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THE STRUCTURE AND FUNCTIONING OF ANTARCTIC MARINE COASTAL ECOSYSTEMS IN THE CONDITIONS OF NATURAL AND ANTROPOGENIC CONTAMINATIONS

The long-term environmental monitoring has provided the insight into the integral structure of marine ecosystem in a poorly investigated coastal area in the vicinity of the Ukrainian Antarctic Station. The structure and function of the local biota are the specific response of environmentally different involved elements to a series of limiting factors. Very short Antarctic vegetation season, the intensive coastal and deep-sea water exchange and environmental pollution add to unbalanced food relations of Antarctic plankton. As a result, despite abundant phyto - and bacterioplankton the fraction of mesozooplankton is underdeveloped and a large portion of primary matter sinks onto the sea floor thereby stimulating intensive growth of bottom organisms. Mass phyto- and zoobenthos and macroplankton species and fishes accumulate toxic heavy metals. The pollution inhibits normal reproduction of krill, the population recruitment of which is now owing to krill aggregations brought from other areas by sea currents. Krill recruitment rate and the local abundance maximums are the determining food conditions for natural consumers of the krill.

Keywords: ecological monitoring, marine coastal ecosystems, pollution, the Antarctic

Though the exploration of Antarctica began more than one hundred and fifty years ago, the structure of marine ecosystems in the majority of local coastal zones, including that of the Ukrainian Antarctic Station "Academician Vernadsky" (UAS), is poorly understood as yet. Therefore, since 1997 when first Ukrainian Antarctic expeditions were launched, series of environmental researches have been made at the spot.

After detection of heavy metals and other pollutants in the sea water and soils of islands of the Argentine Archipelago [6, 29, 30], toxicological tests of grounds and mass aquatic organisms (hydrobionts) belonging to different taxonomic and ecological groups were included in our scheduled investigations. Since 2002 nearly all main hydrobionts have been the objects of the field observations; the resulting data sets permit having the insight into the structure and functioning of the ecosystem and outlining further research trends.

Material and methods. Expedition reports of the Ukrainian research cruises to Antarctica, the related data and scientific literature underlie this survey. The oceanographic, biological and toxicological investigations were made under the guidance and direct participation of the author in performance of the contracts concluded with the National Antarctic Scientific Centre, Ministry of Education and Science of Ukraine within the framework of the programme "Investigation of changes in krill population and other members of pelagic community in Antarctic sector of the Atlantic Ocean as related to the global climate change on the Earth".

The series of hydrological investigations which included observation of currents flowing between islands of the Argentine Archipelago were performed during 1997, 1998, 2000 and 2002 using the automatic data recorders ACIT and MHI-1308 and navigation computations based on a computerized sounding system [20].

Biological samples were collected at the stations in accordance with the scheme (Fig.1) and with the List of the essential biological samplings and observations to be made at the UAS "Academician Vernadsky" during three wintering seasons (2002 – 2003, 2005 – 2006, and 2006 – 2007) and the seasonal survey in April 2005. During the wintering on island Galindez the counts of birds were performed taking into

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consideration the specific flight routes. The species composition, abundance and distribution patterns of phyto-, bacterio-, macroplankton and mesozooplankton, microphytobenthos and zoobenthos were studied in fixed samples according to the List. Besides, biological examination of the krill and fishes was made immediately after catch and the biological observations of penguins around the UAS were carried out. In performing the series of the biological investigations standard methods and techniques suggested in the List were applied.

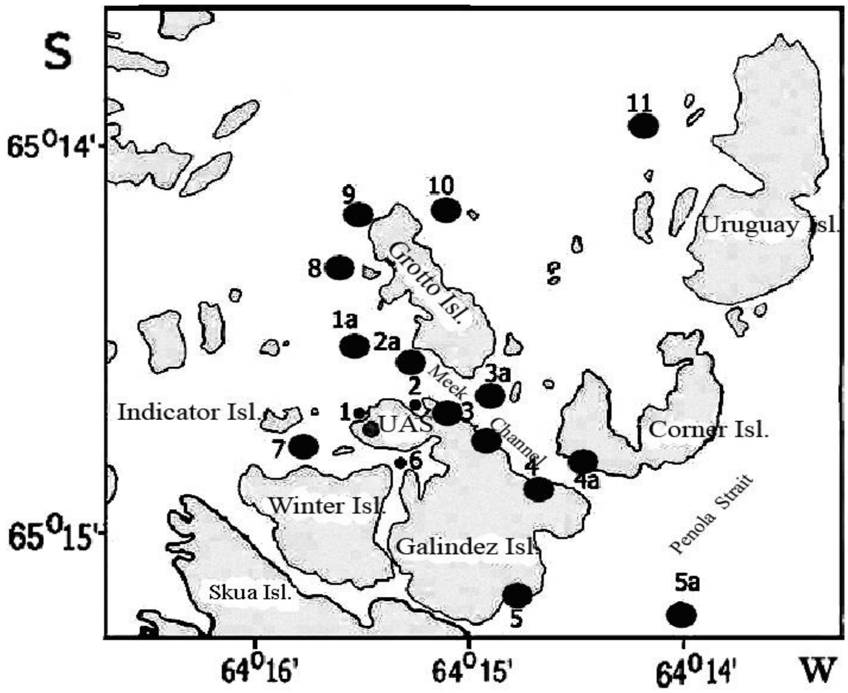


Fig. 1 The map of stations at the UAS and in the vicinities: samples for the oceanological survey were collected at sts. 1 – 11, bottom sediments and marine organisms for biological, chemical and toxicological tests at sts. 1 – 4a

Рис. 1 Положение станций океанологических наблюдений (ст.ст. 1 – 11), отбора проб донных осадков и гидробионтов, в том числе для токсикологического обследования (ст.ст. 1 – 4a) в районе УАС

The samples of ground for toxicological tests were collected at islands of the Argentine Archipelago (Fig. 2, Table 1) and the biological objects and the samples of seabed sediments at the stations located in vicinity of Isl. Galindez.

Sample handling and determination of heavy metals in bottom sediments (*Cd, Cr, Cu, Pb, Zn, Hg*) and in marine organisms (*Fe, Ni, As*) were made in conformity with the Guidelines on the procedure of determination of pollutants in samples of sea-bottom sediments and suspension [10] and Guidelines on the procedure of determination of mercury, arsenic, antimony and selenium using the mercury-chloride generator RGD-105P [11].

Chemical tests were made on a spectrometer AAS-220G (Varian, Australia) using atomic absorption spectrometry with thermal electric atomization. Mercury content was estimated on the spectrometer AAS-220G by cold vapor method using a mercury detachment MD-1 [11]. Combustion method was used in measuring the content of total organic substance and ashes in the examined aquatic organisms.

Total content of oil hydrocarbons in the bottom sediments was determined by means of infrared spectrometry on the Infralume [10]. Samples were handled for further detection of organic chlorine pesticides (OCP) by the technique proposed by [17]. Quantitative analysis of OCP was carried out on a gas chromatograph Crystal 2000 M equipped with the 60-m long quartz capillary column and the electronic trapping detector.

Humic substances and C_{org} in the seabed sediments were measured in accordance with [25], and [26], respectively; carotenoids and chlorophyll *a* as in [18].

The content (%) of pollutants in the samples taken from the seabed and in soils was tentatively evaluated based on the consolidated data about the content of chemical elements in soils [19], and that in the studied hydrobionts – from the maximum concentration limits for chemical elements in food items [38].

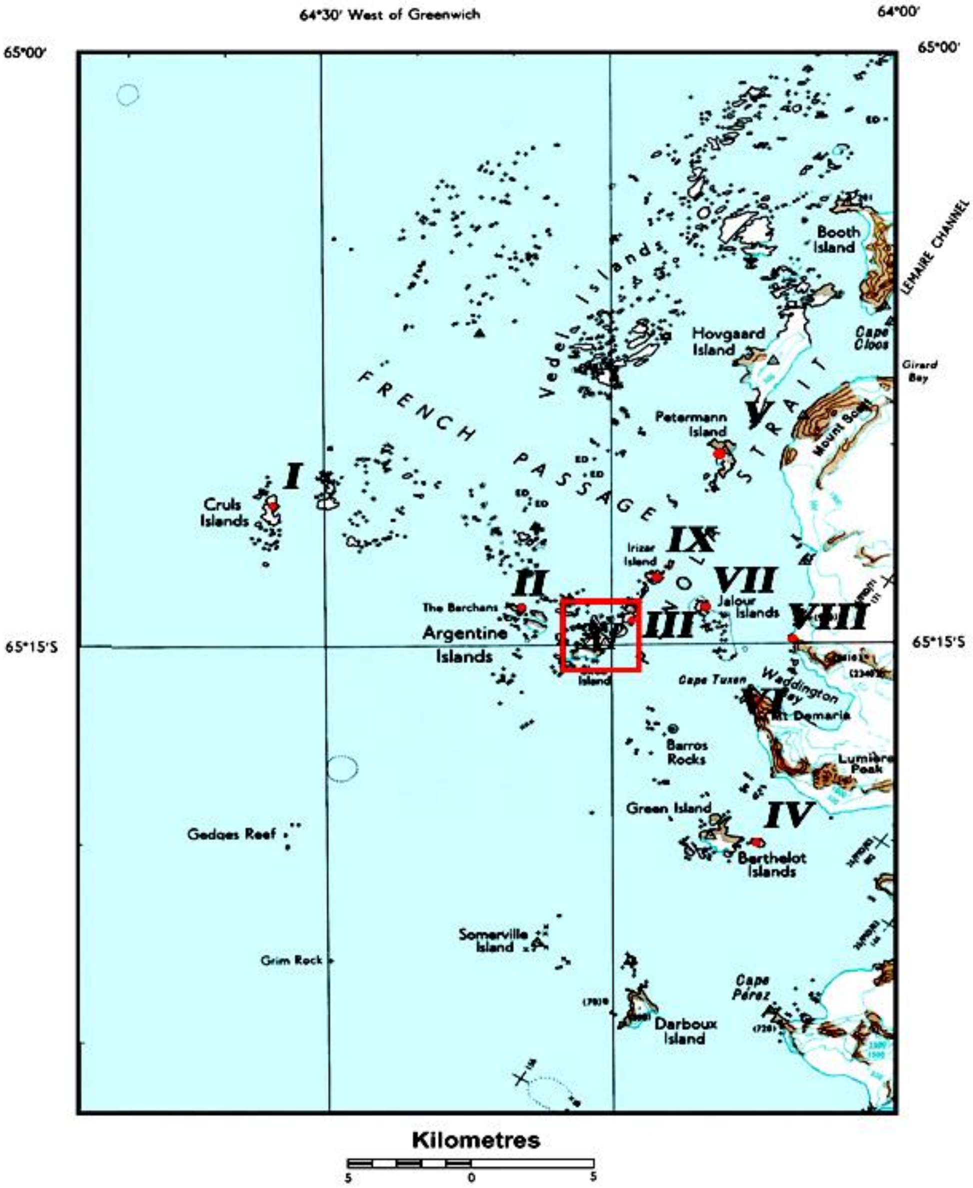


Fig. 2 The sites where the samples of grounds for toxicological tests were collected (Argentine Islands); Roman numerals mark the areas (see Table 1)

Рис. 2 Расположение точек отбора проб грунта для токсикологических исследований на Аргентинских островах. Номера районов нанесены римскими цифрами (см. табл. 1)

Table 1 The designation of the areas and the sites from which the samples of soil were taken for measuring heavy metal content (see Fig. 2)
Табл.1 Районы отбора проб на содержание тяжелых металлов в грунте (обозначения см. на рис. 2)

Area №	Geographical name	Point №
	King George Island	1 – 5
I	Cruls Island	36
II	The Barchans	6, 7
III	Uruguay Island	37
IV	Bertelots islands	38
V	Petermann Island	39, 40
VI	Cape Tuxen	41, 42
VII	Jalour Islands	35, 43
IX	Irizar Isl.	47, 48
X	Mario Pedro Isl.	49, 50
XI	Galindez Isl.	8 – 34

Results and discussion. Water structure. Specific character of the sea around the Argentine Archipelago is owing to wind-induced local gyres, topogenic and ebb-and-flow factors [20]. Tidal cycle, the major factor responsible for the regional hydrophysical fluctuations lasting from a few days to a few weeks, depends upon two interacting tidal waves – semi-diurnal and diurnal. The semi-diurnal tidal wave comes from the north–northwest, and the diurnal moves from the west–northwest toward the east-southeast. The high-tide currents head the south-southeast (Fig. 3.1), and the low-tide – the north-northwest (Fig. 3.2). In both cases the velocity of currents is within 4 – 5 cm s^{-1}, increasing more than twice in the narrows between islands. The tidal streams and the eddy currents they generate do not break weakly stratified local thermohaline field and the vertical cinematic structure. At the same time, the ebb and flow phenomena along with the wind drift component in the residual current bring about non-uniformly directed water transfer in the upper and near-bottom layers.

Optical tests have shown that compared with the background estimates typical of the outlying localities, light reduction estimates measured near the UAS were 5 – 8 times larger.

Icebergs and floating ice have a pronounced effect upon the changeable mosaic horizontal structure of temperature and salinity fields in the sea areas between the islands.

Results of our investigation are insufficient for guessing how heavily the examined area and the adjoining regions may interact. However, structural variability of Gammaridae and krill, the prevailing marine organisms in the pelagic zone, presumes seawater advection from the nearby areas.

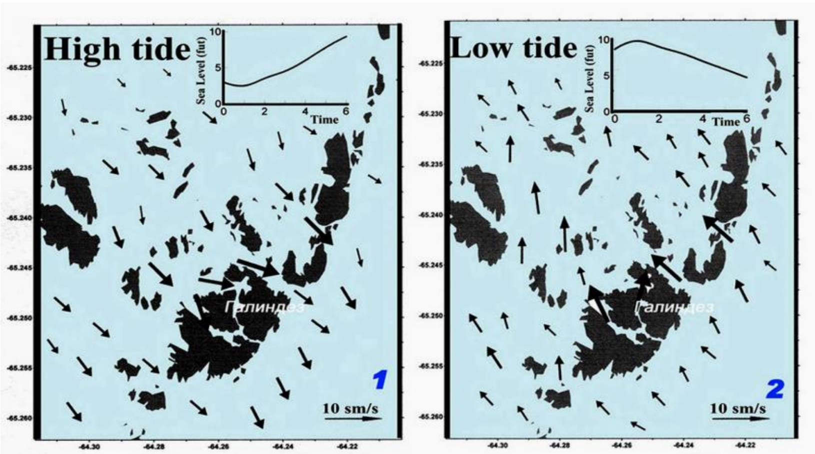


Fig. 3 The vectors of high- and low-tide currents (1 and 2, respectively) near the Argentine Archipelago. Sidebar: sea level fluctuations (ft) [20]

Рис. 3 Векторы течений на фазе прилива (1) и отлива (2) в районе Аргентинских о-вов. На врезке – ход уровня моря (в фут.) [20]

Biology. P h y t o p l a n k t o n. Phytoplankton which taxonomic structure and abundance alter depended upon season and year is the most variable component of plankton; the explanation roots in environmental fluctuations and specific biology of the microalgae. During the wintering season of 2002/2003 in the samples of phytoplankton 156 species belonging to 8 orders were identified, and during 2006/2007 – 114 species of 7 orders, among them 26 species not registered during 2002/2003 [13, 14, 23, 24].

Despite the high species diversity, total abundance of the phytoplankton is nearly half as large as that averaged out for Antarctica [32]. Like in the oceanic zone, diatoms (*Chaetoceros, Fragillariopsis, Astermphalus, Coscinodiscus* and some other) contribute significantly to the near-shore phytoplankton (Fig. 4) and dominate by biomass throughout the vegetation season irrespective of a year, while small dinoflagellates become highly abundant in summer, autumn and winter. The changeable hydrological conditions continuously disturb normal course of phytoplankton succession: the regularly alternating currents give rise to renovation, and calm-water periods – to mass growth of diatoms, small dinoflagellates (*Dunaliella*, *Pyramimonas*, *Cryptomonas*) and Chrysophyta (*Phaeocystis*); owing to the latter total phytoplankton biomass increased an order of magnitude and more. The microalgae maintain moderate growth rates for the most part of a year, and occasionally, as in 2007, during the vegetation period (Fig. 5).

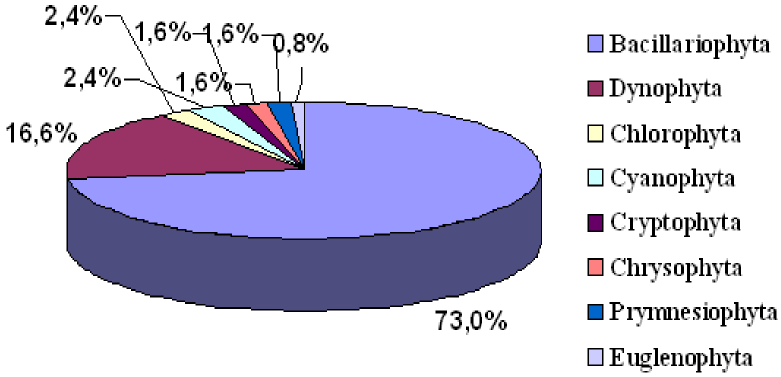


Fig. 4 Taxonomic structure (%) of phytoplankton in the coastal seawater of UAS, 2002/2003 (by L.V. Kuzmenko [14, 33])

Рис. 4 Таксономическая структура (%) фитопланктона в прибрежных водах района УАС (2002/2003 гг.) (по Л.В. Кузьменко [14, 33])

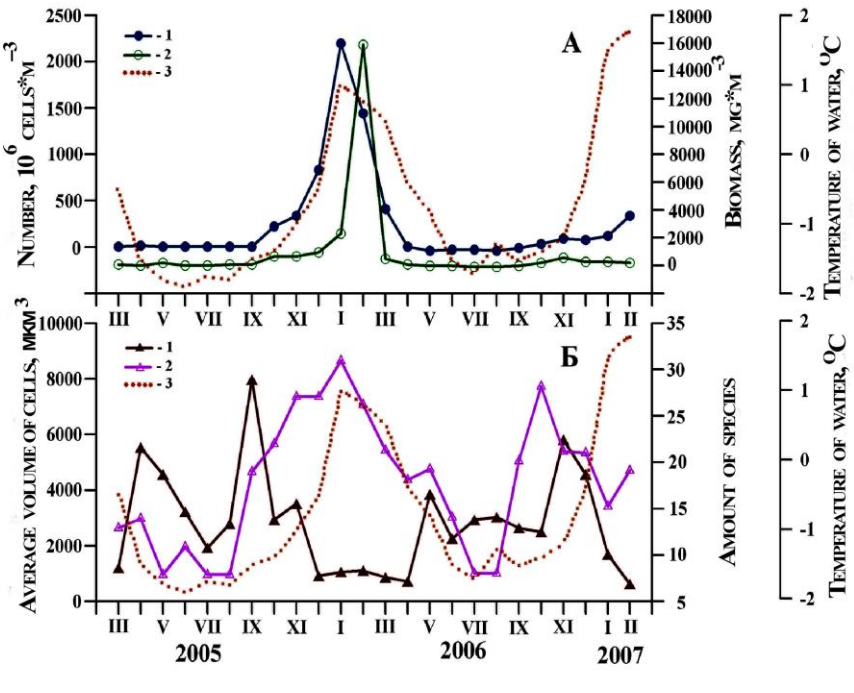


Fig. 5 The seasonal and interannual variability of phytoplankton abundance and seawater temperature near the UAS by L.V. Kuzmenko [14, 33, 34]. A: 1 - abundance, 2 – biomass, 3 - temperature; B: 1 - average cell size, 2 – the number of species

Рис. 5 Сезонная и межгодовая изменчивость в фитопланктоне и температуры воды у УАС по Л. В. Кузьменко [14, 33, 34]. А: 1 – численность, 2 – биомасса, 3 – температура воды; Б: 1 – средний размер клеток, 2 – число видов

M e s o z o o p l a n k t o n. Mesozooplankton inhabiting the sea area of the UAS is very scarce. The majority of 40 taxa registered there were copepods (*Oithona*, *Stephos*, *Ctenocalanus*, *Metridia*, and harpacticoids) and larvae of polychaetes [12]. Under distinct seasonal development the abundance and species composition randomly vary. The mesozooplankton numbers and biomass estimates which fluctuated within the ranges 0 – 310 ind·m^{-3} and 0 – 4.5 mg·m^{-3}, correspondingly, are evidence of intensive water exchange with the open sea and the inhibiting impact of toxicants. The presence of toxicants in the environment can also be deduced from the absence of early developmental stages of larvae of the krill *Euphausia superba* in the samples of zooplankton.

B a c t e r i o p l a n k t o n. In the examined seawater area bacterioplankton is relatively abundant, varying within the range of 0.6 – 3.0 · 10^{6} cell·ml^{-1} and more depending upon season;

the average annual abundance decreases towards autumn synchronously with the phytoplankton abundance trend [37]. Bacterioplankton is found in plenty all over Antarctic seawater area [32]; depending upon season the biomass fluctuates between 60 and 85% of total phytoplankton biomass and the production between 37 and 63% of the primary production (PP) of microalgae. At the same time, the measured estimates are an order of magnitude lesser than the actual PP is, therefore the pronounced imbalance of food relations in the system resulting in an "overstock".

M i c r o p h y t o b e n t h o s. Microphytobenthos are represented by 60 species referred to Bacillariophyta, Chlorophyta, Chrysophyta, Cyanophyta and Dinophyta (50, 4, 2, 2 and 1, respectively), and two marine fungi [23, 28]. The colonies and single cells of diatoms and some epiphytic *Cocconeis* spp. prevail on hard substrates – the stony seabed and thalli of seaweeds – year through.

A community of microphytobenthos is a reliable bioindicator which permits to decide about the health of marine environment and the entire ecosystem. For instance, the fact that cells of mass diatoms, *Fragilaria* and *Licmophora* spp. have been affected with sea fungi *Rhizophydium fragilariae* and *Ectrogella perforans* and the shells and structural elements of *Cocconeis* misshapen points out that marine environment in the vicinity the UAS was polluted.

M a c r o p h y t o b e n t h o s. In the coastal waters near the UAS the diversity of bottom-dwelling marine plants is poor – not more than 20 species of three orders, Chlorophyceae, Phucophyceae, and Rhodophyceae [13, 14, 24, 33, 34]. In the coastal waters the green alga *Monostroma hariotii* and red algae *Curdiea racovitzae*, *Iridea obovata* and *Leptosomia simplex* prevail; in the deep-sea – brown and red algae *Cystoseira* sp. and *Desmarestia menziesii*, and *Kallymenia antarctica* and *Delisea pulchra*, correspondingly. Presumably, ice is the crucial factor influencing attachment to substrate and distribution of the seaweeds. Species richness is greatest in Rhodophyceae and poorest in Chlorophyceae. Increase in the values of indices of surface registered in macrophytes growing on the spot closely adjoining the UAS and receiving the discharged sewage is characteristic of a polluted locality [15].

Z o o b e n t h o s. According to [14, 33], high species diversity is characteristic of zoobenthos inhabiting the seawater area near the UAS; the benthos fauna includes 37 species.

In littoral zone molluscs dominate (Fig. 6): the percentage of Bivalvia and Gastropoda in the total abundance is estimated 51 and 33 %, correspondingly; the overwhelming portion (89 %) of biomass is also owing to gastropods.

In sublittoral zone the most abundant are Arthropoda: Amphipoda; two other prevailing fractions are polychaetes and molluscs which contribute to the total abundance 25 and 21 %, respectively. Sponges, though small in number (2 % of the total abundance), dominate by biomass, producing 34 % of the total amount; two subdominants are bivalve molluscs and Nemertini – 18 and 13 %, respectively; the relatively large share contributed by Nemertini is owing to the heavy individual weight of the giant *Parborlasia corrugatus*. Large and weighty starfishes, (Echinodermata: Asteroidea), occupy the fourth position – 11 %. Referred to the category "and others" by the numbers, the echinoderms due to their large body weight make up 2 1% of the total macrozoobenthos biomass assessed for the examined sublittoral area.

Unlike the sublittoral, the severe littoral environment does not favour development of numerous ecological niches (see the graphs) that explains so evident domination of only a few taxa. The sublittoral zone, where dominancy is not so pronounced and taxa distribute more proportionally, provides far more opportunities for ecological niche development (Fig. 6).

On the littoral the Antarctic limpet *Nacella concinna* (Gastropoda) dominate by the abundance and biomass (Table 2); largest estimates were measured at the lower limits of littoral where the mollusc has perfectly adapted to the local environment and where basic predators were absent. In the sublittoral zone the abundance of *N. concinna* drops by an order of magnitude and more and the biomass by two orders of magnitude; family Rissoidae wins the dominance instead, yielding the numbers estimates twice as large as those of the littoral *N. concinna*. At the same time the sublittoral Rissoidae produce biomass only slightly larger than half of that by the Antarctic limpet and slightly lesser than a quarter by *Neobuccinum eatoni*; the latter were only solitary found in the samples and maintained the dominance owing to the body weight 15.3 g. Inhabiting the depths from 4 to 2350 m, *N. eatoni* is common in Antarctica [8]; the finding of even a few individuals in the sample can substantially influence structural biotic characteristics.

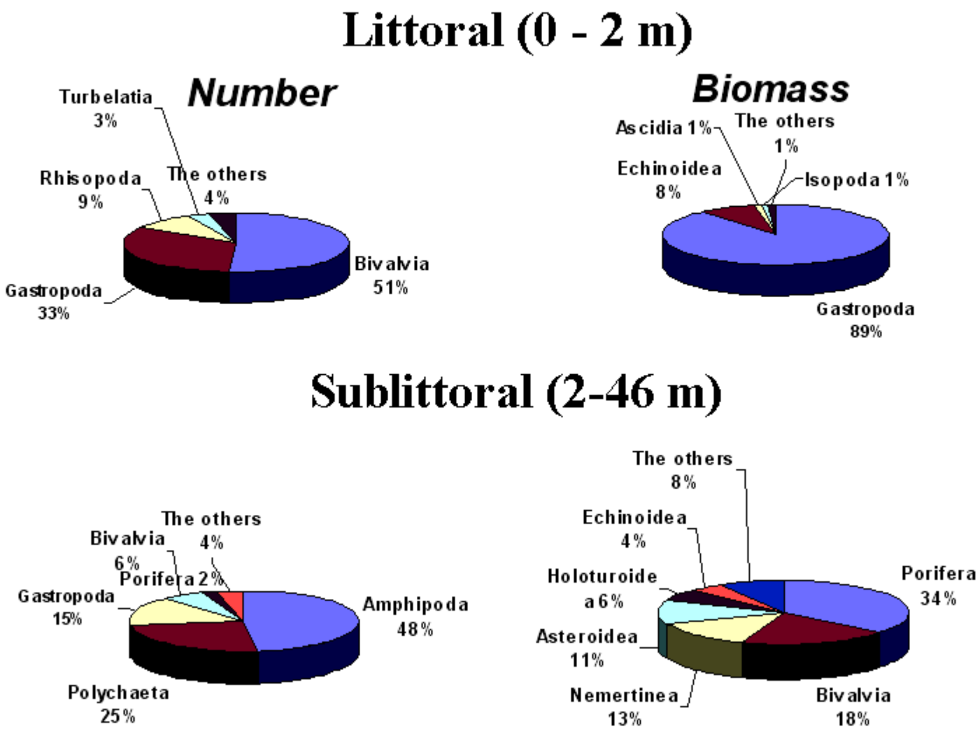


Fig. 6 The predominant taxonomic groups of macrozoobenthos (%) (by I. P. Bondarev [14, 33, 34])

Рис. 6 Соотношение основных таксономических групп макрозообентоса, % (по И. П. Бондареву [14, 33, 34])

Among Bivalvia the genus *Mysella* undeniably dominate by the numbers (Table 3) though total biomass of these molluscs is nearly seven times as less as that the subdominant *Yoldia eightsi*. Measured in the sublittoral area the biomass of *Y. eightsi* has been about a hundred times greater than the collective total biomass of all other bivalves. *Laternula elliptica*, solitary found in the samples at our disposal, was reported as an organism that can yield biomass 5 kg· m^{-2} [9]. This species occupying the depth from 1 to 508 m is one of the Bivalvia widespread in Antarctica [8]; found in plenty in a sample these molluscs indicate pure environmental spots. *L. elliptica*, in which full-grown adults weigh 2.5 – 3 g, can therefore strongly influence relevant structural parameters.

One meets similar or more contrasting situation analyzing the structure of other higher taxa, especially nemerteans, crustaceans and echinoderms, some of which, though not abundant, produce the basic portion of biomass. The brightest example is giant species, primarily the nemertean *Parborlasia corrugatus* with the body weight reaching 100 g [42]. This carrion-eating and predatory species, preying on amazingly diverse life forms to sponges and jellyfishes, performs a very important role in benthic ecosystem of Antarctica.

A m p h i p o d s. Amphipods are referred to phylum Arthropoda, class Crustacea, subclass Malacostraca, superorder Peracarida. These organisms play important role in functioning of marine ecosystems. As a geographic area,

Species	Numbers, ind.		Biomass, g	
	Littoral	Sublittoral	Littoral	Sublittoral
Nacella concinna	467	40	762	8
Margarites refulgens	3	38	0.4	5.1
Falsilunaria sp.	6	1	0.07	0.01
Rissoidae spp.	160	850	1.15	4.25
Eatonella glacialis		2		0.12
Marceniopsis mollis		1		2
Neobuccinum eatoni		1		15.3
Total	636	933	763.62	27.58

Table 2 The numbers and biomass of Gastropoda in the littoral and sublittoral zones (by I.P. Bondarev [14, 33])
Табл. 2 Структура таксона Gastropoda по численности и биомассе отдельных видов на литорали и сублиторали (по И.П. Бондареву [14, 33])

Species	Numbers, ind.		Biomass, g	
	Littoral	Sublittoral	Littoral	Sublittoral
Mysella spp.	829	79	7.8	0.71
Yoldia eightsi		226		487
Limatula ovalis		1		0.15
Laternula elliptica		2		2.8
Cyamiomactra laminifera		1		0.3
Thracia meridionalis		1		2.4
Total	829	310	7.8	493.36

Table 3 The numbers and biomass of Bivalvia in the littoral and sublittoral zones (by I.P. Bondarev [14, 33])
Табл. 3 Структура таксона Bivalvia по численности и биомассе отдельных видов на литорали и сублиторали (по И.П. Бондареву [14, 33])

Antarctica is remarkable for the species diversity of amphipods and their importance for the regional trophic structure. As highly abundant prey even superior to the krill, amphipods are the crucial food item for fish, especially for benthic fishes, and birds. The inventory of amphipods includes 808 species of which 613 are endemic; taxonomic status of 75 species remains uncertain as yet [7]. According to the checklist, the sea of western Antarctica where the UAS is located harbours Gammaridea (370 species including 188 endemic), Caprellidea (17 including 1 endemic), and Hyperiidea (43 including 8 endemic). Though a potentially important component of marine ecosystem of the Argentine Islands, amphipods have long been left only superficially studied because their taxonomic identification entailed considerable difficulties. Seasonal samplings made during 2005, 2006 and 2007 permitted identification of 20 genera and 24 species of 7 families by [14, 33] and have shown that only Lysianassidae, Eusiridae and Gammarellidae (the years 2005, 2006 and 2007, respectively) dominate in the plankton of the investigated area. Eusiridae were represented by the largest number of species; most abundant had been *Gondogeneia aff. antarctica* (Gammarellidae) and *Cheirimedon femoratus* (Lysianassidae), the former prevailed among amphipods in the sea around Isl. Galindez.

The year- and month-dependent qualitative and quantitative variability implies that the regional environment is subject to considerable temporal fluctuations.

A n t a r c t i c k r i l l. The Antarctic krill *Euphausia superba* Dana is an essential member of pelagic ecosystem in Antarctica. Availability of the krill supports survival of a plenty of predatory populations – fishes, birds, cephalopods and mammals; the krill is also a valuable fishing object. Researchers from differed countries have been paying close attention to this small organism for decades; therefore the biology of krill has been studied in minute details.

Our interests focused on dimensional and age structure of the krill population and its variability, recruitment success and the abundance in the inspected seawater area, and on assessment of the nutritive base and nutritional state by Fullton coefficient (C_F) estimated for the open-sea populations. The size-and-age structure and sex ratio of the krill, estimated in the total samplings and in individual catches from one and the same station, considerably fluctuate. The size range suggests that in most cases 2 – 3-year old individuals were the dominant fraction, though in some months full-grown or 4 – 4+year-old pre- or post-spawning crustaceans prevailed. Neither of early larval stages, from Nauplius to Furcilia, had been found in the net mesozooplankton, nor one-year-old juveniles in the net krill. The relatively abundant phytoplankton and the resulting abundance of detritus maintain favorable nutritive base for the krill as the steadily high stomach filling indices imply. Like the oceanic populations, for instance in the Scottia Sea [31], in the vicinity of the UAS the krill population consisting of 3 – 4 groups is morphometrically heterogeneous, as C_F suggests. Results of the cluster analysis have proved the validity of my approach to partitioning of the population as a whole and of individual cohorts (net samples) as well.

Distribution, either solitary or aggregated, depends primarily upon nutriment and reproduction. The density of scattered krill was 2-4 ind·m^{-2}, the majority had been juveniles. Increasing from 480 mg·m^{-3} in spring to 2000 mg·m^{-3} in autumn, the biomass of senior age groups influences annual fluctuations in the numbers of main consumers, penguins (Fig. 7).

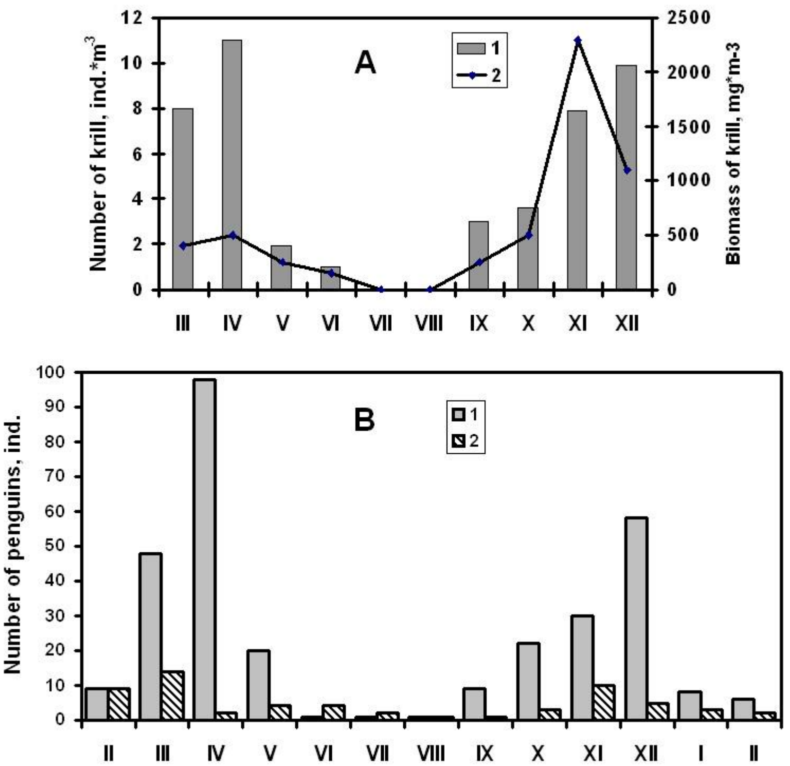


Fig. 7 A. Seasonal variations of abundance of krill and penguins in waters near Isl. Galindez in 2002 – 2003: A - in the number (1) and biomass (2) of krill; B - in the mean numbers of penguins gentoo (1) and Adele (2) (by S.M. Ignatyev [13, 33, 34])

Рис. 7 А. Сезонные изменения обилия криля и пингвинов в водах о-ва Галиндез в сезон 2002-2003 гг.: А - численности (1) и биомассы (2) криля; Б - средней численности пингвинов дженту (1) и Адели (2) (по С.М. Игнатьеву [13, 33, 34])

B i r d s. The inventory of birds observed at the UAS and in the surroundings during the recent decade includes 16 – 17 species; 13 of them are typical for the place and seen each year. Some of the birds spend the breeding season on Isl. Galindez [13, 33]. Among numerous for the region are penguins gentoo, *Pygoscelis papua*; their continually increasing population is expanding be-seasonally fluctuating abundance of the krill aggregations near the UAS (Fig. 7). It was found that yond the limits of the natural habitat. During the season of 2002/2003 researchers had counted some 5000 adult penguins on Isls Peterman, Nameless and Galindez, more than 90 % of the adults concentrated on Isl. Peterman; the index of reproductive success had also been high. 150 – 200 birds permanently inhabit Isl. Galindez, their seasonal migrations are synchronized with food demand of the gentoo penguins staying on Isli. Galindez 6 – 7 times exceeded the local stock of krill evaluated in monthly surveys. This suggests continuous time-to-time variable replenishment of the krill stock through aggregations carried from other localities by streams that agrees with the already mentioned conclusion that replenishment of the local krill population goes other way than spawning in the investigation area.

Unlike gentoo, the population of Adelie penguin (*Pygoscelis adeliae*) has reduced twice [33].

I c h t h y o f a u n a. The ichthyological surveys of 2002 – 2008 have identified 16 species of 4 families (Nototheniidae, Channichthyidae, Bathydraconidae, Harpagiferidae) in the seawater area of the UAS [33]. In the catches *Notothenia corniceps* prevailed by numbers and by weight, the collective share of other dominants (*Trematomus bernacchii, T. newnesi, N. rossii, Chaenocephalus aceratus* and *Parachenichthys charcoti*) made up 30 %. The cited above 16 species are all having been found during the long-term series of observations; annual counts of species for that period were always more moderate. According to [4, 21, 22], Antarctic ichthyofauna comprises nearly 370 species of 59 families; 35 species occur in the regional coastal water.

The material was collected by angling and therefore is insufficient for reliable quantitative assessment of the ichthyofauna and the role it plays in functioning of the examined ecosystem and in the seawater area close to the UAS. However, species diversity variations elicited based on the catches of different years, the knowledge of biological features and nutritive spectrum of fishes and other marine life permit to show up and interpret relations existing between the ichthyological observations and the data bulks resulted from oceanographic, hydrobiological and toxicological investigations carried out simultaneously.

Toxicological investigations. S o i l s a n d b o t t o m s e d i m e n t s. Until recently the deficiency of information about the content of heavy metals in Antarctic coastal zone permitted only to guess about potential contamination of the Southern Ocean with these toxicants. Investigations that N.I. Ryasintseva launched in 1997 on Isl. Galindez and the neighbouring sea have given proof to such assumptions [30]. Unfortunately, the limited spatial scale of her research does not allow having the insight into the etiology and the extent of pollution and assessing the toxic impact upon the regional environment.

The toxicological tests we have first conducted in the area point out that the content of cadmium and zinc measured in the grounds of all islands of the Argentine Archipelago and on King George Island are 13 – 474 and to 30 times greater, correspondingly, than the allowable norm (Table 4, Fig. 8). Presumably, the pollution is due to the regional tectonic activity. Cadmium is a rear-earth metal; as uncombined element it is nearly absent in the earth's crust and is derived from zinc ore. Therefore, located far from Antarctica plants working for minerals and metallurgical industries are not to be blamed for the abnormal cadmium concentrations. Similar estimates were measured in the samples of bottom sediments from the sea near the Argentine station on King George Island [41]. It is noteworthy that the levels of cadmium and zinc pollution estimated in bottom sediments near islands of the Argentine Archipelago are comparable to those in many bays of the Crimean peninsula [35, 36]. Among other metals having been detected in the samples copper yielded especially high estimates – sometimes more than 470 times larger than the allowable norm (the sea floor of some islands of the Argentine Archipelago and Isl. Galindez).

The tests have shown that sediments taken from the sea floor close to the UAS have accumulated large content of oil hydrocarbons (OHC); the values measured in the silts exceeded maximum permissible concentration (MPC) to 50 times (Table 5).

In the repeatedly collected and tested samples of bottom grounds from Penola Strait OHC were absent (Table 6).

H y d r o b i o n t s. To asses the quality of the material, prior to the investigation marine organisms were examined for the content of organic

Table 4 Heavy metals contents in soils, mg·kg^{-1}
Табл. 4 Содержание тяжелых металлов в грунтах, мг·кг$^{-1}$

№ of sample	№ of point	Name of region	Cd	Cu	Hg	Pb	Zn	Cr
1	2	3	4	5	6	7	8	9
001	1	Peruvian station “Machu-Pikchu”	0.325	54.49	0.047	1.756	81.07	-
002	2	Peruvian station “Machu-Pikchu”	2.1	93.68	0.014	0.299	90.7	-
004	3	Russian station “Bellinsgauzen”, i. King George	0.45	38.45	0.045	2.025	35.99	-
005	4	Russian station “Bellinsgauzen”, i. King George	0.35	79.9	0.017	1.584	105.57	-
006	5	Russian station “Bellinsgauzen”, i. King George	0.121	38.16	0.035	0.49	30.89	-
007	6	i. Barkhans	3.178	160.41	0.205	0.522	491.86	-
008	7	i. Barkhans	3.61	261.36	0.074	10.197	87.12	0.496
009	8	i. Galindez, the Testing area. The Lake-1	2.787	81.55	0.014	5.685	351.31	-
010	9	i. Galindez, the Testing area. The Lake-2	5.407	54.06	0.014	0.774	146.32	-
011	10	i. Galindez, the Testing area. The Lake-3	9.92	84.59	0.065	3.644	326.14	-
012	11	i. Galindez, the Testing area. The Lake-4	3.91	28.67	0.004	0.955	145.64	-
013	12	i. Galindez, the Testing area. The Lake-5	0.62	125.52	0.106	5.139	78.78	-
014	13	i. Galindez, the Testing area. The Lake-6	23.41	90.77	0.023	0.384	30.62	-
015	14	i. Galindez, the Testing area. The Lake-7	1.55	30.47	0.037	8.1	26.21	-
016	15	i. Galindez, the Testing area. The Lake-8	0.29	193.07	0.042	2.084	110.83	-
017	16	i. Galindez, the Testing area.	0.65	39.76	0.024	2.806	79.43	-
018	17	i. Galindez, the Testing area.	0.609	44.26	0.056	2.612	48.79	-
019	18	Edge of Lake “Arc” outside the "Penguin Point", lichens	0.507	48.16	0.025	2.42	77.9	-
020	19	i. Galindez, the Testing area	0.289	8.00	0.028	1.03	83.31	-
021	20	i. Galindez, the Testing area. The Lake-	0.653	122.16	0.011	0.489	77.5	-
022	21	i. Galindez, the Testing area. The Lake-	0.513	25.94	0.014	1.397	113.19	-
023	22	i. Galindez, the Testing area. The Lake-	2.43	49.17	0.044	4.012	74.33	-
024	23	i. Galindez, the Testing area. The Lake-6	0.704	35.06	0.036	1.758	46.21	-
025	24	i.Galindez. Test. area. Cascade of lakes through the mossy field	0.91	40.91	0.058	3.263	23.89	1.16
026	25	i. Galindez. Testing area. Cascade of lakes through the mossy field	0.337	31.68	0.014	1.748	191.94	-
027	26	i. Galindez. Testing area. Cascade of lakes through the mossy field	0.497	42.32	0.055	1.316	53.75	-

Table 4, cont

1	2	3	4	5	6	7	8	9
028	27	i. Galindez. Test. area. Cascade of lakes through the mossy field.	0.734	34.56	0.02	0.451	78.31	-
029	28	i. Galindez. The testing area. Cascade of lakes through the mossy field.	0.429	32.24	0.028	6.305	55.1	-
030	29	i. Galindez, The testing area. The Lake-	0.486	16.9	0.007	0.925	110.93	0.46
031	30	i. Galindez, The testing area. The Lake-. Lichens.	0.228	12.56	0.06	0.786	39.2	-
032	31	The stone in to snow before the testing area	1.445	9.7	0.010	0.338	113.96	-
034	32	i. Galindez, the rock	0.211	9.04	0.017	1.438	60.34	-
037	33	i. Galindez, the rock	0.447	3.58	0.023	1.543	31.75	-
038	34	i. Galindez. The testing area “Mossy field”	1.083	15.59	0.03	31.161	276.06	-
044	35	i. Jalour	28.43	382.87	0.038	0.275	324.31	-
45	36	i. Cruls	5.211	558.09	0.009	2.016	228.03	-
46	37	i. Uruguay	3.782	95.23	0.011	1.103	140.98	0.924
47	38	Bertelots islands	18.801	228.67	0.059	1.347	551.18	-
03-1	39	i. Petermann	2.024	305.31	0.053	1.063	93.43	1.596
03	40	i. Petermann	0.38	258.87	0.021	0.0498	225.80	-
04-1	41	Cape Tuxen	0.81	34.5	0.018	1.751	207.00	1.372
04	42	Cape Tuxen	0.31	50.32	0.021	1.115	137.36	2.252
01	43	i. Jalour	5.442	290.92	0.028	1.342	213.33	1.46
043/1	44	i. Rasmussen	0.804	45.82	0.020	1.13	85.77	-
043/2	45	i. Rasmussen	0.890	37.17	0.011	1.05	87.32	2.032
02	46	i. Rasmussen	0.68	16.29	0.002	0.389	122.22	-
009 Irizar	47	i. Irizar	10.429	425.54	0.012	2.107	1572.78	-
To east of Irizar	48	i. Irizar	11.749	284.04	0.002	0.267	1193.53	
02	49	i. Mario Pedro	1.41	47.41	0.045	0.237	139.41	-
01	50	i. Mario Pedro	0.811	64.03	0.050	7.26	361.33	0.816
Limit of determination			0.095	0.90	0.02	0.05	0.5	0.005
The “norm” in soil [19]			0.06 (0.01-0.07)*	30 (2-100)*	0.03 (0.01-0.3)*	10 (2-200)*	50 (100-300)*	100 (1-1000)*

substance and ash in them. The obtained estimates agree with those known for macrophytes and aquatic animals from the classical works ([5, 39], correspondingly).

As we expected, macrophytes and bottom-dwelling and pelagic organisms collected from the coastal sea of Isl. Galindez were contaminated with metals: the former with cadmium, zinc, nickel, and chromium, the latter with cadmium, zinc, iron, arsenic, and some of the animals with copper, lead and chromium (Fig. 8, Table 7; Fig. 9A and Table 8; Figures 10 – 13, respectively).

The estimates of cadmium, zinc, nickel and copper we measured in the macrophytes had been to 34, 14, 155 and 39 times greater than the conventional norms, correspondingly; the content of copper in the bottom ground was not high, nickel content was not assessed. Cadmium content determined in the tested mass molluscs *Neobuccinum eatoni*, amphipods, krill and mass fishes had been to 320, 26, 20 and 10 – 30 times as high as the norm, correspondingly.

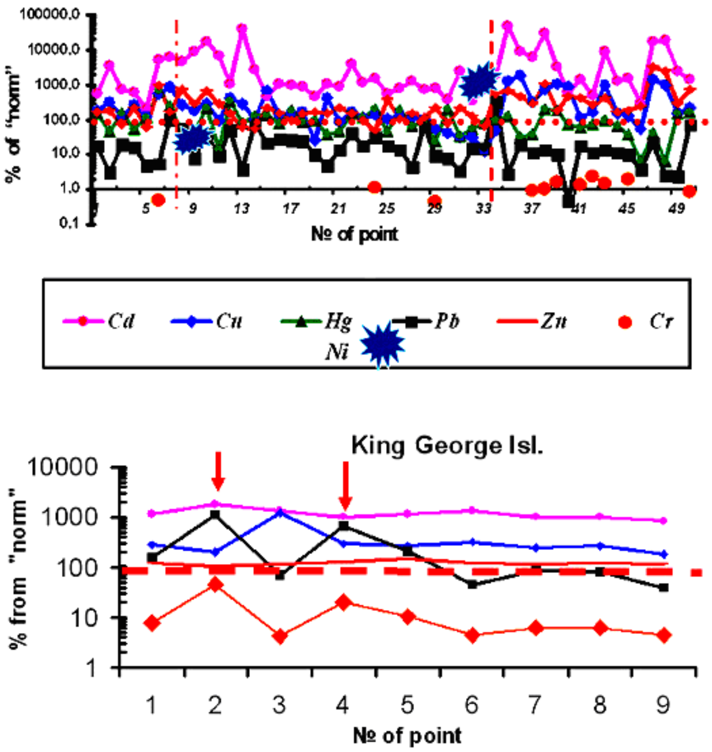


Fig. 8 The content of heavy metals in the grounds samples from islands of the Argentine Archipelago. In the top graph we used our data [36, 33, 34]; nickel content estimates are adopted by [30]. Localities are given in Table 1 (regions) and Table 4 (points). Vertical dash-dots show the sampling spots area on the Galindez i. (NN 8-34, Tables 1 and 4). Bottom graph is based on the data for Jubany Station (Argentine), King George Isl. [41]. Arrows show spots NN 2 and 4 (incinerator area and at the boat house, respectively). Dotted line: conventional norm (100%) [19]

Рис. 8 Содержание тяжелых металлов в грунте о-вов Аргентинского архипелага. Вверху – наши данные [36, 33, 34]; содержание никеля по [30]. Обозначения районов в табл. 1, точек – в табл. 4. Вертикальными штрихпунктирными линиями обозначен интервал точек на о. Галиндез (№№ 8-34, табл. 1 и 4). Внизу – по табличным данным в [41], р-н Jubany Station (Аргентина), о. Кинг Джордж. Стрелками обозначены точки №2 (район печи для сжигания мусора) и №4 (район эллинга). «Норма» (100%) по [19] обозначена пунктирной линией.

Increased concentrations of other chemical elements were mainly within an order of magnitude lesser than the cadmium estimates. J. Kahle and J.P. Zauke [16] reported that mass copepods in the Weddell Sea accumulated even greater cadmium, copper, zinc and lead concentrations (Fig. 12).

Taking into consideration the impressive extent of sea-floor pollution near the Argentine Archipelago, it can be presumed that the heavy metals and their moveable compounds have been entering the sea and accumulated in marine life and plants from times immemorial. Rapidly thawing especially in warm periods glaciers trigger the increased inflow of these pollutants into the sea. The farther to the open ocean, the lesser concentrations owing to natural dilution and uptake one way or another; however, in the vicinity of pollution sources, especially those sheltered by the indented coastline, islands and submarine elevations, the situation favours long-term retention of polluted sea water, and biota of these localities is to survive through the risky natural experiment.

Table 5 Organic matter's composition in bottom deposits (by 11 UAE collections)
Табл. 5 Состав органического вещества донных осадков (по сборам в 11 УАЕ)

№ of sample	Station	Oil hydrocarbons, mg*kg^{-1}	Integral indexes, % г		Pigments, mg*kg^{-1}			Notice
			Gumus matters	$C_{org.}$	Carotin µg*kg^{-1}	Chlorophyll «a», mg*kg^{-1}	C_{car} / C_{chl}	
1	5-A	95.99	0.042	0.007	0.95	0.92	1.03	sand
2	„ – „	115.94	0.152	0.024	2.51	3.19	0.79	sand
3	„ – „	101.10	0.129	0.021	2.05	2.49	0.82	sand
4	„ – „	167.53	0.166	0.026	2.65	3.56	0.74	sand
5	„ – „	125.59	0.186	0.030	2.05	2.53	0.81	sand
6	Getty	2491.24	2.928	0.467	7.90	3.52	2.24	silt
7	Getty, 1C	318.52	0.353	0.056	2.85	1.06	2.69	sand
8	1 C	215.65	0.342	0.054	2.75	0.97	2.84	sand
9	1 C	575.02	3.726	0.592	22.25	30.09	0.74	silt
10	6-A	93.48	0.069	0.011	0.15	0.05	3.00	sand

Where: maximum admissible levels for oil hydrocarbons in soil is 50 mg*kg^{-1}, $C_{org..}$ — organic carbon

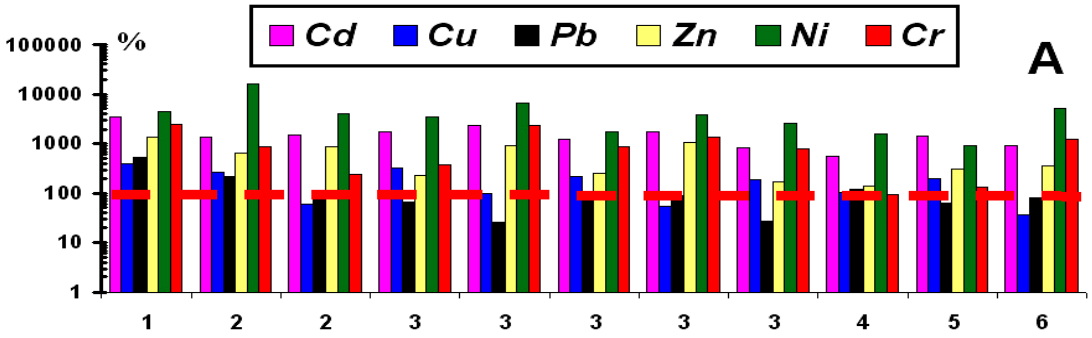
According to the present classification [38], in our case the most toxic heavy metals are nickel and lead, moderately toxic are cadmium, chromium, iron and zinc; oil hydrocarbons are the most hazardous organic pollutant.

The knowledge having been gained about impacts that various pollutants have upon marine organisms of different trophic level, taxonomic status, age and physiological condition is insufficient as yet. The situation gets even more complicated when a rich mix of pollutants in the environment gives rise to synergism and antagonism. The effect that mixed pollutants produce upon marine communities can be assessed through "residual principle" and, partially, through the broadly acknowledged responses to the pollutants that one or another hydrobiont or a certain developmental stage has evolved.

Table 6 Chlororganic pesticides content in bottom deposits, mg*kg^{-1}
Табл. 6 Содержание хлорорганических пестицидов (ХОП) в донных отложениях, мг*кг$^{-1}$

№ of st.	DDT	DDE	DDD	α-HCCH	β-HCCH	γ-HCCH	Aldrin	Heptachlor	Keltan	MTC	Phosphamide	Metaphos
5 A	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.005	<0.001	<0,005
« - »	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.005	<0.001	<0.005
« - »	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.005	<0.001	<0.005
« - »	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.005	<0.001	<0.005
« - »	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.005	<0.001	<0.005

Specific results of the biological investigations permit to assess at least tentatively the degree of the pollution impact upon the examined living components of biota in the area. Crustaceans, eggs and larvae of all tested hydrobionts are most sensitive to pollutants of all sorts; therefore the local scarcity of mesozooplankton and the absence of their larvae in the catches. Inducing total mortality of the laid eggs, the toxicants inhibit normal recruitment of the krill population, the more so that the eggs are incubated on the sea floor [32]. Unlike the krill, amphipods bear their eggs and larvae in the marsupial (brood) bag that contributes to their survival. In all probability, the toxicants are similarly ruinous to fish populations. No wonder that under these conditions the "vulnerable" regional populations are dependent.



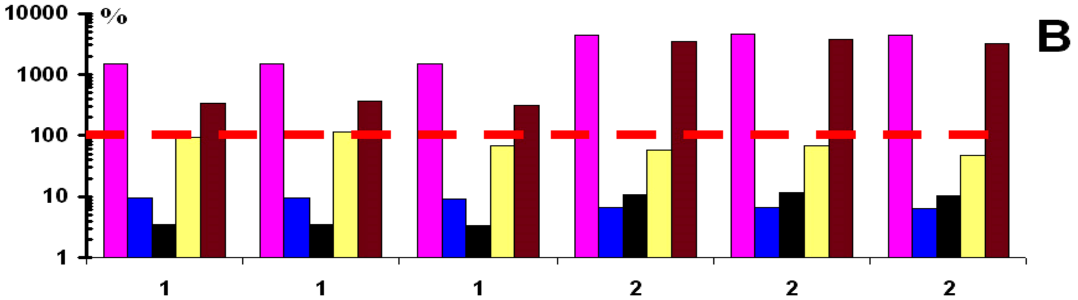


Fig. 9 The content of heavy metals in macrophytes: A – near the UAS: 1 – *Iridea obovata*, 2 – *Kallymenia antarctica*, 3 – *Curidea racovitzea*, 4 – *Delisea* sp., 5 – *Rhodopyta* sp., 6 – *Monostroma hariotii* [36, 33, 34]. B – near King George Isl. [3]: 1 – *Iridea obovata*, 2 - *Adenocystis utricularis*. Dotted line: conventional norm (100%) given in this and other figures corresponds to maximum concentrations admissible for foodstuffs cited in [38]
Рис. 9 Содержание тяжёлых металлов в макрофитах: А – у УАС: 1 – *Iridea obovata*, 2 – *Kallymenia antarctica*, 3 – *Curdiea racovitzea*, 4 – *Delisea sp*., 5 – *Rhodopyta sp*., 6 – *Monostroma harioti* [36, 33, 34]. В – у о. Кинг Джордж по табличным данным в работе [3]: 1 - *Iridea obovata*, 2 - *Adenocystis utricularis.* «Норма» (100%) на этом рисунке и на всех последующих – ПДК для пищевых продуктов по [38] – обозначена на графиках пунктирной линией

Table 7 Contents of organic matter, ashes and heavy metals in mass species of macrophytes in region of UAS
Табл. 7 Содержание органического вещества, золы и тяжёлых металлов в массовых видах макрофитов в районе УАС

Species	№ of list in herbarium	Contents of organic matter, %	Contents of ashes, %	Contents of elements in sample, mg* kg^{-1}					
				Cd	Cr	Cu	Ni	Pb	Zn
RHODOPHYTA									
Iridea obovata	5	86.42	13.58	3.40	12.55	38.84	22.07	5.27	548.61
Kallymenia antarctica	23	79.75	20.25	1.36	4.38	26.21	77.74	2.18	269.59
K. antarctica	9	78.47	21.53	1.49	1.20	5.89	19.75	1.14	348.85
Curdiea racovitzae	29	80.44	19.56	1.69	1.85	31.97	17.03	0.69	91.20
C. racovitzae	35	86.3	13.7	2.33	11.92	9.92	34.02	0.26	369.52
C. racovitzae	36	84.42	15.58	1.23	4.37	22.32	8.38	0.90	103.57
C. racovitzae	37	83.54	16.46	1.73	6.61	5.26	19.43	0.92	419.16
C.racovitzae	38	84.72	15.28	0.86	3.96	18.05	13.02	0.270	67.67
Delisea sp.	15	79.03	20.97	0.54	0.48	10.33	7.69	1.187	54.75
Rhopophyta sp.	13	88.19	11.81	1.41	0.65	20.09	4.64	0.648	122.52
CHLOROPHYTA									
Monostroma hariotii	17	86	14	0.933	5.96	3.69	24.99	0.832	143.79
Maximum admissible levels for foodstuffs cited in [38]				0.1	0.5	100	0.5	4	40

Table 8 Contents of organic matter, ashes and heavy metals in to mass species of benthic hydrobionts and fishes
Табл. 8 Содержание органического вещества, золы и тяжёлых металлов в массовых видах бентосных гидробионтов и рыбах

Species	Objects	Contents of organic matter, %	Contents of ashes, %	Contents of elements in sample, mg* kg^{-1}							
				Cd	Cu	Pb	Zn	Ni	Cr	Fe	As
				ECHINODERMATA							
Sterechinus neumaeri	Whole (1)	26.24	73.76	0.02	5.47	0.01	13.51	11.66	0.59	-	-
S. neumaeri	Whole (2)	27.13	72.87	0.01	4.48	0.002	8.29	2.60	0.04	-	-
				MOLLUSCA							
Nacella concinna	Body without shell (1)	80.06	19.9	0.04	0.49	0.03	0.75	1.47	0.05	-	-
N. concinna	Body without shell (2)	68.8	30.7	0.01	0.37	0.03	0.41	0.91	0.05	-	-
N. concinna	Shell (1)	8.81	91.2	0.004	8.64	0.11	18.88	9.95	0.25	-	-
N. concinna	Shell (2)	8.36	91.6	0.03	8.30	0.26	28.00	8.10	0.22	-	-
Neobuccinum eatoni	Body			32.09	104.73	5.87	505.2	14.18	27.61	156.3	17.4
N. eatoni	Shell			2.72	5.66	7.99	47.52	0.02	10.5	47.8	12
				CRUSTACEA							
Ceradocus sp.	Whole (1)	72.8	27.2	1.430	5.87	0.07	1.82	1.43	0.06	-	-
Ceradocus sp.	Whole (2)	72.8	27.16	0.782	2.97	0.02	1.34	1.48	0.01	-	-
Ceradocus sp.	Whole (3)	-	-	2.56	31.13	3.1	111.41	2.52	7.37	101.6	12.0
Euphausia superba	Whole (1)	-	-	1.77	1.54	1.32	55.08	1.15	3.63	115.8	4.25
E. superba	Whole (2)	-	-	0.91	14.63	2.14	87.19	0.67	3.29	107.32	2.08
E. superba	Whole (3)	-	-	1.96	11.28	0.94	176.79	0.03	12.12	60.76	0.82
E. superba	Whole (4)	-	-	1.56	3.13	0.55	78.74	0.02	5.89	32.52	0.59
				PISCES							
Notothenia corriiceps	Whole (1)	-	-	3.14	23.03	1.82	84.48	4.84	18.53	30.28	6.99
Parachaenichtys charcoti	Whole (2)	-	-	0.89	1.83	2.14	100.07	0.03	3.31	103.56	1.12
Trematomus bernacchii	Whole (3)	-	-	0.84	54.61	13.5	202.97	1.3	3.72	151.08	0.67
Maximum admissible levels for foodstuffs cited in [38]				0.1	10	1	40	0.5	0.5	30	1

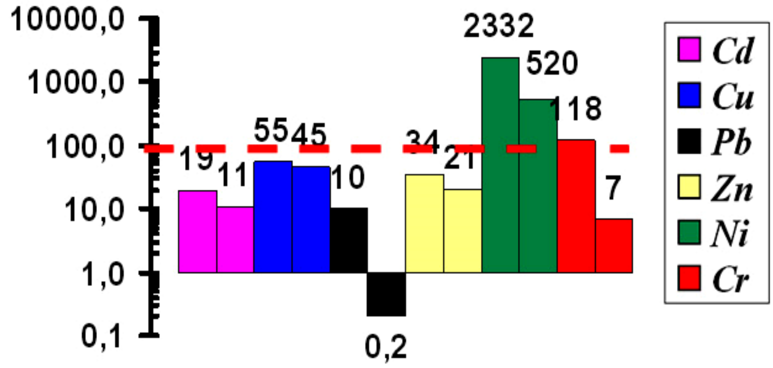


Fig. 10 The content of heavy metals in sea urchins *Sterechinus neumaeri* collected near the UAS [36, 33, 34]

Рис. 10 Содержание тяжёлых металлов в морских ежах *Sterechinus neumaeri* у УАС [36, 33, 34]

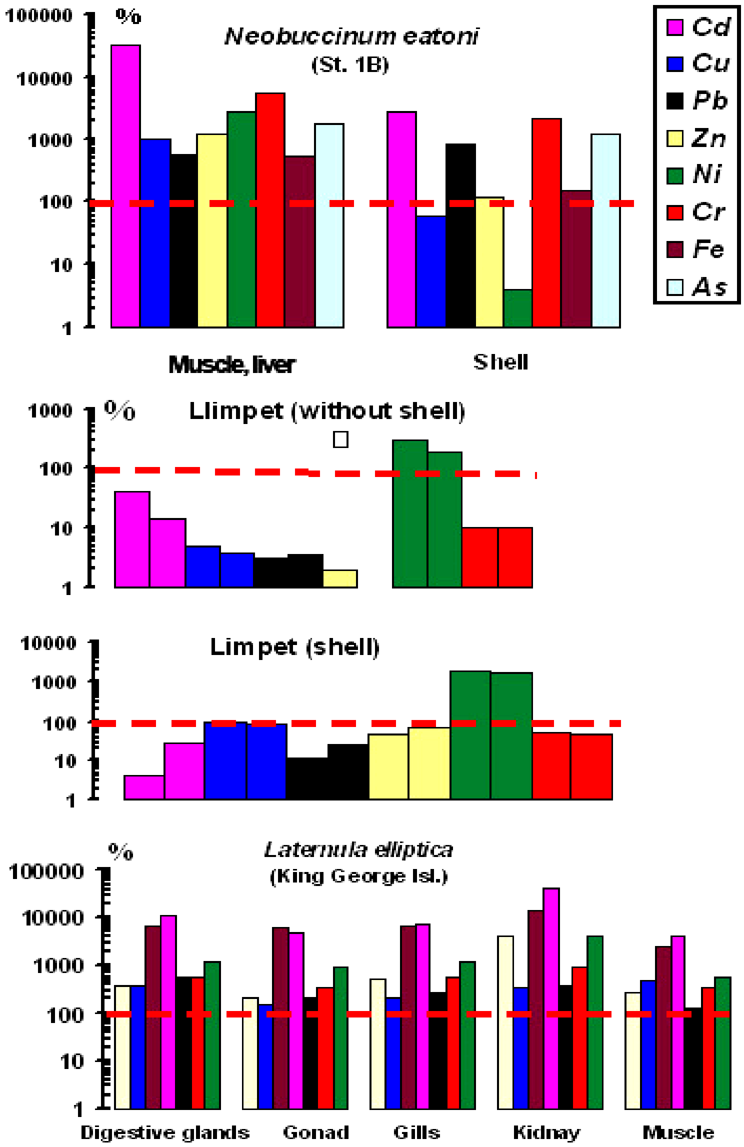


Fig. 11 The content of heavy metals in the muscle, shell and liver of molluscs collected near the UAS [36, 33, 34].
Bottom graph is based on the data from the content of heavy metals in the alimentary glands, gonads, gills, kidneys and the muscle of molluscs collected near King George Island [1, 2]

Рис. 11 Содержание тяжёлых металлов в моллюсках (в мускуле, раковине, печени), собранных у УАС [36, 33, 34].
Внизу – в различных органах моллюсков (пищеварительных железах, гонадах, жабрах, почках, мускуле) в районе о. Кинг Джордж по табличным данным в работах [1, 2]

Though heavy metal accumulation in sedentary animals and in attached macrophytes is a common phenomenon, the character and intensity of this process are insufficiently understood as yet. The known factors ensuring survival success are metal desorption by macrophytes, low ambient temperature and pH, and such mechanisms as antagonism and adaptation.

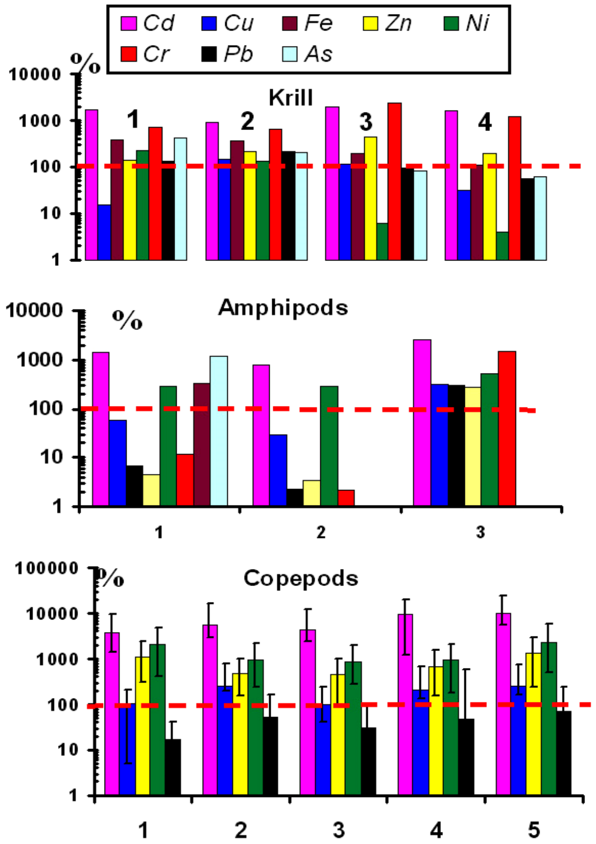


Fig. 12 The content of heavy metals in crustaceans. Top: in the krill *Euphausia superba* and amphipods *Ceradocus sp.* collected near the UAS [36, 33, 34]. Line across: sample NN. Bottom graph is based on the materials from the content of heavy metals in mass copepods from the Weddell Sea: 1 - *Rhincalanus gigas*, 2 - *Calanus propinquus*, 3 - *Calanoides acutus*, 4 - *Metridia curticauda*, 5 - *M. gerlachei* by [16]. In plotting the graph maximum concentrations of the metals the cited authors measured in the crustaceans were used

Рис. 12 Содержание тяжёлых металлов в ракообразных. Вверху: в криле *Euphausia superba*, амфиподах *Ceradocus* sp. в районе УАС [36, 33, 34] . По горизонтальной оси – номера проб. Внизу – в массовых видах копепод из моря Уэдделла по табличным данным в работе [16]: 1 – *Rhincalanus gigas*, 2 – *Calanus propinquus*, 3 – *Calanoides acutus*, 4 – *Metridia curticauda*, 5 – *M. gerlachei*. На графике нанесены предельные значения концентраций металлов, обнаруженные в рачках этими авторами

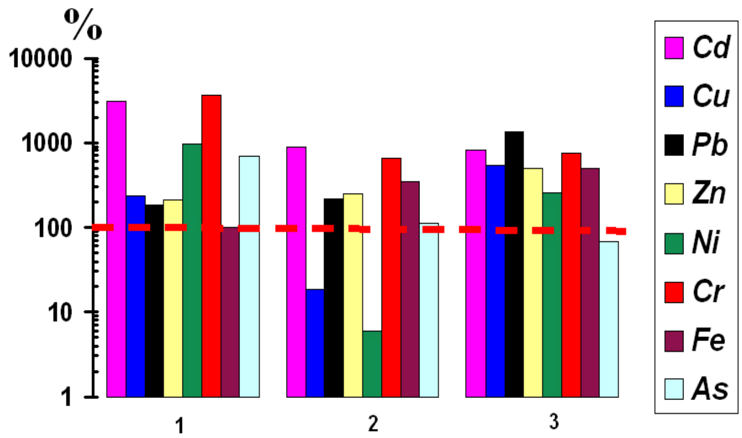


Fig. 13 The content of heavy metals in the fishes from the coastal sea area of the UAS (2007): 1 – *Notothenia corriiceps* (st. 1A), 2 – *Parachaenichthys charcoti* (st. 10) and 3 – *Trematomus bernacchii* (st. 1A) [36, 33, 34]

Рис. 13 Содержание тяжёлых металлов в рыбах из прибрежья района УАС (2007 г.): 1 – в нототении широколобой *Notothenia corriiceps* (ст. 1 А), 2 – в парахенихте Шарко *Parachaenichthys charcoti* (ст. 10) и 3 – в трематоме-пестряке *Trematomus bernacchii* (ст. 1 А) [36, 33, 34]

Conclusions. 1. The species composition, abundance and functioning of organisms that constitute marine community in the sea close to the Ukrainian Antarctic station fully depend upon special features of the environment – local gyres, currents of different directions which alter with ebb and flow, varying water exchange with the open ocean, natural and anthropogenic pollution. **2.** High trophic status of the seawater area typical of near-shore zones is owing to abundant phyto- and bacterioplankton, inhabitants of the sea floor, krill and fish entering the area**. 3**. Inhibitory effect of the disclosed variety of pollutants is clearly manifested in the "vulnerable" members of biota – mesozooplankton (predominantly copepods), krill and, apparently, fish which eggs and larvae are affected by the toxicants. As a result, populations of these organisms are dependent. That populations of attached and sedentary macrophytobenthos, zoobenthos and amphipods are resistant to heavy metals they accumulate in large amounts is probably owing to specific mechanisms insufficiently understood as yet. **4**. Our discovery of polluted grounds on islands of the Argentine Archipelago is evidence of the extensive regional pollution with heavy metals; increasing due to the global warming, this toxic inflow into the sea water dramatically reduces the efficient spawning zone and thereby population recruitment of the Antarctic krill *Euphausia superba*.

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Структура і функціонування антарктичних морських прибережних екосистем в умовах природного та антропогенного забруднення. Е. З. Самишев. На основі екологічного моніторингу отримане цілісне уявлення про структурну організацію водної екосистеми в маловивченій прибережній зоні, прилеглій до Української Антарктичної станції. Структура і функціонування біоти визначаються специфічною у відповідь реакцією її екологічно різних елементів на ряд чинників що лімітують. Відома незбалансованість антарктичного планктону по трофічних взаємостосунках спільнот посилюється короткочасністю вегетаційного періоду, активним обміном вод прибережжя з відчиненим океаном і забрудненням середовища. В результаті при великій кількості фіто- і бактеріопланктону слабкий розвиток одержує мезозоопланктон, а значна частка первинної речовини поступає на дно, зумовлюючи інтенсивний розвиток донної фауни. Виявлена акумуляція важких металів різної токсичності в організмах масових видів фіто-зообентоса, макропланктону і риб. Вплив забруднення, що інгібірує, виявляється в придушенні процесу відтворення кріля, популяція якого є залежною, доповнюваною принесенням з інших районів. Інтенсивність цього доповнення і локалізація максимумів його чисельності визначають кормові умови організмів-споживачів рачка.

Ключові слова: екологічний моніторинг, морська прибережна екосистема, забруднення, Антарктика

Структура и функционирование антарктических морских прибрежных экосистем в условиях природного и антропогенного загрязнения. Э. З. Самышев. На основе экологического мониторинга получено целостное представление о структурной организации водной экосистемы в малоизученной прибрежной зоне, прилегающей к Украинской Антарктической станции. Структура и функционирование биоты определяются специфической ответной реакцией её экологически разных элементов на ряд лимитирующих факторов. Известная несбалансированность антарктического планктона по трофическим взаимоотношениям сообществ усугубляется кратковременностью вегетационного периода, активным обменом вод прибрежья с открытым океаном и загрязнением среды. В результате при обилии фито- и бактериопланктона слабое развитие получает мезозоопланктон, а значительная доля первичного вещества поступает на дно, обусловливая интенсивное развитие донной фауны. Выявлена аккумуляция тяжелых металлов разной токсичности в организмах массовых видов фито-зообентоса, макропланктона и рыб. Ингибирующее влияние загрязнения проявляется в подавлении процесса воспроизводства криля, популяция которого является зависимой, пополняемой приносом из других районов. Интенсивность этого пополнения и локализация максимумов его численности определяют кормовые условия организмов-потребителей рачка.

Ключевые слова: экологический мониторинг, морская прибрежная экосистема, загрязнение, Антарктика