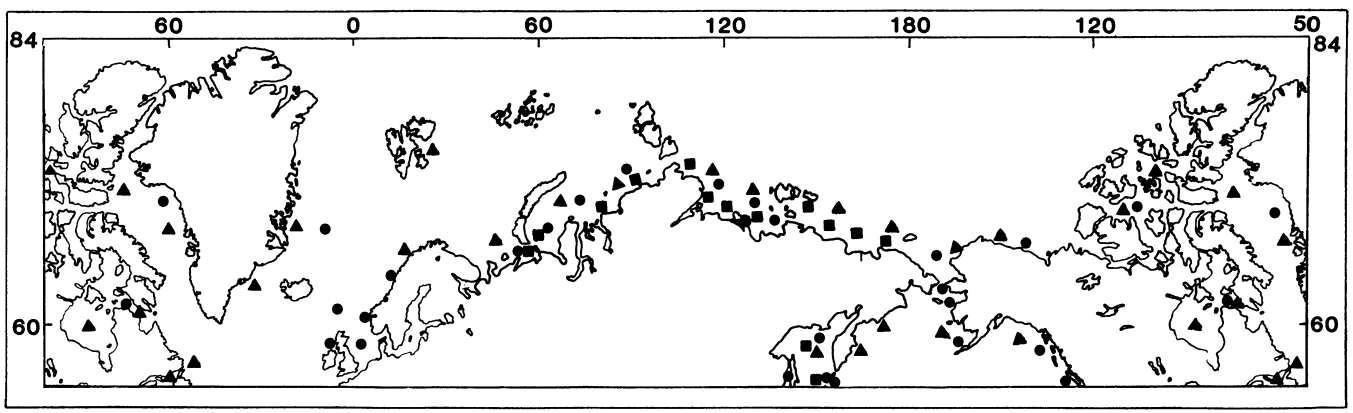


PLATE 14-IV



MAP 14-1



MAP 14-2

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