Journal of International Scientific Publications:
Ecology & Safety, Volume 6, Part 1
ISSN 1313-2563, Published at: http://www.science-journals.eu

EVOLUTION AND DISTRIBUTION OF THE ANTARCTIC AND ARCTIC CHEILOSTOMATE BRYOZOA

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Abstract

Bipolar distribution of marine organisms was connected with a history of fauna and changes in hydrological regime. Bryozoa in Arctic and Antarctic are mainly eurybathial and play often a dominant role in polar shelf biocenoses. Both eurybathial and deep water bryozoan cheilostomate species inhabit deep waters of these regions. The deep water of Antarctic and Arctic bryozoan species often relate to widespread genera and families in the World Ocean. Calcareous skeletons of common Arctic and Antarctic species consist of calcite, which can have originated in coldwater conditions of life. Number of Cheilostomata species higher in Antarctic waters, although Arctic fauna is more diversified in systematic relationship. The shelf fauna possibly have penetrated in young oceanic depressions such as Antarctic pseudoabissal and Arctic deep depths and probably have had deepwater ancestors; therefore species in pseudoabissal could retrace characters of earlier ancestors. Hence the bryozoan fauna could have an origin in deep and cold water conditions in the World Ocean.

Possible ways of evolution bipolar bryozoan families and genera can be explained by a model of recent global oceanic circulation.

Key words: *Antarctic, Arctic, Bryozoa, Cheilostomata, distribution, fauna, evolution*

1.INTRODUCTION

Bipolar distribution of species is a questions, which is always considered in connection with the history of fauna and its environments. L.S.Berg (1953) maintainted justly that the term bipolar distribution should not be used for Arctic and Antarctic species, but for groups of species, but to the groups of species of temperate latitudes: boreal and notal subregions as it stated from recent biogeographical notion of latitude and climatic zonality. In connection with this circumstances it should be mentioned as Berg wrote that bipolar distribution is characterized by taxa of higher level than species, i.e., genera and families, although bipolar species occur. Bryozoa are always attached to substrata hav short–living and often nonfeeding planktonic larvae. They are widely distributed in the World Ocean and have a long (first representatives are known from the Ordovician) and well studied paleontological record. Short life of a planktonic larva of Bryozoa can testify about a small area of a habitation for each species (Gontar et al., 2004), although it can spread by streams of larva at long distances (Gontar and Naumov, 1994, Gontar and Naumov, 2004). The distribution of Bryozoa in each region of World Ocean, for instance, in shelf seas, as a best studied from the point of view of composition and distribution of fauna, is always connected with available substrata and distribution of water masses of different origin (Gontar et al, 2001, 2002, Gontar, 2003(a), 2003(b), Gontar et al., 2004). Species, which inhabit boreal and Polar Regions, are eurythermal and eurybathyal forms often. Bryozoa of the Arctic and Antarctic waters live at relatively low temperatures of water.

2.MATERIAL

An information about the deep water fauna of the World Ocean is still incomplete. It can be asserted that deep water species together with the eurybathial species live typically in deep depths; nevertheless the deep water species belong to the widespread genera and the families in the World Ocean. We used a collection of the German Antarctic Expedition in the Weddell Sea and a deep–sea collection from the region of Clarion Clipperton for a comparison.

3.RESULTS

The forming of deep near–bottom waters of the World Ocean as the result of a sinking of shelf waters down along the continental slope of the Antarctica contributes to the freshening, cooling and enrichment of the water by oxygen. In our view it can give a possibility to explain some features of evolution of the Bryozoa fauna in the World Ocean and in the Polar regions as well. Moss animals are sestonophages and have enough of food resources in the World Ocean. It is interesting to note that the calcareous skeletons of the widespread species of Bryozoa of the Arctic and Antarctic waters consist of a calcite mainly, which can form only in coldwater conditions (Borisenko, Gontar, 1991). Only species from the Antarctic waters *Chondriovelum adeliense* (Livingstone) from Family Onychocellidae Jullien, 1882, Superfamily Microporoidea Gray, 1848 has an aragonite skeleton and this testifies to its warm water origin. Calcite skeletons of relative cold water Bryozoa testify about an origin of fauna in relatively cold waters. The fact that indirectly supports this point of view is that a reproductive season of the Antarctic cheilostome bryozoa occurs during the Antarctic winter. A.P.Andrijashev has developed the concept of the disjunctive areas of sea biota and proposed a new type of an interrupted distribution – amphipacific (Andrijashev, 1939(a)). As he stated, a formation of a larger part of the amphiboreal disjunctions has occurred during the Pliocene and the Miocene periods (Andriyashev, 1939(b)). Probably, this is true for the bipolar distribution as well. It should mention also that young deep cavities, i.e. pseudoabyssal (Andrijashev, 1953) and pseudobathyal zones (Andrijashev, 1975), for instance, in the Arctic Ocean or in the Antarctic shelf accordingly, have an altered fauna of continental shelf in a greater or lesser extent. These are eurybathyal shelf species, re–deepwater species and some other fauna elements. According to Andrijashev thalassobathial is characterized many different kinds of oceanic banks, underwater mountains (including guyots), chains, and especially the all–world system under water middle–ocean ridges had to serve as an important way to a distribution of bathial fauna in the World Ocean. As a result of comparison of the systematic composition of Bryozoan cheilostomate fauna in the Arctic Ocean and the Antarctic seas it has appeared that though in the Antarctic seas the number of bryozoans species is larger, than in the Arctic ocean, the Arctic fauna is more various in systematic composition, as belongs to greater number of genera and families (Gontar, 2006).

Superfamily Buguloidea Gray, 1848 is relatively young in the evolution and consisting of seven families. The superfamily has the greatest number of species in two families, Bugulidae Gray and Candidae d'Orbigny. Species from these families have vertical colonies; they inhabit both Arctic and Antarctic waters. Vertical colonies have originated in Bryozoa evolution later than incrusting (Gontar, 1994, 1998); therefore it is very probable their bipolar distribution reflects last picture of such distribution, i.e., it is possible to reject the with the certain share of confidence the assumption about reinvasion of ancient species in the regions, which could cause incorrect conclusions (as it has taken place, for instance, in some representatives of fishes (Andrijashev, 1953, 1987).

The thesis (Taylor's principle-cites following of Andrijashev, 1988) that the ancestral forms are preserved on the periphery of an area, because they are superseded by more progressive phylogenetic groups, in this case is hardly fair. It is interesting to note that four bipolar genera from these families in the Arctic waters are distributed up to 800 m and in the Antarctic waters up to 650 m maximum.

However, more typical they can be found up to 400 m in both regions. Strictly speaking, they can be referring to relatively deep forms in these regions.

Genus *Dendrobeania* from family Bugulidae is widely distributed in marine water of the Northern Hemisphere. The species registered for the Arctic Basin had three ways of migration: from the Pacific Ocean in the East in the Atlantic and the Barents Sea; from the Pacific Ocean in the West in Russian Arctic seas, and from the Atlantic Ocean directly. Genus *Bugula* had obviously common ancestors with above mentioned genus *Dendrobeania*, and therefore both parallel evolutionary tendencies, i.e., from the multiserial colonies to biserial- and uniserial colonies (Gontar, 2006). Bipolar genus *Bugula* is widely distriuted in shallow temperate and tropical water of an ocean, although only three species were met in the Antarctic seas and five ones in the Arctic seas, that can be explained probably of their relatively penetration into these regions. The genus *Camptoplites* Harmer, 1923, which species have been determined by H.A. Kluge as *Bugula* Oken, 1815, can be found in the marine waters of the Southern Hemisphere. Species of the genus are known from the abyssal waters of the Indian and Atlantic and Pacific Oceans and they live on the shelf of Antarctic, where the species are the most numerous, that confirms a conclusion of Darwin (1939). Apparently, if we compare these species with the species of the above mentioned genera, they have non–stable reticulate form of colony. This can testify in turn to relatively late settlement by them of the Antarctic shelf. They also have parallel tendencies from multiserial to bi– and uniserial shape of colony (Gontar, 2006)

It can be supposed that evolution in the family Bugulidae derives through the way of parallel evolution and, as should be stressed, through a contact or, perhaps, a migration of Arctic and Antarctic faunal elements as well. Whereas fauna of a shelf has a capability to settle at young oceanic depth, so respectively this shelf fauna could have an origin from the deep water elements (for instance, *Camptoplites)*. It is very probable that this shelf fauna has had deep water ancestors and therefore this fauna returned back to the characters of earlier ancestor. All the above described has a good connection with ideas of Vavilov (1935) about homologous lines, because characters which we used for the identification, according to Darwin (1939), are a reaction of organism to environmental conditions.

Analogical tendencies can be traced for the family Candidae D'Orbigny, 1851. Bipolar genus *Notoplites* Harmer, 1923, which H.A. Kluge has considered as *Scrupocellaria* Van Beneden, 1845 in the Antarctic collections, is characterized as deepwater around the World Ocean and it distributed in bathyal and abyssal waters. By contrast, it distributes on a shelf in the Antarctic and Arctic waters and has very large number of species in the Antarctic water, probably, owing to pseudobathyal depths. Genus *Scrupocellaria* Van Beneden, 1845 is resident in marine waters of the North Hemisphere, whereas the genus *Amastigia* Busk, 1852, a part of which Kluge has referred to *Scrupocellaria* Van Beneden, 1845, is common in marine water of the Southern Hemisphere. *Amastigia* Busk, 1852 has a species maximum on the Antarctic shelf; although behind the subtropical convergence some species are known from abyssal depths only.

It is interesting to discuss a finding near Senegal, near Green Cape Islands, West Africa, 44–64 m (Cook,1964, 1967) of species: these are *Hippoporina pertusa* (Esper), which can be regarded as species with a tendency to bipolar distribution, because it was previously found in the Pacific Ocean from Cape Code to California and Galapagos Islands, and in the Atlantic Ocean from the Shetland Islands to the Mediterranean from 10 m up to 180 m; and typical Antarctic genus *Cellaria* (Ellis et Solander), 60–80 m from the same place. The latter is widespread in the Antarctic waters, and it was found in the Northern Hemisphere near Spain. *Cellaria* sp is known as fossil, for instance, near Norwegian coast.

ISSN 1313-2563, Published at: http://www.science-journals.eu

4.CONCLUSION

High frequency climatic fluctuations of different nature heterodyne with long-term climate changes. Modern science has data about the faunal composition for the last 170–180 years maximum. There were essential changes in species composition of the fauna of different regions of the World Ocean, which have been traced by numerous expeditions. This testifies that any short-term changes and fluctuations in the hydrosphere of the Earth reflected at once on the composition and a distribution of living organisms. It is probable, that deep Antarctic currents which had penetrated to more Northern depths earlier, could influence of Arctic species diversity to a larger extent.

Fig.1. *Camptoplites bicornis* А – bottom of Clarion Clipperton, Б – manganese concretion with the colony on it, В – the colony in Petri dish, Г – the colony

Possible ways of the evolution in families and bipolar genera can be explained also by the model of global oceanic circulation. *Camptoplites bicornis* (Busk) is widespread in Antarctic shelf waters. The species was discovered recently in the region of the eastern part of the Northern Pacific, known as Clarion Clipperton, at the depth of 4,500 m, 13°N 134°W (see figures 1, 2 and map). Probably, Antarctic Bryozoans' fauna have had a larger influence on the Arctic fauna.

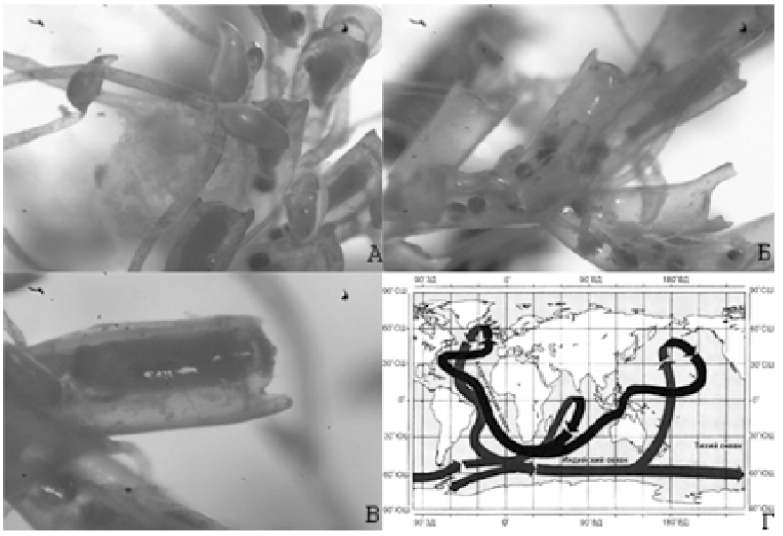

Fig.2. *Camptoplites bicornis* А – avicularia, Б – autozooids, В – autozooid, Г – Oceanic belt of currents.

5.ACKNOWLEDGEMENTS

I would like to express my appreciation to Dr. V.F. Melnik НПП "Центральная аналитическая лаборатория" for a permission to use his collection and photos.

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