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SOME BREACH OF THE WALLES' RULE AND OTHER PECULIARITIES OF THE FAUNA IN THE WEDDELL SEA

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Abstract. According to the rule of de Candolle-Walles a species diversity decreases from low latitudes regions to high latitudes regions. However in the Weddell Sea the biodiversity of the fauna of some groups are approximately the same (Actiniaria, Mysidacea, Cumacea, Gastropoda, Bryozoa, Echinoidea) or more than this in the Magellan region (Spongia, Pycnogonida, Holothuroidea, Asteroidea, Ohpiuroidea, Ascidiacea). In spite of the rather high species diversity of bivalves in the Weddell Sea, communities where bivalves dominated (like in Arctic seas) practically are absent and average size of gastropods and bivalves is much less than in the Arctic Ocean. Moreover Reptantia from Decapoda crustacean is absent in the Weddell Sea. We will try to explain the reasons of the breach of the Walles rule of the fauna and will try to explain some other peculiarities of the Weddell Sea. For this purpose we will compare the fauna of some groups in the Magellan region and in the Weddell Sea (Table. Number of species of different genera the Magellan Region and in the Weddell Sea).
Key words: Antarctic fauna, Walles' rule, Weddell Sea, Magellan region.

Нарушение правила Уоллеса и другие особенности фауны моря Уэдделла. Б.И. Сиренко, И.С. Смирнов.
Реферат. Согласно правилу меридионального изменения разнообразия Декандоля–Уоллеса, разнообразие видов уменьшается от низких широт к высоким. Сравнение фауны моря Уэдделла с фауной соседнего с ним Магелланова района обнаруживает нарушение этого правила для некоторых групп морских донных животных. У актиний, мизид, кумовых раков, брюхоногих моллюсков, мшанок и морских ежей (Actiniaria, Mysidacea, Cumacea, Gastropoda, Bryozoa, Echinoidea) видовое разнообразие в море Уэдделла почти не уступает таковому в Магеллановом р-не, а у губок, морских пауков, голотурий, морских звезд, офиур и асцидий (Spongia, Pycnogonida, Holothuroidea, Asteroidea, Ohpiuroidea, Ascidiacea) оно даже выше, вопреки правилу Уоллеса. Несмотря на довольно высокое разнообразие видов двустворчатых моллюсков в море Уэдделла, сообщества, где двустворки доминируют (как в арктических морях), фактически отсутствуют, а средний размер гастропод и двустворчатых моллюсков – намного меньше, чем в Северном Ледовитом океане. Кроме того, ракообразные из группы Reptantia (Decapoda) в море Уэдделла отсутствуют.
Мы попытаемся объяснить причины нарушения правила Декандоля–Уоллеса и некоторые другие особенности фауны моря Уэдделла. С этой целью мы сравним фауну некоторых групп беспозвоночных Магелланова района и моря Уэдделла.
Ключевые слова: антарктическая фауна, правило Уоллеса, море Уэдделла, Магелланов район.

Порушення правила Уоллеса та інші особливості фауни моря Уедделла. Б.І. Сіренко, І.С. Смирнов.
Реферат. Відповідно до правила меридіональної зміни різноманіття Декандоля–Уоллеса, різноманіття видів зменшується від низьких широт до високих. Порівняння фауни моря Уедделла з фауною сусіднього з ним Магелланового району виявляє порушення цього правила для деяких груп морських донних тварин. У актиній, мізид, кумових раків, черевоногих молюсків, мшанок та морських їжаків (Actiniaria, Mysidacea, Cumacea, Gastropoda, Bryozoa, Echinoidea) видове різноманіття в морі Уедделла майже не поступається такому в Магелланову районі, а у губок, морських павуків, голотурій, морських зірок, офіур і асцидій (Spongia, Pycnogonida, Holothuroidea, Asteroidea, Ohpiuroidea, Ascidiacea) воно навіть вище, всупереч правилу Уоллеса. Попри досить велике різноманіття видів

двостворчастих молюсків у морі Уедделла, угруповання, де двостворки домінують (як в арктичних морях), фактично відсутні, а середній розмір гастропод і двостворчастих молюсків набагато менший, аніж у Північному Льодовитому океані. Окрім того, ракоподібні з групи Reptantia (Decapoda) в морі Уедделла відсутні.
Ми спробуємо пояснити причини порушення правила Декандоля–Уоллеса та деякі інші особливості фауни моря Уедделла. З цією метою порівняємо фауну деяких груп безхребетних Магелланового району й моря Уедделла.
Ключові слова: антарктична фауна, правило Уоллеса, море Уедделла, Магелланів район.

1. Introduction

According to the rule of de Candolle-Walles a species diversity decreases from low latitudes regions to high latitudes regions. However in the Weddell Sea the biodiversity of the fauna of some groups are approximately the same (Actiniaria, Mysidacea, Cumacea, Gastropoda, Bryozoa, Echinoidea) or more than this in the Magellan region (Spongia, Pycnogonida, Holothuroidea, Asteroidea, Ohpiuroidea, Ascidiacea). In spite of the rather high species diversity of bivalves in the Weddell Sea, communities where bivalves dominated (like in Arctic seas) practically are absent and average size of gastropods and bivalves is much less than in the Arctic Ocean. Moreover Reptantia from Decapoda crustacean is absent in the Weddell Sea.

We will try to explain the reasons of the breach of the Walles rule of the fauna and will try to explain some other peculiarities of the Weddell Sea. For this purpose we will compare the fauna of some groups in the Magellan region and in the Weddell Sea.

2. Results

We will compare some general abiotic and biotic peculiarities in the Weddell Sea and the Magellan region as well.

2.1.Temperature, salinity, ice conditions and light regime

Weddell Sea

Water temperatures of the shelf are normally low and stable (-1.8±0.2°C) with the exemption of irregularly occurring intrusion of Warm Deep Water into the shelf which increase the temperature (Bathmann et al., 1991; Gerdes and Montiel, 1999). The salinity shows little variation with a normal range between 34.6 to 34.9‰S (Gerdes and Montiel, 1999). There are ice coverage and clearly defined seasonality in light regime.

Magellan region

Temperatures in the Magellan Straits are comparably high and vary seasonally between 6.5 to 9.0°C (Artegiani and Pachini, 1991). The salinity is usually lower than in the Weddell Sea and vary from 34.0 to 31.0‰ and less in the vicinity of the glaciers (Antezana, 1999). Ice coverage is absent and seasonality in light regime is less defined than in the Weddell Sea.

2.2.Currents

Weddell Sea

The Weddell Sea is included in circulation system of the Weddell Gyre (Fig. 1). Northern boundary of the Weddell Gyre is the northern boundary of the Weddell Sea current (Fig. 2). On the east part of the Gyre approximately in 20-40^{0}E from south edge of the Antarctic Circumpolar Current relatively warm waters go to south and then westward along the Antarctic coast coming back to the Weddell Sea.

Magellan region

The waters of West Wind Drift from Pacific Ocean penetrate in the Magellan Strait and are transformed there.

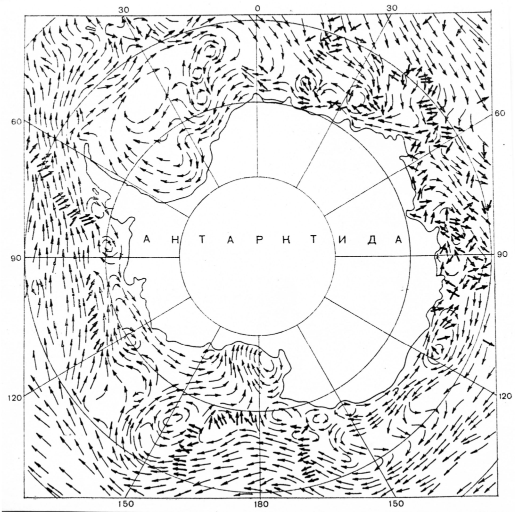

Fig. 1. Circulation of surface waters of the Southern Ocean (Ledenev, 1969).

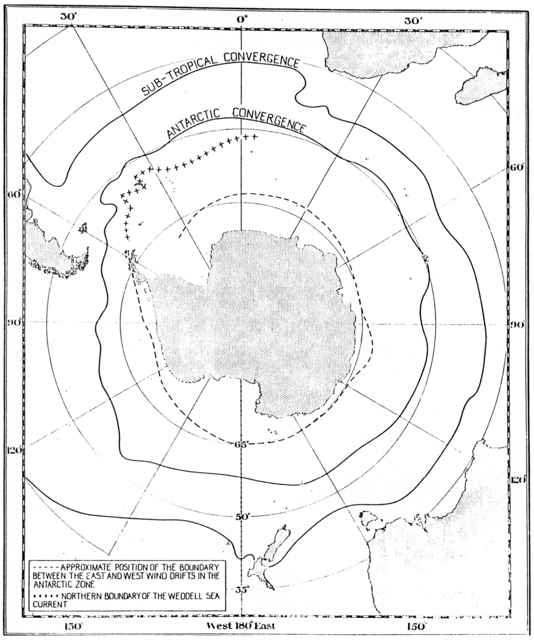

Fig. 2. Antarctic and Subantarctic Convergence and Northern boundary the Weddell Sea current (Deacon, 1977).

2.3. Bottom sediments

Weddell Sea

The usual sediments of the Weddell Sea shelf are muddy sand with gravel and boulders of various sizes (Gerdes et al., 1992). The main specific character of bottom in Antarctic shelf is very poor sorting deposits (Pasternak, Gusev, 1960). There are a lot of various sizes rough stones on the surface of the bottom. They were transported by icebergs from Antarctic coast (Ushakov, 1962).

Magellan region

Bottom sediments in the Magellan region are very various. There are rocks, stones, gravels, sand, mud, clay and different their combination in the Magellan region.

2.4. River outflow

Weddell Sea

River outflow in the Weddell Sea is absent. There is transport of terrestrial mineral particles with icebergs.

Magellan region

River outflow is moderate.

2.5. Diversity of facies

Weddell Sea

Monotony of sediments in the Weddell Sea shelf, domination of flat landscapes which are interrupted by rare depressions and hills and absence of a shoals and islands are responsible for low diversity of facies.

Magellan region

Contrary of the Weddell Sea, Magellan region possesses high diversity of sediments, different depths from littoral to bathyal zones, and a lot of small and large islands and straits. Taken together these characters create big diversity of facies.

2.6. Nutrients and primary production

Weddell Sea

Concentrations of Phosphate and Nitrogen compounds are very high in an Antarctic waters and even in summer period during bloom of phytoplankton they are more than in temperate waters of North Hemisphere during winter maximum (Bogojavlensky, 1958). The reason of richness of nutrients in Antarctic are in constant renew of their stocks owing to circulations of deepwaters where regeneration of these salts are occured. Concentration of silicic acid in Antarctic water also high and the highest in the region of the Weddell Sea and Weddell circulation. Gorshkov et all. (1993) note that the interesting peculiarity of distribution of silicic acid in deep water is increase its concentration along stream from the Weddell Sea to Dreak strait (Fig. 3). Authors suppose that the reason of this increase is in accumulation of silicic acid as silicic remains of organism skeletons from deep and nearbottom dissolve.

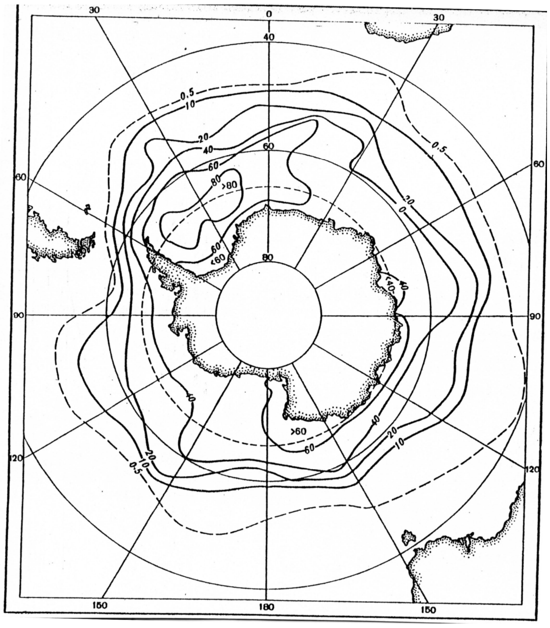

Fig. 3. Distribution of solved silicic acid in surface waters (microgramms-atom/litter) (Gorshkov et al., 1993).

In whole South Ocean including Subantarctic regions the concentrations nutrients do not limit the development of phytoplankton. The main reason which limits quantitative development of phytoplankton is density of water structure that is the intensive vegetation of phytoplankton begins after a development of summer pycnocline (Voronina, 1984). On the assessment of different scientists primary production of the Antarctic waters vary from 36 to 182 g C/m^2, often about 46 g C/m^2 (Koblents-Mishke, 1977). However Voronina (1984) considers that this figures of the production are lower than real ones. According to Knox and Lowry (1977) the Antarctic waters are about 400% more productive than the rest of the oceans.

Magellan region

In subantarctic waters nutrients concentrations are much less then in Antarctic waters. There are seasonal alterations of concentrations of these salt and their reduction towards north, like in Antarctic waters (Fedorov, 1970)

About phytoplankton vide supra.

2.7. Zooplankton

Weddell Sea

The most abundant species of zooplankton in Antarctic waters are three species of copepods (Rincalanus gigas, Calanoides acutus, Calanus propinquus) and one species of krill (Euphausia superba). The average biomasses of zooplankton in Antarctic waters are 72-75 mg/m^3 (Voronina, 1984). The biomass of krill in rich Antarctic regions is in the average 30 g/m^2 (Marr, 1962).

Magellan region

The most abundant species of zooplankton in Subantarctic region are three species of copepods (Rincalanus gigas, Calanus simillimus and Calanus tonsus). Share of macroplankton is small (3% from whole zooplankton)(Voronina, 1984). The average annual biomasses of zooplankton of Antarctic and Subantarctic region are measured in the same order (Foxton, 1956).

2.8. Composition of benthic dominant groups and structure of benthic settlements

Weddell Sea

There is clear domination of sessile groups and some slow moving benthic organisms (Porifera, Bryozoa, Ascidiacea, Pterobranchia, Holothuroidea and Crinoidea) in the most regions of the Weddel Sea shelf (Sirenko et al., 2001). In the same sea sponges and holothurians were in dominant group even in the samples taken with multibox corer (Gerdes et al., 1992) which usually did not show real dominants owing to its too small boxes. The same main group of sessile fauna (Porifera, Bryozoa, Ascidiacea) were marked for the depths 100-500 m in the eastern part of the Weddell Gyre and eastward up to 90^{0}E (Pasternak, Gusev, 1960).

The suspension feeding communities consisted of epibenthic animals are the most common in the shelf of the Weddell Sea. They are replaced by infauna communities in the not numerous shelf depressions.

It is interesting to consider a structure of epibenthic settlements. There are a lot of high animals in the epibenthic communities. Large sponges and ascidians, small sponges and ascidians arranged on high shaft, high gorgonarians and hydroids form highest level of the settlement. Bryozoans, tube worms, sea anemones, pterobranchs, corals and other small sessile groups of invertebrates including small individuals of sponges, ascidians, gorgonarians and hydroids form one or more lower levels of settlements. Small sessile animals (bryozoans, sponges, hydroids, byssus bivalves etc.) attach to high animals as high as possible. Different representatives of vagile fauna (ophiuroids, holothurians, crinoids, crustaceans etc.) go up on sessile organisms. Most of animals try to occupy place as high as possible in order to be closer to seston – their main food. Therefore they form settlement with several levels. Each level of such settlement has own special habitat and own feeding conditions. As a result of this multilevel settlement a number of niches increase.

Biomass of benthos in Antarctic suspension feeding communities at the depth 100-500 m in Indian Ocean Sector (Ocean grab samples, square 0,25 m^2) is 319.46-1244.82 g/m^2 (Pasternak, Gusev, 1960) and 450-500 g/m^2 (Belyaev, 1964), off Sabrina Coast at the depth 200-300 m (Ocean grab samples, square 0.25 m^2) is 183-1363 g/m^2 (Ushakov, 1962), in the Weddell Sea at the depth 170-2037 m (Multibox corer samples, 9x0.0225 m^2) is from 0.12 to 1673.0 g/m^2 (Gerdes at al., 1992). Thus the average biomass of benthos on the Antarctic shelf is more than 400-500 g/m^2 that is rather high.

Magellan region

There are many different communities in the Magellan region owing to high diversity of faces. Main dominants in the Magellan region are bivalves, polychaetes, echinoids, holothurians and crustaceans (Gerdes, Montiel, 1999). The average biomass in the Magellan Straits at the depth 8-459 m is 96.8 g/m^2 in the Beagle Channel at the depth 38-348 m is 301.6 g/m^2 (Gerdes, Montiel, 1999).

2.9.Pelagic – benthic coupling

Weddell Sea

The main source of food in the Weddell Sea is phytoplankton of the open waters and diatoms of criopelagic communities. Zooplankton feed on algae and than both including dead and alive and their faces are the food for zoobenthos.

The Weddell Gyre seemingly influences on productivity of this region and can explain the abundance of both plankton and benthos. The Gyre is large-scale cyclonic circulating system disposed southwards from Polar Frontal Zone, from Antarctic Peninsula to 20-40^{0}E (Klepikov, 1963; Deacon, 1979; Danilov and Guretsky, 1993). Cold waters from the south-western Weddell Sea extend first to north then to east. The cold waters which go out from the Weddell Sea near north part of Antarctic Peninsula are rich with nutrients and krill. According to Marr's counts (Marr, 1962) the most abundant krill concentrations are in the Atlantic Sector of South Ocean exactly in the Antarctic Circumpolar Current and the Weddell Gyre Boundary (Fig. 4). Approximately in 20-40^{0}E from south edge of the Antarctic Circumpolar Current relatively warm waters with abundant phyto- and zooplankton (including krill) go to south and then mainly westward along the Antarctic coast coming back in to the Weddell Sea. There the waters rush over the bottom communities dominated by sessile suspension feeders and feed them on abundant dead and alive phyto- and zooplankton and faeces.

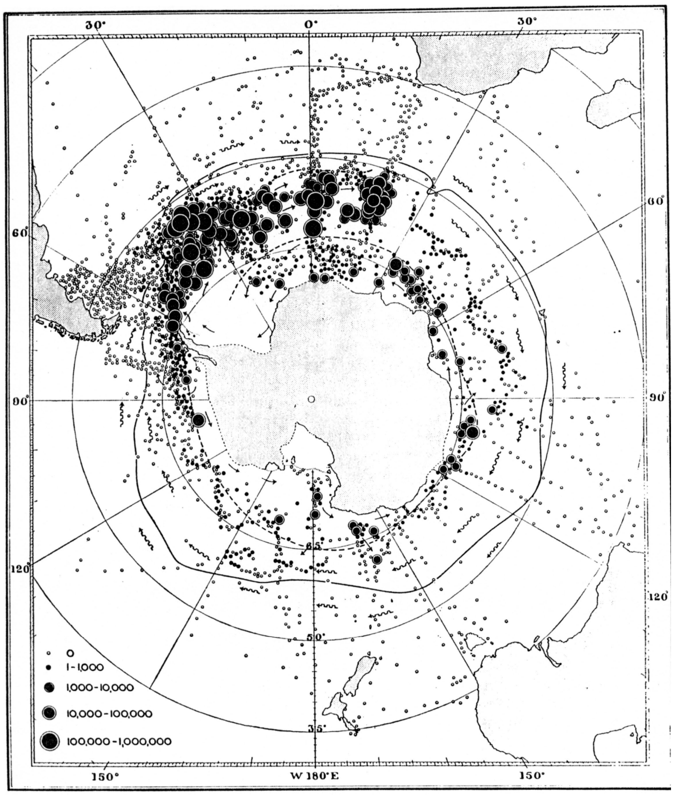

Fig. 4. Distribution of krill in the Southern Ocean (Marr, 1962).

Magellan region

There are several sources of food in the Magellan region. Main from them are phytoplankton and benthic algae. As it was mentioned krill are not abundant in the Subantarctic waters (3% from whole zooplankton) in contrast to the abundance of krill in Antarctic waters. There is a belt of kelps including huge Macrocystis pyrifera in the shallow waters of the Magellan region. Both benthic algae and the their detritus serve as a main or additional food for different bottom animals.

2.10. Species diversity

The comparison of species diversity in the Weddell Sea and Magellan region (Table 1) shows that first group of invertebrates in the Weddell Sea have less diversity than in the Magellan Region. They are Hydrozoa, Polychaeta, Sipuncula, Gammaridea, Isopoda, Polyplacophora, Bivalvia, Scaphopoda,. Second group of invertebrates have approximately the same species diversity (Actiniaria, Mysidacea, Cumacea, Gastropoda, Bryozoa, Echinoidea). Third group of animals have more rich fauna in the Weddell Sea than in the Magellan Region (Porifera, Pycnogonida, Holothuroidea, Asteroidea, Ophiuroidea and Ascidiacea). First group of invertebrates follows the Walles' rule, but second and especially third groups of animals do not follow this rule.

3. Discussion

Comparison of abiotic and biotic peculiarities in the Weddell Sea and the Magellan Region allows us to select several general ones. Among them: temperature, currents, ice coverage, light regime, bottom sediments, diversity of facies, composition of benthic dominant groups and structure of their settlement.

On the one hand warmer temperature, absence of ice coverage, longer light time, diversity of bottom sediments and facies in the Magellan Region favor to development of more rich fauna in this region as compare with the Weddell Sea. On the other hand a composition of benthic dominant groups in the Weddell Sea and a structure of their settlements and as well a peculiar disposition of the Weddell Sea in the system of currents allow the fauna of this sea support the high species diversity at least in several dominant groups of invertebrates and high productivity of ecosystem of Weddell Gyre.

Indeed the Weddell Sea is included in the Weddell Gyre, which is giant circulating system and occupies about 25% of the Southern Ocean. Northern boundary of the Weddell Gyre dispose to south from the Antarctic Circumpolar Current where the most abundant krill concentrations are reported (Marr, 1962). Alive and dead phyto- and zooplankton (including krill) and its faeces seemingly came back in the Weddell Sea as a result of westward moving of waters along Antarctic coast. The waters of the Weddell Gyre pass whole way of Gyre during about 3 year. According to Voronina (1984) to the end of first year larvae of krill finish their development, during second year they feed on and grow up and during third year they mature and spawn. The life span of *Euphausia superba* is 3-4 years (Siegel, 1987; Spiridonov, 1987) but the experimental investigations show a possibility of the longevity of krill up to 8-9 years (Ikeda, 1984). Be it as it way the longevity of krill is sufficiently for they to pass whole way in the Weddell Gyre one time at least. During this way krill (alive, dead and its facies) along with other components of plankton serve as a main food for sessile suspension feeders. Sokolova (1993) reported that krill was main food for abyssal brittle stars in the Weddell and Scotia seas. Moreover krill was in 100% studied specimens and it was main component of food (94.2% in the Weddell Sea and 89.5% in the Scotia Sea). Dearborn (1977) registers several species of stars and brittle stars that feed on euphausiids and supports the idea that kril is of considerable direct importance to benthic invertebrates. According to data of Tseitlin and Voronina (1996): "The average flux of C_{org} from the layer 0-100 m in the areas rich in krill is nearly the same as in the rest part of the Antarctic, but in the places of extremely high concentrations of krill it may be several times more than the average value. In such regions the flux of dead krill is much more intensive than that of faeces, and thus, it serves as the main source of food for the bottom fauna". Makarov and Spiridonov (1993) consider that the stable and large-scale caring out of krill from the Weddell Sea and from Antarctic Peninsula region is a cause of high biomass of E. superba in the Scotia Sea. Perhaps each large gyre (Weddell, Bellinsgausen and Ross) have own subpopulation of the krill (Latogursky, 1979; Makarov, Spiridonov, 1993). In

Eastern part of the Weddell Gyre apart from the main drift of krill back to the Weddell Sea part of krill brings out from the Gyre eastward with the surface waters (Makarov, Spiridonov, 1983).

High biomass of krill was noted in many regions of the Weddell Gyre especially in northern part that is free from ice in summer period. High biomass of krill was found under ice in the Weddell Sea as well (Elbrachter et al., 1987). Taking into consideration the domination of krill (49-77% of whole biomass of zooplankton) in the Antarctic waters that are riches with krill (Voronina, 1984) there appears to be krill play one of the main roles in feeding of benthos of the Weddell Sea. The rich settlements of sessile benthos like a giant sieve that filter water mass and feed on alive and dead phyto- and zooplankton (including krill) and their faices. Average biomass of benthos in the Weddell Sea (400-500 g/m^2) is characterized as one of the highest. Bottom communities accumulate huge quantaty of organic and nutrients in their biomass. Cold waters from north-western part of the Weddell Sea bring a lot of nutrients that are results of destruction organics of the Weddell Sea communities. Moreover in the Weddell Sea only there is the dome-shaped raising of bottom Antarctic water that is a result of cyclonic circulation (Klepikov, 1963). The raising of bottom water riches of surface water with nutrients as well. In spring time when light regime became better in the north part of the Weddell Gyre the bloom of phytoplankton starts. Owing to the circulating system which is the Weddell Gyre the most part of energy that formes in its north part are kept into the Gyre accumulating in alive biomass of zoobenthos in south part of the Gyre. From the preceding the quantitative riches of the Antarctic benthic communities become understandable. The bottom communities that consume a live and dead phyto- and zooplankton play a part of accumulator of energy and temporal depository of nutrients.

Table 1

Species diversity of several invertebrates groups of from Antarctic waters the Weddell Sea and Magellan region

Taxon	Antarctic waters	Weddell Sea	Magellan region	Source
1	2	3	4	5
Porifera	350[1]	159[1]	44[2*]	[1] Bartel et al., 1997 [2] Pansini, Sara, 1999
Hydrozoa	104[1]	41[2]	126[1]	[1] Canterro, Carascosa, 1999 [2] Stepanjants, Sloboda, 2000 with addition
Actiniaria	-	16	14	Grebelnyi. 2000 with addition
Polychaeta	650+[1]	60[2]	223[1]	[1] Knox, Lowry, 1977 [2] Gamby, in expedition, 1996
Sipuncula	-	9	16	Saiz-Salinas, Pagola-Carte, 1999
Pycnogonida	200	85	46	Turpaeva, in letter, 2002
Decapoda (Reptantia)	-	0	30	Arntz et al.,1999
Decapoda (Natantia)	-	5	11	Arntz, Gorny, 1996
Mysidacea	37[2]	32[3]	31[1]	[1] Brandt et al., 1998 [2] Brandt, 1999 [3] Wittmann, 1991
Gammaridea	470[1]	116[2]	206[1]	[1] De Broyer, Rauschert, 1999 [2] Rauschert, De Broyer, 2000
Cumacea	52	29	31	Mühlenhardt-Siegel, 1999
Isopoda	348[1]	68[2]	101[2]	[1] Brandt et al., 1998 [2] Brandt, 1999
Polyplacophora	13	4	15	Sirenko, Smirnov (in press)

1	2	3	4	5
Gastropoda (Prosobranchia)	-	221[2]	210[1]	[1] Linse, 2002,[2] Linse et al., 2006
Bivalvia	-	80[2]	131[1]	[1] Linse, 2001,[2] Linse et al., 2006
Bryozoa	310[1]	184[2]	205[3]	[1] Bullivant, 1969 [2] Gontar, 2000 with addition [3] Moyano, 1999
Holothuroidea	-	34[1]	27[2]	[1] Gutt, 1988 [2] Deichmann, 1947
Echinoidea	-	4[2]	7[1]	[1] Larrain et al., 1999 [2] Sirenko, Smirnov (in press)
Asteroidea	-	50[2]	21[1]	[1] Larrain al., 1999 [2] Sirenko, Smirnov (in press)
Ophiuroidea		56	26	Smirnov in letter, 2002
Ascidiacea	129[1]	51[2]	35[1]	[1] Kott. 1969, 1971 [2] Romanov, 2000 with addition

* - only Demospongiae which compose about 80% of all species of sponges of region.

High diversity of faces in the Magellan Region which depends on the diversity of sediments, different depths and presence of small and large islands and straits gives many niches. The diversity niches in the Magellan Region promote high biodiversity. There is a low diversity of faces in the Weddell Sea but a lot of niches which are reveal by high diversity of many groups of invertebrates and primarily dominated sessile invertebrates (Spongia, Bryozoa, Ascidiacea, and Actiniaria) and some movable forms of animals (Holothuroidea, Asteroidea, Ophiuroidea, Picnogonida and others). The explanations of the increase of number of niches in the Weddell Sea are in composition of bottom communities and in structure their settlements.

Many hard particles (gravels and boulders of various sizes) in sediments of the Weddell Sea is favorable for the development of climax bottom communities of sessile suspension feeders where Spogia, branchy Bryozoa, Ascidiacea and others dominate. Most of dominant species trying to grow upwards. Large sponges, high coelenterates, ascidians and sponges arranged on high shaft. All of them strive upwards closer to food-seston that is drifted with water. A lot of movable species (Holothuroidea, Ophiuroidea, Crinoidea and Bivalvia) try to climb on to top of large sponges, gorgonarians, and ascidians closer to food-seston. They (high sessile and some movable organisms) compose the highest level of bottom settlements. Smaller sponges, gorgonarians, branchy bryozoan, tube worms and others form a lower level of settlements, and so up to soft sediments where lowest level consisted of infauna animals are situated.

As a result the multilevel settlements are formed. Each level has different conditions for life and feeding. The animals of each lower level of settlements have the rest of seston and fecal masses of animals of higher levels. As far as seston sinks not vertical but at an acute angle owing to a current the effect of multilevel settlement keeps in rarefied settlements as well. Seemingly multilevel settlements of bottom communities compensate low diversity of faces in the Weddell Sea and increase the number of ecological niches. The increase of niche numbers promotes increase of biodiversity.

During temperature fall in Antarctic the increase of species number was going on in dominant groups of sessile benthos: Spongia, Bryozoa, Ascidiacea and in other groups which were ready to low temperature.

Seeming in many cases the increase of the number of species in the Weddell Sea was owing to sympatric speciation. This is confirmed by a great number of species in the Weddell Sea belonged to one genus (Table 2). The most number of endemic species (endemism more 70%, Brandt 1991, Hayward, 1995) characteristic for groups-edificatiors (Spongia, Bryozoa, Ascidiacea) and movable groups (Pycnogonida, Cummacea, Amphipoda, Tanaidacea, Isopoda, Echinoidea, Holothuroidea, Ophiuroidea, Asteroidea and Pisces). Probably new species were formed as a result of food specialization and spatial divergence on different level of bottom settlements.

Abundant development of sponges, bryozoans, ascidians and other sessil organisms was a reason of appearance rich fauna of predators that feed on these sessil animals and a lot of numbers of symbionts that live with them. Abundance of sea stars, brittle stars, sea spiders and other movable animals in trawls is easily to explain by abundance and diversity of their preys. Pantopods feed on sponges, bryozoans, hydroids, sea anemons and other animals and even detritus (Arnaud and Bamber, 1987). Brittle stars and sea stars feed on different crustaceans (including krill and copepods), sponges, polychaetes, bivalves and other animals and detritus (Deaborn, 1977; Sokolova, 1993). Some mollusks (chitons and nudibranchs) feed on bryozoans and sponges (Sirenko, 1997).

Symbiosis of antarctic animals is in the beginning of its study. We know only some Antarctic symbiotic pairs: gastropod *Harpovoluta charkoti*+ sea anemon *Isosicyonis alba* (Arnaud, 1978); gastropod *Dickdelia labioflecta*+ sea spider *Nymphon isabellae* (Sirenko, 2000); gastropod *Capulus subcompressus*+ polychaete *Serpula narconensis* (Schiaparelli et al., 2000; Sirenko and Schrödl, 2001); brittle stars Ophiurolepis brevirima+sponge Iophon radiatus (Smirnov and Koltun, 1996); brittle stars *Ophiurolepis spp*. and *Theodoria relegata*+hydroid *Hydractinia vallini* (Smirnov and Stepanjants, 1980) and others. Apparently a symbiosis is more wide spread among the Antarctic animals than we know that can testify about a long way of development of Antarctic fauna. Some animals are necrophaguses (some gastropods, brittle stars, sea stars, pantopods, sea anemones and others).

Table 2

Number of species of different genera the Magellan Region and in the Weddell Sea

Group, source	Genus	Magellan region	Common species for two regions	Weddell Sea
Sipuncula Saiz-Salinas, and Pagola-Carte, 1999	Golfingia	2	2	3
	Nephasoma	4	3	5
Cumacea Mühlenhardt-Siegel, 1999	Hemilamprops	2	1	2
	Leucon	6	1	5
	Campylaspis	7	5	7
	Diastylis	5	0	6
Echinoidea Mironov, in letter, 2003	Amphipneustes	0	0	4
	Antrechinus	0	0	2
	Ctenocidaris	0	0	5
	Notocidaris	0	0	2
	Sterechinus	1	0	2
Ophiuroidea Smirnov, in letter, 2003	Astochlamys	0	0	2
	Amphioplus	2	0	2
	Amphiura	4	3	10
	Ophiocten	1	0	4
	Ophiosteira	1	1	4
	Ophiura	1	0	7
	Ophiurolepis	1	1	5
	Ophiacantha	3	1	4

Seemingly the trophical factor is one of the main one that can explain why Antarctic bivalves have so small size and are not abundant like in Arctic shelf. They were not able to compete with large sessil suspender feeding animals in feeding. Moreover gastropods many of which feed on mainly bivalves have small size of body as well.

The absence of whole group of brachyuran crabs in Antarctic has another reason. The distribution of brachyuran crabs is limited by low temperature that influence on the metabolism crabs owing to Magnesium regulation (Frederich et al., 2001). In spite of the fact of presence of crabs and helmit crabs in Arctic Ocean (Vassilenko, 2001; Petrjashov, 2001) all of them inhabit waters with positive temperatures connected with warm Atlantic or Pacific currents. The most western find of the crab Chionocoetes opilio was in the Laptev Sea (RV "Polarstern" ARK IX/4, st. 40, depth 231-233 m) where the bottom temperature was +1.44°C (Rachor et al., 1994). From two orders of Decapoda (Natantia and Reptantia) the only first one had been luck. Shrimps in contrast to crabs lithodids and anomurans gained an advantage from the Nature and could live in cold waters with the negative temperature. Species of suborder Natantia must have a high physiological plasticity and thus the adaptive potential to colonize different environments of the Arctic and Antarctic Oceans.

It is necessary to note that biodiversity of the Magellan Region can be less because of late glaciations when south part of South America was covered by ice during several thousand years up to 12000 years ago (Fig.5). Moreover Magellan Strait was formed about 2000 years ago only (Moore, 1975). During the late glaciations marine fauna of Magellan Region moved northward where it was able to survive.

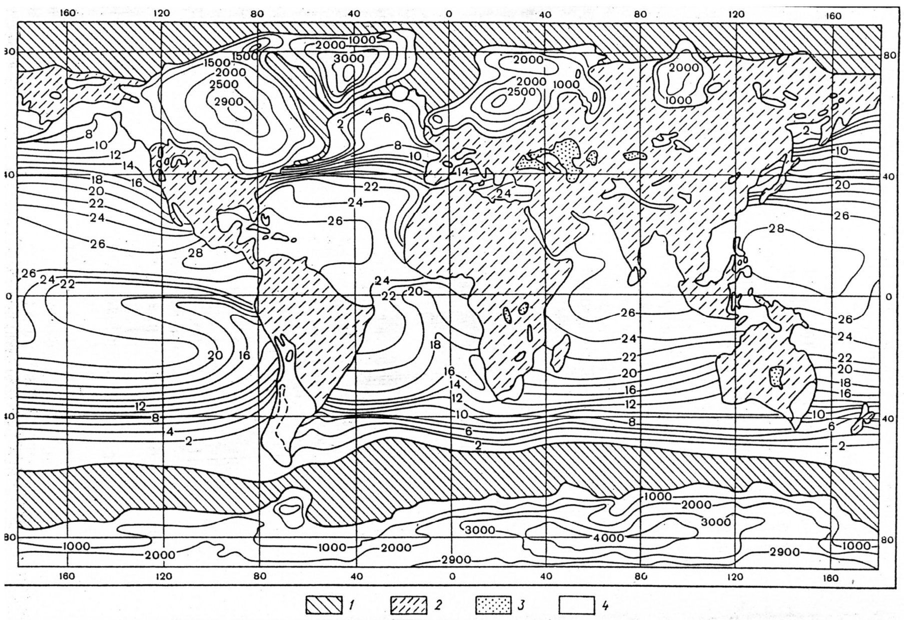

Fig. 5. Reconstruction KLIMAP of earth surface in August during the maximal stage of latest glaciations 18000 years ago. High of surface of glaciers in meters, isotherms in C°. Contours of continents is coincide with the present-day isobate 85 m. The boundary of continent ice in the Southern America is showed with dotted line. 1 – sea ice, 2 – surface free from ice, 3 – internal waters, 4 – snow and ice (Monin, Shishkov, 1979).

In conclusioin we remind the main reasons of the peculiarities of fauna of the Weddell Sea. First of all it is the history of origin and development of the Antarctic fauna. Antarctic fauna was formed in condition of permanent glaciaton. Antarctic glacier had rolled down and carried out mainly very poor sorting deposits with a lot of various size rough stones, in the contrary from the Arctic where many large rivers carry out mainly soft terrigenous materials. As a result of presence of rough materials on bottom in the Weddell Sea during several million years the stable climax epifaunal communities with sessile suspension feeders are formed, whereas in the Arctic the infaunal communities with domination of representatives small buried animals are formed.

The permanent Weddell Gyre supplies bottom communities near Antarctic continent in its south part by seston and krill that are produced mainly in north part of the Gyre. Bottom communities are the accumulators that accumulate and keep organic and nutrients inside of themself.

The main differences of Antarctic and Arctic ecosystems implies that in Arctic Ocean in spite of a huge input of organics and nutrients from large river they are burring in thick deposits of shelves and abyssal basins and are removing out from the biological cycle whereas in Antarctic Ocean in spite of poor receipt of organic and nutrients from outside most of them are permanently involved in the biological cycle and losses of organic and nutrients are minimum.

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