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95th Anniversary of Academician of the NAS of Ukraine

Yuvenaly Zaitsev

CONTENT

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CONTRIBUTION OF YUVENALY ZAITSEV TO THE SCIENTIFIC RESEARCH OF THE BLACK SEA

It is already more than 60 years that Yuvenaly Zaitsev dedicates his life and efforts to study and to protect the Black Sea. He started his research as an ichthyologist, having described the quantitative distribution of fish in the Dniester Estuary (1950). Investigating the density of spawn for different fish species, he used to determine the places of their special distribution. He discovered that the spawn of mullet is being concentrated at the sea surface and made a world-known discovery having described the so-called Sea Neuston (1959, 1970) – new life form. He was the first one in 1973 to describe the phenomena of large-scale eutrophication over an area of 3700 km. In 1990 he published a forecast of climatic changes. In 2007 he discovered that survival structures of bacteria, unicellular algae and fungi are saving their resilience at maximum depths in sulphurous layer, normally without any regular life. In one of his latest publications (Zaitsev, 2017), Yuvenaly Zaitsev formulated the concept of ecologic outlines of marine ecosystems presented in a form of "Tree of Life", starting from the definition of main terms up to the global monitoring of the World Ocean.

From 1994 until today he has been taking an active part in the activities under GEF/UNDP Black Sea Ecosystem Recovery Project (BSERP) and Commission on the Protection of the Black Sea Against Pollution. He contributed to the elaboration of bibliography for all scientific publications in the Black Sea in the period of 1974-1994; prepared for publication the Biodiversity Overview in the Black Sea and Ukraine, in particular; prepared the Student Book on Ecology in Russian and English; the First Overview on a state of Black Sea Wetlands; a series of posters devoted to the biodiversity of marine waters, Danube Delta and alterations in the list of commercial fishery species in all Black Sea languages; 17 types of indicators (for algae, invertebrates, fish and birds) to describe quality of marine waters for different coasts of Black Sea for children and other people concerned; those indicators are designed as game in form of mobile application, it contains the images of indicators and provides the server with registered information with coordinates of places of observation, where automatically the map of state of coastal line of the entire sea is being displayed; as of today this game is available in English, Georgian, Russian and Ukrainian languages. So, no wonder that Yuvenaly Zaitsev, an international expert of UN, was awarded with two highest prizes of the Secretariat of the Commission on the Protection of the Black Sea Against Pollution – "The Silver Dolphin" and «Crystal Medal for Protection and Rehabilitation of the Black Sea».

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THE TEACHING OF VERNADSKY-ZAITSEV ABOUT BOUNDARY AREAS IN THE HYDROSPHERE AND ITS APPLICATION IN PRACTICE

The fact that initially the structure of the biosphere was considered with an emphasis on the features of the structure of the ocean (Вернадский, 1926) was not sufficiently discussed in numerous publications related to the analysis of the ideas of V.I. Vernadsky about the biosphere and its structure. V.I. Vernadsky wrote that the studying the biosphere should be based on the density of life - the selection of areas enriched by it. In the structure of the ocean, we can distinguish such areas, which he called films and life condensations. It is important to emphasize: in the films and condensations of life, obviously, they form in the ocean areas of the greatest transformation of solar energy. In fairness, I must say that Vernadsky himself in his later works (Вернадский, 1965) somewhat paradoxically paid more attention not to the structure of the ocean (this geosphere, which, according to him, is permeated with life), but the atmosphere. But the biosphere does not consist only of condensations: the areas of rarefied life together with films of condensations create the most large-scale system of the biosphere – the system of biospheromerons (Протасов, 2013).

The biosphere is a fractal system, it consists the levels and subsystems that have the properties of fractal similarity. It is the fundamental property of the biosphere that became the basis for creating a holistic theory of the contour structure of the hydrosphere (Зайцев, 2015), which began with the study of microprocesses and microstructures at the border of the atmosphere and water phase (Zaitsev, 1970).

One of the important steps in the practical implementation of the ideas of V.I. Vernadsky was the creation of the concept of the biological structure of the ocean (Богоров, 1959; Богоров, Зенкевич, 1966), but it concerned only macro-scale processes and was not related to the fractality of the hydrosphere.

With a greater degree of detalization, the problem of boundary areas was considered in the 1970s (Айзатуллин, Лебедев, Хайлов, 1979). This authors made an attempt to quantify the diversity of conditions and the probability of life condensation under these conditions.

However, the most detailed elaboration of the contour biotopes of the sea and their population was made by Yu.P. Zaitsev (2008, 2012, 2015).

The significance of the teaching of the contour structure of the hydrosphere consists not only in the fact that an important step was taken of general ideas about the structure and functioning of the biosphere as a whole. Studies have been carried out in the management of coastal ecosystems of the Black Sea (Александров, 2008), a general classification of global biotopes in the hydrosphere has been developed (Протасов, 2011).

The doctrine of the contour structure of the hydrosphere, the heterogeneity of the structures and properties of the hydrosphere, not only played important role in the formation of modern principles of hydrobiology, but became an important section of biospherology.

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HOW DO MEDITERRANEAN ASSOCIATIONS OF MACROPHYTOBENTHOS CHANGE IN THE BLACK SEA?

The prodromus of the bottom vegetation of the North Caucasus coast of the Black Sea was compiled by the method of ecological-floristic classification of Braun-Blanqet. Since communities of the Mediterranean Sea were revealed using a similar method (Giaccone, Bruni, 1972–1973; Verlaque, 1987; Ballesteros, 1990; Giaccone et al., 1993, 1994a, b), it became possible to conduct a comparative analysis of the macrophytobenthos communities of the Mediterranean and Black Seas. It is shown that oligosaprobic sublittoral vegetation of hard substrates of the Black Sea consists of combinations of three Mediterranean elements: fragments of associations *Cystoseiretum barbatae* Pignatti 1962, as well as some euryhaline eurybiont diagnostic and constant species of different syntaxons of the alliances *Cystoseirion crinitae* Molinier 1958 and *Peyssonnelion squamariae* Augier & Boudouresque 1975 emend. Giaccone 1994. *Cystoseira barbata* with several accompanying species of Ceramium (as *Ceramium diaphanum, Ceramium deslongchampsii*, *Ceramium siliquosum*), forming communities in the Mediterranean only in estuarine desalinated areas on the 1st floor of the horizon of photophilic vegetation, in the Black Sea due to low interspecific competition it occupies the entire horizon, forming several ecotonic associations. The ecological niches of all associations of the alliance *Cystoseirion crinitae* Molinier 1958, connected with the conditions of intensive hydrodynamics and represented by several species of Cystoseira, in the Black Sea it is occupied by communities dominated by only one species – the endemic *Cystoseira bosphorica.* From the diversified deep-sea Mediterranean communities, only a few species penetrated into the northeastern part of the Black Sea (f.e. *Nereia filiformis*, *Phyllophora crispa*, *Codium vermilara*), making up only few similar associations. At the same time, lower temperature and transparency of water, as well as low interspecific competition contributed to the spread of several genetically deep-water species in all sublittoral areas, in particular, *Peyssonnelia rubra* and *Vertebrata subulifera*, which in the Black Sea has become an integral component of all sublittoral communities.

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AMPHIPOD ASSEMBLAGES AND PROSPECTIVE IMPACTS OF THE RECENT INVADER, THE KILLER SHRIMP *DIKEROGAMMARUS VILLOSUS*, IN TRANSITIONAL WATERS OF LITHUANIA

Transitional waters due to their location close to ports contain the most dynamic crustacean assemblages. Alterations usually are induced by biological invasions frequently associated with marine shipping. Transitional waters of Lithuania include the Curonian Lagoon and the mouth of the Šventoji River. The Curonian Lagoon is a large, shallow, largely fresh water eutrophic water body. The Šventoji River is a medium-sized river emptying directly into the sea. First alien amphipods reached Lithuanian transitional waters at the end of the 18th century when the basins of the Nemunas (Baltic Sea drainage) and Dnieper (Black Sea drainage) rivers were connected by the Oginsky Canal. The three species invaded: *Chelicorophium curvispinum*, *Chaetogammarus ischnus* and *Gammarus varsoviensis*. The last species *G. varsoviensis* only recently has been hypothesised to be a cryptic historical invader of Ponto-Caspian origin, and the amphipod *C. ischnus* recently has not been recorded in Lithuanian waters (Arbačiauskas et al., 2011; 2017). The second invasion wave consisted of deliberately introduced three species, two pontogammarids *Pontogammarus robustoides* and *Obesogammarus crassus*, and the gammarid *Chaetogammarus warpachowskyi*. These peracaridans were transferred from Ukrainian waters to the reservoir located on the Nemunas River and reached the lagoon by downstream dispersal in 1962 (Arbačiauskas et al., 2011). Modern invaders are represented by two species, the North American gammarid *Gammarus tigrinus*, which was first recorded in 2004 (Daunys & Zettler, 2006), and the Killer Shrimp *Dikerogammarus villosus* first observed in the Curonian Lagoon and the mouth of the Šventoji River in 2015 (Šidagytė et al., 2017). In 2016, this new invader was found to be dispersed throughout the Curonian Lagoon. Stable isotope analysis showed the dominant amphipod species to be omnivores with propensity to predatory feeding increasing with body size. Stronger carnivory was seen in large-bodied amphipod species and was related to species identity. Until the last invader, the amphipod assemblage was dominated by *P. robustoides* in the freshwater part of the Curonian Lagoon and *O. crassus* in the northern part of the lagoon, and co-domination of *G. tigrinus* and *P. robustoides* was a characteristic of the mouth of the Šventoji River. Prospective impacts of the Killer Shrimp on amphipod assemblages in transitional waters are derived basing on trophic role, identity and invasion history of the last invader *D. villosus*.

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THE HYDROCHEMICAL PARAMETERS AND THE CONTENT OF THE THIOL SUBSTANCES IN THE UPPER LAYERS OF THE LOWER DNIESTER RIVER

The territory of the Republic of Moldova is crossed by 3 important streams of cross-border river waters: the Dniester river, the Danube river and the Prut river, respectively the territory of the country is divided into 3 river basins. More than half of the country's territory (57%) represents the river basin of the Dniester river (19.2 thousand km^2), 657 km long on the republic's territory.
Therefore, the river Dniester's waters are being used for various purposes, the main one - being the provision of drinking water to the big cities, including Chisinau. That's why, the importance of monitoring of hydrochemical parameters of river waters is indisputable.
Besides this, the Dniester river is a complex aquatic biotope, the quality of which is maintained thanks to self-purification processes. The normal state of natural waters is oxidizing, mainly due to the presence of two oxidizing agents: dissolved oxygen (O_2) and hydrogen peroxide (H_2O_2), and the presence of reducing compounds such as thiol substances (R-SH) may disturb the *redox state*. There are two sources of thiol compounds in natural waters: autochthonics- thiols which are participating in biochemical processes of hydrobionts (cysteine and glutathione) and alohtones- thioles occurring from anthropogenic pollution (thiourea and thioglycolic acid). All thiol compounds are of peroxidase nature, i.e. they are preferentially oxidized by H_2O_2.
During 2015-2018, was monitored the content of H_2O_2 and thiol compounds, which were determined using the Ellman method. Samples were taken seasonally, with a frequency of 5-6 times a year, downstream of the dam in Dubasari. The average multi-annual concentration of thiol substances is $4.52 \cdot 10^{-6}$M, and H_2O_2- $2.04 \cdot 10^{-7}$M.
During all 4 years of monitoring, the maximum mean concentration of thiol compounds during the summer period ($9.30 \cdot 10^{-6}$M) was recorded, compared to spring ($2.42 \cdot 10^{-6}$M) and autumn ($4.23 \cdot 10^{-6}$M), that indicate that thiols are predominantly of natural provenience.
To evaluate the impact of thiolic substances and to predict the redox state of natural waters Pearson linear correlations between the R-SH concentration with H_2O_2 and OH radicals were calculated, the values obtained show a non-existent correlation (r = -0,01) in the case of peroxide of hydrogen and low-moderate inverse correlation (r= -0.34) for OH radicals. Therefore, the correlation values probably indicate the dominance of the self-purification biologic processes compared to the radical ones with the OH radicals, which are being carried out with a small intensity.
Therefore, the content of thiol compounds determined in the Dniester waters does not significantly affect the redox state of the water, participating with low intensity in the processes of self-purification. They are subjected to seasonal variation, which indicates the natural origin of thiols and the development of biological processes of self-purification, through the entrainment of thiol compounds in metabolic processes of hydrobionts.

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POLYCHAETA IN THE PSEUDOMEIOBENTHOS OF THE ODESSA MARINE REGION (THE BLACK SEA)

The time component of meiobenthos plays an important role in the formation of reservoir productivity. It serves as the main food for the larvae, juveniles and adults of commercial benthos-eating fish. According to the density of settlements and biomass, the majority of cases of pseudomeiobenthos are represented by the young of bivalve mollusks and polychaetes.
The biomass of the temporary component of meiobenthos can reach 37,0-57,7%, production – 35,0-84,5% of the total parameters of the whole meiobenthos (Vorobyova et al., 2017).
Among the representatives of the temporal component, the most abundant groups are juvenile polychaete and bivalve mollusks. In the meiobenthos of the Odessa marine region we registered 17 species pseudomeiobenthic polychaete from 9 families in 2005-2007: Phyllodocidae (3 species), Nephtyidae (1), Glyceridae (1) Polynoidae (2), Sigalionidae (1), Nereidae (1), Spionidae (5), Capitellidae (2), Ampharetidae (1). The maximum abundance of juvenile polychaete were recorded 19143 ± 3476 ind.·m^{-2}.
On silt sediment 9 species of polychaetes were registered. The most common juvenile individuals were *Melinna palmata* Grube, 1870 (57,4% of the total abundance), *Prionospio cirrifera* Wiren, 1883 (50,0%) and *Heteromastus filiformis* (Claparède, 1864) (42,6%). The abundance of juvenile polychaete on this substrate ranged from 0 to 46000 ind.·m^{-2} and was dominated by juvenile *M. palmata*.
On silted sand juvenile individuals of 8 species of polychaetes were noted. The total abundance varied from 700 to 10633 ind.·m^{-2}. The average abundance was 4683±1810 ind.·m^{-2}, 53,4% of which was accounted for by *P. cirrifera*, and 19.7% by *C. capitata*.
The 11 species of pseudomeiobenthic polychaetes were present on the shelly sediments. Main species were *C. capitata* (36.7% of the total abundance), *P. cirrifera* (21,2%), *P. cornuta* (18,3%), and *A. succinea* (11,2%).
On the silty-shelly sediment the juvenile individuals of the Spionidae family were most abundant. In total 12 species of polychaetes were registered on this substrate. Juveniles of *P. cirrifera* (80,0%), *P. cornuta* (53,3%), *C. capitata* (53,3%) and *H. filiformis* (40,0%) were characterized by high rates of occurrence on this substrate, whereas only one juvenile of *P. cirrifera* formed 87.1% of the total abundance of pseudomeyobenthos polychaetes. The largest number of juvenile polychaete species is recorded on the silted shell.

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ON THE MECHANISM OF "QUASI TOXICITY" OF THE PHOTIC LAYER OF THE WATERS OF THE DNIESTER BASIN

The phenomenon of "quasi toxicity" or "redox toxicity" of surface natural waters is not yet sufficiently used in monitoring as a precursor of shifts in the ecological prosperity of aquatic ecosystems. The biological usefulness of the natural aquatic environment is not impaired if, in addition to biological self-purification, the aquatic ecosystem also implements a chemical self-purification channel with the participation of free radicals and metal ions of variable valence, such as copper and iron.

To identify the presence of a chemical self-purification channel in aquatic ecosystems of the Lower Dniester basin (small rivers, Dniester, reservoirs), a correlation and regression research method was used based on a database for 2015-2016, including concentrations of various forms of metal migration and quality indicators of natural water.

The study carried out suggests that the oxidation of dissolved organic matter in the small rivers Ichel and Raut takes place by an ion-molecular mechanism, without the formation of free radicals. The migration of the studied metals is dominated by mineral forms, the dynamics of migration is of a pronounced seasonal nature.

In the segment of the Dniester from Dubasari to Vadul-lui-Voda, a change in the nature of the forms of migration of metals from mineral-organic to organic has been revealed. At the Vadul-lui-Voda cross-section, considerable involvement of copper in the processes of chemical self-purification was established. Iron, apparently, accumulates in bottom sediments and does not play a decisive role in the intensification of the radical processes of chemical self-purification in the studied segment of the Dniester.

The priority role of iron in the intensification of radical processes of chemical self-purification has been identified for the aquatic ecosystems of the reservoirs Ghidighici and Danceni. Copper, apparently, as a necessary trace element is accumulated by intensively developing biota of reservoirs.

As a result of the study, it is possible to conclude about irreversible problems with the ecological prosperity of the waters of Ichel and Raut, on the establishment of the Dniester cross-sections, where chemical self-purification processes are not intensive and about the greatest contribution of iron to the processes of chemical self-cleaning of reservoirs.

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INVASION HISTORY, CURRENT DISTRIBUTION AND DISPERSION VECTORS OF *POTAMOPYRGUS ANTIPODARUM* (GRAY, 1843) IN LITHUANIA

New Zealand mudsnail (*P. antipodarum* (Gray, 1843)) is one of most widespread aquatic invasive species worldwide, native to New Zealand. In Baltic Sea the species was recorded as early as 1887 year and only in 1954 it was found in Curonian lagoon (Lithuania) beside the marine shipping port, suggesting marine shipping as vector of primary introduction. In 2004 year *P. antipodarum* was found in Nemunas delta, suggesting active upstream species dispersion. However, in 2010 for the first time it was found in several lakes and river in southern part of Lithuania. Currently invader is recorded in 22 different ecosystems. As the species was not found in largest Lithuanian rivers, rapid spread across the distant ecosystems implies secondary dispersion vectors facilitating the dispersion. Laboratory experiments indicated, that significant number of consumed *P. antipodarum* individuals survives the gastrointestinal tract of various benthivorous fishes, including anadromous migrants (e.g. *Vimba vimba*). Such results implies, that fishes can facilitate the dispersion of the invader inside the particular ecosystems and between the ecosystems. The analysis of *P. antipodarum* distribution patterns in Lithuanian inland waters revealed boat transportation as one of the most probable secondary dispersion vector. It was found, that in most of invaded lakes, various water recreation activities and watercraft (yachts, kayaks, boats) translocation are common. Also, it was found, that highest densities of the snail are present in watercraft translocation sites and the abundance gradually decreases with increasing distance. In conclusion, rapid and distant spread of *P. antipodarum* is ongoing in Lithuanian inland waters. Current distribution pattern suggests secondary dispersion vectors facilitating the spread of the invader. In current study it was found, that boat transportation could be one of the most important secondary dispersion vector in distant species translocation. Also, as the snail is capable to survive the digestion of riverine, particularly, migratory fish digestive tract, the latter could be assumed to facilitate the upstream spread of *P. antipodarum*.

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FRAGMENTATION OF ECOSYSTEMS BELOW THE DNIESTER RESERVOIR FOR ECONOMIC EVALUATION OF ECOSYSTEM SERVICES

Ecosystem services are the benefits that people get from ecosystems; hence, the importance of assessing their economic value follows. The underestimation of real economic value is the main cause of ecosystems degradation and of the natural resources value in general.
In the current literature on the economic valuation of ecosystem services, the following steps are given priority:

- Determination of spatial boundaries of the area under a study;
- Identification of ecosystems and their services to be assessed and determination of the ecosystems' area size;
- Selection of methods for the economic valuation and development of the set of relevant indicators.

A purpose of this work was to fragment the Dniester River's ecosystems below the Dniester reservoir as the first step in their services valuation. Usually, the identification of ecosystem services of water bodies is the most difficult task due to their close connection with riparian areas, river floodplains, presence of wetlands, and diversity of terrestrial ecosystems in the catchment area. The latter include forests, pastures and agricultural land that perform important functions in a hydrological cycle due to services they provide. The basis for identifying areas that provide water-related ecosystem services was based on the principles of the European Water Framework Directive.
On the whole, 8 parts of the Dniester floodplain were identified, which include both individual reaches of the river and reservoirs. Their area varies from 1.02 km^2 (the Dubossary reservoir dam – the mouth of the Raut River) to 62.8 km^2 (the Dubossary reservoir).
The territory under study (785.62 km^2) includes the following ecosystems (more than 1200 plots): water (25.4%), forest (8.35%), grass (47.64%), wetlands (2.5%), perennial plantations (7.49%), arable land (3.49%) and built-up areas (5.15%). Within this territory there are also two Ramsar sites: "Unguri-Holosnita" and "Lower Dniester". For the selected sub-basins, the fragmentation coefficients were calculated, which reflects the high mosaic pattern and the degree of ecosystem diversity. These coefficients within sub-basins vary from 6.81 (the mouth of the Bic River – the mouth of the Botna River) to 15.29 (the dam of the Dubossary reservoir – the mouth of the Raut River).
The carried out estimations are necessary steps in the subsequent process of economic valuation of ecosystem services. Among these services the most important are: the conservation of biodiversity and habitats; the regulation of runoff and water supplies; improving the quality of surface and ground water; improving water infiltration and promoting soil accumulation and groundwater recharge; reduction of erosion, landslides and stabilization of river banks; prevention and mitigation of floods, etc. In addition, a block of cultural services related to water, such as beneficial recreational, aesthetic and spiritual effects of water bodies, forests and wetlands can be highlighted.
This work was performed in the framework of the BSB 165 *HydroEcoNex project*, the EU Joint Operational Programme Black Sea Basin 2014-2020.

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BIOSPHERE ROLE OF ESTUARIES AND LAGOONS OF THE BLACK SEA REGION IN THE ENERGY MAINTENANCE OF THE TRANSCONTINENTAL MIGRATIONS OF WADERS

Waders, and in particular, tundra waders, are a group of species nesting in the Arctic tundra of Eurasia, actively using the forage resources of wetlands. During long non-stop flights between wintering and nesting sites, they use places rich in food to provide them with the necessary energy reserve due to the fats and polyunsaturated fatty acids obtained from the food. These energy components provide a long non-stop flight of several thousand kilometers from stopover areas to breeding sites in the high latitudes of Eurasia.
Such unique places of migration stopovers on the Mediterranean area of the Afro-Eurasian flyways are estuaries and lagoons of the Black Sea region.
Special research of 13 tundra species of waders and sites of their stopovers at Sivash and the key estuaries of the Azov-Black Sea coast have shown that the amount of potential forage objects available for birds at the Sivash reach 1552 -2041 tons of wet weight. In the controlled estuaries similar value can reach at: Molochnyi estuary 15-368 tons, Tuzlovskiy group of estuaries 59-62 tons and Tylihulskiy estuary 77-103 tons. It is proved that waders use no more than 13% of the total produced macrozoobenthos biomass in spring and autumn. Against the background of the share of withdrawals from the total biomass of macrozoobenthos by waders, the significant bio-producing role of estuaries and lagoons for the entire biome of ecotones, and not only for its transit components, is clear.
The volume of forage resources, used by tundra species of waders, on the whole Sivash - at the maximum water level from 460 tons in spring to 409 tons in autumn (from 1590 to 1343 GJ respectively), at the minimal water level - from 757 tons in spring to 950 tons in autumn (from 1590 to 2846 GJ respectively). In different parts of the estuaries similar values were considerably lower and ranged from 76 (in spring) to 283 tons (in autumn). The differences in the total forage resources, used between lagoons and estuaries, are primarily due to the areas available for foraging waders, dominant in the Eastern and Central Sivash, providing a high concentration of waders at the stopovers.
The number of only 13 studied species of waders on estuaries and lagoons of the Black Sea region is from 200 thousand (in spring) to 400 thousand individuals (in autumn).
With the duration of stopovers from 3 to 20 days, the entire flow of migrants during the season can use 1400-1800 tons of macrozoobenthos in wet weight. It in the form of bioenergy provides a continental flight of migrating waders. In other words, the biomass of aquatic invertebrates used by waders is an "exported" part of the total energy produced by aquatic organisms of estuaries and lakes of the Black Sea region.

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THE BLACK SEA COASTAL MONITORING IN 2012-2017

During 2012-2017 the coastal monitoring was carried out by UkrSCES on 9 stations of Odessa Gulf (beaches Arcadia, Dolphin, Langeron, Luzanovka, cape Small Fountain, Port Odessa, Port Yuzhny, Kovalevsky Dacha, sanatorium of Chkalov). Total 35 samples of macroinvertebrate were collected and analyzed. Assessment of the state of the communities was carried out using the Shannon, AMBI and m-AMBI indices. In the composition of benthic invertebrates, 81 taxa of species rank and higher were found. The most abundant were Crustacea – 35, Annelida – 18, Mollusca – 18. Most frequent taxa (occurrence more 20%) were *Alitta succine, Ampelisca diadem, Balanus improvise, Capitella capitata, Chamelea gallina, Eteone pict, Microdeutopus damnoniensis, Microdeutopus gryllotalpa, Mya arenaria, Mytilaster lineatus, Mytilus galloprovincialis, Neanthes succinea, Platynereis dumerilii, Pontogammarus maeoticu, Pygospio elegans* and *Spio filicorni.* The number of species per station varied from 3 to 27, the number from 0.7 to 30 thousand ind.$\cdot m^{-2}$, the biomass from 6 to 800 g.$\cdot m^{-2}$. The assessment of the status of benthic communities was performed using Shannon, AMBI and m-AMBI indices. The values of the indices vary from year to year – the Shannon index 0,45-3,97 bit/ind., AMBI 0,298-4,484, m-AMBI 0,29-0,87, but it is impossible to say a pronounced change trend. The stations with Good Environmental status (GES) and non-GES had following share during the period 2012 – 67%/33%, 2013 – 67%/33%, 2014 – 20%/80%, 2015 – 88%/13%, 2016 – 25%/75%, 2017 – 38%/63%.

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CLIMATE CHANGE IN THE LOW DNIESTER BASIN AS A FACTOR OF IMPACTS ON WATER ECOSYSTEMS

Obviously, the biotic composition, structure and function of freshwater ecosystems depend largely on the climatic conditions in a river basin. This dependence becomes more complicated in the context of global warming, when the centuries-old relative climate stability, or its stationarity, disappears, and the more and more increasing changes in climate are observed. The aim of the present research was to compare statistically temperature-humidity conditions in the Low Dniester basin in two thirty-years (1961-1990 and 1991-2018) that respectively characterize different climatic periods according to the WMO classification. For each period, the average annual and seasonal values of key climate variables – air temperature and precipitation – as well as their linear trends were considered. As initial information there were taken observations at weather stations of Moldova, located in this part of the Dniester basin.

The analysis showed that in the second periods the annual mean (Tmean), maximal (Tmax) and minimal (Tmin) temperatures have increased in absolute terms by 1.0, 1.8 and 0.7 °C, respectively. With regard to seasonal temperatures, the highest Tmean increase was observed in summer (1.6 °C), the smallest – in autumn (0.4 °C). Tmax increased mostly in winter (by 3.1°C), and to a lesser extent – in autumn (by 0.6 °C). The greatest increase in Tmin was observed in winter (1.7 °C), the smallest – in spring (0.2 °C). At the same time, the total change in precipitation was extremely small: only 6 mm decrease per year. A slight increase in precipitation (by 25 mm) was noted only in the autumn months. An increase in air temperature, which is not compensated by an increase in precipitation, is inevitably accompanied by an increase in the climate aridity, already characteristic for the northern Black Sea coast.

The analysis of linear trends confirmed the results of a comparative analysis. Negative air temperature trends in 1961-1990, with the exception of a slight positive one for Tmax, have changed to their positive values for all parameters in the last three decades. In particular, during this period the increase in mean air temperature was 0.6 °C per decade. The slight negative trend of precipitation (~2 mm/year) in 1961-1990 was replaced by their negligible increase (~0.5 mm/year).

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AZOV-BLACK SEA ESTUARY MANAGEMENT PROBLEMS

Azov-Black sea coast is represented by a numerous estuaries and bays that for a long time functioned due to artificial connection with the sea. Among them are Molochnyi, Berezan, Tylihul Tuzly Estuaries, Eastern Syvash, etc.; they have significant scientific, social and conservation value. Most of them are included to the protected areas of Ukraine as parts of National Parks with international wetland status. On the other hand, they have important socio-economic value, because there is fish breeding, fish feeding and further active fishing in its waters.

Long-time management of these territories had spontaneous character with various ecological states formation. The main aim of such anthropogenic transformations was obtaining high water fish productivity due to single-minded ichthyotsenosis formation. Sometimes recreation, melioration or industrial problems were solved by using estuaries too.

In general, estuaries of the region became as polygons of various managerial decisions for a long time. These decisions were implemented without deep analysis and contrary to local natural processes. Such decisions led to large-scale environmental crisis with ecosystem degradation and natural resource potential destruction.

It is well known that viability of most estuaries related with the water exchange level through artificial channels with Azov and Black Seas. But there are still no acceptable calculations of desirable hydraulic engineering changes results.

Unfortunately, presently it is not yet decided what condition of estuaries will be the most acceptable under current conditions and what hydroecological indicators will ensure the integrated and the most efficient use of natural resource potential of reservoirs. The requisite decision cannot be accepted without system conception in process of management plans developing.

Although, prognosing models of hydrological and hydrochemical estuaries conditions are developed currently, but unfortunately no hydroecosystem models and chosen management strategy exist.

That's why, elaboration of estuaries operation regularities considering with productivity indicators, individual groups' species richness, fish productivity based on hydrological models, can be using as a background for the making ecologically important decisions.

Thereby, this approach may become a new basis of environmental management for the different types of estuaries and provide balanced nature management.

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POLLUTION OF SEA SANDS OF ODESSA AGGLOMERATION

The sandy beaches of the Odessa agglomeration are situated in the zone of influence of the millionth city and three large marine trading ports: Odessa, Chornomorsk and Yuzhny with a total volume of cargo more than 80 million tons (in 2016). More than 3.9 million m^3 of household waste are exported from the territory of the Odessa agglomeration. Coastal sands accumulate various types of pollution: remnants of marine organisms thrown on the shore, debris, including fragments of shattered glass, plastics, macro and microplastics, etc. Since the 1950s, more than 8 billion tons of plastics have been produced in the world, two thirds of which were thrown away with household waste. The content of plastics in household waste usually ranges from 4 to 13%. Under the influence of climate changes the intensity of reproduction of macrophyte algae has increased. Its big amount is also thrown by the sea to the shore. Dozens of organisms of various systematic units take part in the process of decomposition and mineralization of macrophytes on the coast. In the industrial and port areas ore dust, coal particles, graphite and soot predominate in the coastal sands. In the sand of popular city beaches cigarette filters and fibers dominate.

The aim of the work was to assess the level of pollution of the sandy beaches of the Odessa agglomeration at a time when pollution was minimal after winter storms. This will be a reference point for further research. The studies covered beaches located in the zone of coastal protection structures and open beaches of Odessa. The samples were taken in the surface layer of sand (0–20 cm) in the middle part of the Odessa agglomeration beaches at the following sites: 1 – Grigoriivka, 2 – Vapnyarka, 3 – Luzanovka, 4 – Dolphin, 5 – Old Man, 6 – Chornomorsk, 7 – Rybakovka, 8 – spit of the Tiligul Liman, after winter storms. The sand fractions of beaches were determined in the range of 0.1-2.0 mm (6 fractions). To identify debris and microplastics the samples of sand were examined under a binocular microscope.

The nature of the distribution of sand fractions on the open beaches of Rybakovka, the spit of the Tiligul Liman, Grigorievka and Luzanovka, was similar. A similar situation was observed in the closed beach of the Old Man, however, there was practically no small sandy fraction. The distribution of sand fractions on the open beaches of the Velykiy Ajalyk Liman and the Black Sea coast was also similar. On the closed Dolphin beach, large (47.3%) and medium sand fractions (40.0%) prevailed, possibly due to the annual nourishment of these fractions. Among the beaches of Odessa, which are included in the system of shore protection structures, the easternmost dipper of the Dolphin beach stands out. Due to the absence of a breakwater here, the surface of the sand was littered with shutters of mussels and other mollusks thrown ashore by the sea.

The average content of organic carbon in the sands was 0.15%, the minimum – 0.03% (on the beach Luzanovka), and the maximum – 0.25% (on the beach near Grigoriivka). The level of contamination of sands with oil products was low, the maximum was observed at Lanzheron beach – 0.4 mg $\cdot$ g^{-1}. Beach sands are contaminated with plastic (fibers, threads, scales, granules), slag, particles of rust, paint and coal, glass and organic residues. In the sands of the open beach Luzanovka, the largest number of inclusions was noted: plastic – 600, slag – 75, paints – 50, coal – 30, rust – 10 particles per sample. On an open beach near Grigorievka (near the port of Yuzhny), the amount of plastic particles per sample was 92, while on the other beaches their number ranged from 0 to 22; other inclusions were present in a minimum amount.

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NANOREMEDIATION TECHNOLOGY FOR SOIL CONTAMINATED WITH RESIDUAL PESTICIDES

In the Republic of Moldova, soil contamination with toxic substances—persistent organic pollutants (POPs), such as DDT and Lindan-HCH—is an urgent problem, which is particularly acute in places of former pesticide depots. Due to the lack of cheap and effective technologies, these territories are hardly purified; therefore, the contaminated zone is expanding. The proposed methods of phytoremediation and bioremediation are ineffective because of the duration of the decontamination process (10–15 treatment cycles for several years). The use of new methods including soil treatment with nanocomposites based on iron nanocomposites can significantly accelerate the remediation process.

Over the last 5 years, at Gitsu Institute of Electronic Engineering and Nanotechnologies, theoretical and applied studies on the synthesis of nanocomposites capable of degrading organochlorine and nitroaromatic pesticides have been conducted; a nanoremediation technology has been developed. Nanoremediation is the reductive dechlorination of organochlorine pesticides under anaerobic conditions.

The nanoremediation technology was tested in situ as part of the technology transfer project 219T "A Nanoremediation Technology for Soil Contaminated with Residual Pesticides" in places of former pesticide depots in Bilicenii Vechi and Bilicenii Noi in the district of Sangerei with a total area of 100 m^2. It was shown that, in the case of using a nanocomposite based on zero-valent iron, even after two cycles of treatment of soil contaminated POPs (organochlorine pesticides), the amount of the pollutants (clororganic DDT, DDE, DDD, and HCH) decreased by 86.3% in Bilicenii Noi, lot 1; by 67.6% in Bilicenii Vechi, lot 2; and by 84.9% in Bilicenii Vechi, lot 3.

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THE VARIABILITY OF THE RELATIVE GROWTH OF THE BIVALVE MOLLUSK *ANADARA KAGOSHIMENSIS* OF DIFFERENT ECOTONES OF THE AZOV-BLACK SEA BASIN

To research the adaptational response to anthropogenic and climate changes, we have obtained the variability ranges of the relative growth of the bivalve mollusk *Anadara kagoshimensis* of different ecotones of the Azov-Black Sea basin depending on climatic conditions (mean annual temperature) and their relationship with morphological indicators.
For the studies the samples of mollusks from several areas with different bottom sediments, depths and temperature conditions were used.
In the Odessa region, mollusk samples were taken from three settlements: 1 –"Molodaya Gvardiya" beach area (2011, soil - silty sand, depth 7-10 m), 2 — c. Maly Fontan (2009-2010, soil - silty sand, depth 12-15 m), 3 – wastewater discharge area of the biological treatment plant (BTP) "Yuzhnaya" (2009, soil - silt, depth 8-9 m).
Samples of the Caucasian shelf mollusks were taken from four settlements: 1 – Khosta region (1991, soil - fine sand, depth 9.5 m), 2 – N. Mikhailovka region (1991, soil - fine sand from shell, depth 17 m), 3 – Pshada region (1991, soil - fine sand, depth 10 m), 4 – Gadautskaya Bay (in 1991, soil - silty sand with broken shells, depth 12 m).
The value of the coefficient *b* in alometric ratios gives an indication of the quantitative changes in the relative growth of mollusks.
The presence of the variability values of the coefficient *b* in allometric ratios was analyzed depending on the average annual temperature of the habitat of mollusks.
To assess the influence of the environment on the growth of the bivalve mollusk *A. kagoshimensis* the influence degree of the average annual water temperature was analyzed. Multivariate analysis of variance showed a significant effect of the average annual water temperature on the value of the coefficient *b* of the relative growth ratios *A. kagoshimensis* for the Odessa region (F = 169.94, p = 0.000) depending on the depth (F = 284.01; p = 0.000). For the mollusks of the Caucasian shelf, the value of the coefficient *b* of the ratios of relative growth also differed significantly depending on the average annual temperature (F = 131.10; p = 0.015) and depth (F = 75.92. p = 0.000).
On the basis of the obtained results which are being considered in the study the strength of the influence of environmental factors (η2) was determined on the formation of morphological features of the *A. kagoshimensis* shell. It is revealed that in the Odessa region the value of the indicator η2 for the factor "depth" is 23.63%, and for the factor "average annual temperature of sea water" is 14.14%. For the Caucasus shelf area, the value of η2 for the factor "depth" is 17.22%, and for the factor "average annual temperature of water" is 29.73%.
The data obtained can be used for prognostic characteristics of these molluscs from other areas of this region.

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CYCLOPID COPEPODS OF ASTATIC WATER-BODIES IN NATURE CONSERVATION AREA OF CITY KYIV

Contour biotopes are thin structures on the borders of the hydrosphere with the atmosphere and lithosphere in which the basic biogeochemical processes in the Earth occurs (Zaitsev, 2015). For marine ecosystems it has been established that, in the interaction of two different environments "sea" and "land", the physicochemical and biological processes are activated, which cause a high taxonomic diversity and production characteristics of hydrobionts (Snigireva, 2015). The features of the contour biotopes of freshwater ecosystems are not well understood.

Species composition of cyclopoid copepods has been studied in contour biotopes such as astatic water-bodies, located in the floodplains of small rivers and their tributaries on the territory of the Nature Reserve "Lisnyky" and the Feofaniya Park.

We conducted our research over 2014-2019 in the spring period (March - May), as periodic water-bodies appear in spring, and as a rule, dry up in the summer. The astatic water-bodies in the Nature Reserve "Lisnyky" are formed following spring floods and in the Feofaniya Park – they are formed in lowlands pools where water from melted snow and rainwater is accumulated.

In pools of the Feofaniya Park we recorded 5 species of cyclopoid copepods (*Acanthocyclops vernalis vernalis, Cyclops strenuus strenuus, Diacyclops bicuspidatus bicuspidatus, D. crassicaudis brachycercus, Eucyclops serrulatus*). In March two species – *C. strenuus strenuus* and *D. bicuspidatus bicuspidatus* were dominant. In this period the reproduction of these species was observed with water temperature between 4-6 °C. The species *D. crassicaudis brachycercus* was found only in small number in late March – first part of April. In mid-April the most abundant was *A. vernalis vernalis* which is reproduced in this period. The species *E. serrulatus* was found only in small number in April.

In astatic water-bodies of the Nature Reserve "Lisnyky" we recorded 6 species of cyclopoid copepods (*A. vernalis vernalis, A. viridis, C. strenuus strenuus, D. bicuspidatus bicuspidatus, D. bisetosus, Macrocyclops fuscus*). In March two species – *C. strenuus strenuus* and *D. bisetosus* were dominant. In mid-April the reproduction of *A. viridis* и *D. bicuspidatus bicuspidatus* was observed and egg-bearing females and juvenile individuals of these two species were registered. In May *M. fuscus* was found only in small number.

Consequently, eight species of copepods belonging to family Cyclopidae are recorded. Among them five species (*Acanthocyclops vernalis vernalis, Cyclops strenuus strenuus*, *Diacyclops bicuspidatus bicuspidatus*, *D. bisetosus*, *D. crassicaudis brachycercus*) are specific to astatic water-bodies, others three species (*Eucyclops serrulatus*, *Acanthocyclops viridis*, *Macrocyclops fuscus*) were previously recorded in various types of water-bodies, including temporary pools (Monchenko, 1974).

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PHYTOPLANKTON FEATURES OF NORTHWESTERN PART OF THE BLACK SEA IN COASTAL AREAS WITH A DIFFERENT LEVEL OF DESALINATION UNDER INFLUENCE OF THE DNIEPER-BUG ESTUARY WATERS

It is known that in the areas of river hydrofronts of the northwestern part of the Black Sea there is a dependence of the total phytoplankton biomass on the salinity of the waters. In particular, in the area of the Dnieper-Bug hydrofront phytoplankton biomass was increased with decreasing salinity (Ivanov, 1967; Nesterova, 2006). The greatest impact of freshwater runoff of the Dnieper-Bug Estuary on the hydrological and hydrochemical conditions in the Odessa region occurs in the spring period (April-May), when the flow rate the Dnieper is maximal and the frequency of the north winds decreases but the frequency of the southeastern and southern winds increases (Dotsenko, 2003). The purpose of this work was to identify the features of the microalgae plankton community in the coastal areas of the northwestern Black Sea with different level of desalination as a result of influence the Dnieper-Bug Estuary waters.

Studies were conducted in April, July, September 2018 at 5 stations (in the direction from the Dnieper-Bug Estuary to the Odessa Bay: Cape Ajiyask, Berezan, Koblevo, Yuzhny, Cape Malyi Fontan) of the northwestern part of the Black Sea. In the study period, the minimum value of salinity was in the area of Cape Ajiyask – 4 ppt, the maximum in the area of Cape Malyi Fontan – 17.72 ppt. Samples of phytoplankton were collected from a depth of 0 and 3 m.

As a result of phytoplankton research in the coastal areas of the northwestern Black Sea with different level of desalination, it was found that quantitative indicators from the Dnieper-Bug Estuary to the Odessa Bay are decreasing both in the water's line zone and at a depth of 3 m: the abundance was up to 432 times (0.024 -10.369 106 · kl · l-1), biomass – up to 368 times (97-35754 mg · m-3). In the community of phytoplankton species of microalgae are found that can be used as indicators of transit waters: *Oscillatoria kisselevii* Anissim., *Ceratoneis closterium* Ehrenberg, *Monoraphidium arcuatum* (Korsch.) Hindak. In general, their quantitative indicators increased by several orders in areas of the coast with a high level of desalination. It should be noted that in July 2018, water bloomed due to the *Eutreptia lanovii* Steuer algae with a biomass of 96.784 mg · m-3 in the area of Malyi Fontan, Koblevo and Ajiyask – 6317.050 and 8298.513 mg · m-3, which, was accordingly, 65 and 85 times higher.

Thus, as a result of phytoplankton research in the northwestern part of the Black Sea in coastal areas with different desalination level, it has been established that quantitative indicators are decreasing in the direction from the mouth of the Dnieper-Bug Estuary to the Odessa Bay, both in the water's line zone and at a depth of 3 m. In the phytoplankton community, species of microalgae were found that can be indicators of transit waters.

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FROM 'HYPONEUSTON OF ZAITSEV' TO 'COUNTOROBIONTS OF ZAITSEV': THE IMPORTANT TREND IN CONTEMPORARY AQUATIC ECOLOGY

The surface film of water, inhabited by 'hyponeuston of Zaitsev', covers more than 70% of the world's surface. Although neustonic organisms do not cover all the surfaces of the oceans, seas and fresh waters uniformly, they were found to be abundant in productive coastal waters, where they play a potentially important ecological role. There are two ways in which the aquatic biota can potentially affect the properties of the surface film: (1) the physico-chemical influence of biogenic surfactant films, exuded by hydrobionts, on the water film; and (2) the mechanical influence of turbulence in the laminar layer, caused by the swimming motion of zooneustonic organisms. The potential effect of abundant zooneuston organisms on the heat and gas (oxygen) exchange, between water and air via a decrease of thickness of the laminar layer may be comparable with that of a moderately strong wind. Besides, the zooneuston exhibit an early and clear reaction to pollution and thereby it is believed to be the important object for ecological monitoring.
The term 'contourobionts', coined by Yu.P.Zautsev, besides the neuston, encompass all the organisms, inhabited interfaces in aquatic environments. Although conturobionts may be less abundant, than pelagobionts, they evidently play a key functional role at benthic and periphytic interfaces, as well at density gradients in water column, such as thermocline and pycnocline. Thus, the 'hyponeuston of Zaitsev', expanded to 'conturobionts of Zaitsev', appeared to be the important contribution to pure and applied contemporary aquatic ecology.

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CETACEANS IN THE NORTH BLACK SEA AREA: POLL MATERIALS

The continental Black Sea coastline (from Odessa till Mariupol) and adjoining marine environment is the unique habitat for different organisms existing in frontier line between sea and freshwater ecosystems. In particular, this area is an extreme northern edge of distribution of the Black Sea cetacean species; and from a number of angles their geographical, annual and seasonal occurrence, specific structure, and strandings are advantageous. The analyzed material was obtained from polling of 3750 university and college students and local people (324 of respondents are residents of coastal continental region, the others visit it from time to time) since 2002 till today; 130 sightings and 63 strandings were reported. The most of sightings were recorded along the Black Sea coast from Khorly to Odessa (69.2%), especially in Karkinit Bay (43.8%), and mainly in Djarylgach area (16.2%); whereas in the Azov zone, from Genichesk to Mariupol, – 24.6% only (6.2% – in other coastal areas). Harbour porpoises (PP), bottlenose dolphins (TT) and common dolphins (DD) were registered in the Black Sea region, just as PP were observed in the Sea of Azov (meanwhile there are arguable descriptions of three cases of TT occurrence near Berdyansk and Kirillovka in 1999-2001). In the specific structure of sightings PP (61.5%) dominated, while TT (33.8%) and DD (3.1%) were rather less (1.6% of sightings were not identified). Animals were observed mainly in summer, with several exceptions (PP in February 1991 near Obitochnaya Spit; PP in March 2005 near Kinburn Spit, *etc*.). The annual peaks of cetacean occurrence took place in 2005 (10.0%), and in 2007-2009 (9.2-16.9%). In April-May 1997 some PP were observed in the freshwater – the animals came in several km up Molochnaya River in the northern Azov coast. In March 2005 groups of two-three TT individuals were described in Dnieper estuary; and in April 2008 in 20 km south of Kahovka Reservoir. The most of strandings were reported from the Azov coast (50.8%) because of PP vulnerable situation, and 44.4% – in the Black Sea region, Karkinit Bay mainly (27.0%) (in 4.8% of cases site of finding was not indicated). PP and TT (68.3 and 11.1% of identified cases) dominated in strandings. Highest level of strandings coincided with 2002-2005 (in 11.1%). Several cases of stranded animal carcasses consumption for the dog feeding were reported.

Conclusions.

1. The poll materials in a certain degree create some view about specificity of cetacean inhabitance in continental Black Sea coastline.
2. The coastal species (bottlenose dolphin and harbour porpoise) highly dominate in cetacean populations; at the same time common dolphin is far behind them.
3. Cetacean runs into the estuaries and rivers take place periodically.
4. Three species of the Black Sea cetaceans (first of all, it relates to subspecies of harbour porpoise – Azov dolphin "azovka", sharp dominating in strandings) are vulnerable.
5. Current status of cetaceans in the region defines the necessity of organization of additional measures for their protection, educational and explanatory initiatives, as well as improvement of existent environmental legislation.

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CONTOUR DOCTRINE AND ITS APPLICATION FOR SNOW AND ICE BIOTOPES

Modern views about contour structure of aquatic environment have developed over the past 60 years by Prof. Yu.P. Zaitsev and his school of thought, starting with neuston, and then step by step by researching various biotopes. Beginning as a continuation of the ideas of V.I. Vernadskiy about the "film of life" (Vernadskiy, 1965) at the boundary of different habitats, this led to the formation of an extensive system of knowledge which can rightly be called the "contour doctrine". In this scientific paradigm the classification of biotopes is defined, where the effect of "thickening of life" occurs. At the moment, six major contour biotopes are identified and well studied (by Zaitsev, 2015):

Aerocontour (αέρος – air) biotope on water-air interface
Psammocontour (ψάμμος – sand) water-sand interface
Lithocontour (λίθος – rock) water-solid surface interface
Pelocontour (πηλός – clay) water-sediments interface
Potamocontour (ποταμός – river) river-sea interface
Biocontour (βίος – life) water-living surface interface.

Recently, more and more information has been accumulating on the biological, chemical and physical processes occurring during the melting of polar sea ice and snow, mountain glaciers, ice processes in fresh water, etc. It has been established that in snow and ice there can be migration, accumulation and/or transformation of nutrients that can enrich the waters during the melting. Living forms of organisms internally existing within the sea ice and on ice-snow and ice-water interfaces make a significant contribution to the total primary production of the ice covered areas. Ice associated organisms are an important food source for many pelagic animals and may initiate phytoplankton spring blooms after ice melt because of enrichment by living microalgae (seeding effect). Sea ice organisms often are enriched by some orders of magnitude if the same volume of melted ice is compared to that of the underlying water column (Spindler, 1994).

It is safe to say that the intensification of biological processes near the ice as well as such phenomenon like "watermelon snow" is an appearance of the contour effect in the hydrosphere. In our opinion, a biotope at the boundary of the liquid and solid phases of water can be included in the number of contour biotopes. We suggest definition "**cryocontour**" (κρύος – cold, frost) for this biotope. In addition, for the snow and ice can be distinguished subcontours: "**chionocontour**" (χιών – snow) and «**pagocontour**» (πάγος – ice).

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MONITORING OF NONLIVING SUBSTANCE FLOWS IN CONTACT (BOUNDARY) ZONES (REGIONS) OF ECOSYSTEMS

The phenomenon of boundary effect is a quantitative increase of living matter and an increase in species diversity of flora and fauna in the border areas of normally functioning ecosystems. Mainly it is determined by diversity of environmental conditions and a combination of factors that are typical for various barrier zones, including in the seas and oceans (Yemelyanov, 1998). At the same time, living systems play a significant role in the biological filling of such formations, determined by geological and geographical characteristics of the territories. Such territories are referred as boundary biotopes or contact zones (Aleksandrov, Zaitsev, 2012). Their size, composition, structure and age do not always fit into clear definitions and depend on the scale of assessments or goals and conditions for solving various scientific and often practical tasks.

One of the features of regional biotopes within the limits of water bodies, as noted by B.G. Alexandrov (2017), is an increased risk of anthropogenic pressure and subsequent negative changes for qualitative and quantitative composition of their biological component. Introduction of anthropogenic component into such systems occurs mainly through transfer of aquatic and aerial subsystems by bio-inoculated medium, i.e. water and atmospheric sedimentation flows. Subsequent accumulation of pollutants is observed both in biocenoses objects and in accumulative bodies of biotopes. They determine the necessity to make complex observations of number of indicators of living component state of contacting systems with different structural characteristics, properties and functions, for example, transfer or accumulation of components of adjacent geo-ecosystems. In particular, it means: organization of collecting, processing, systematic accumulation and analysis of scientific information on an ongoing basis to assess composition of air and water flows of sedimentary substances; features identification of their quantitative and qualitative characteristics.

But experience showed that such assessment is impossible without targeted long-term monitoring studies and identification of changes dynamics in number of biotopes components and without intensification of processes of influx and redistribution of pollutants in sedimentary flows. Studies directed at obtaining above characteristics are conducted, in particular, by members of the modern marine sedimentogenesis department of the Institute of Geological Sciences of the National Academy of Sciences of Ukraine and the State Scientific Institution "Center for problems of marine geology, geoecology and sedimentary formation of ores of the NAS of Ukraine". They cover boundary areas of reserves geo-ecosystems that are most susceptible to anthropogenic impact, including pollutants introduction from territories of zones of anthropogenic landscapes (Yemelianov., Nasiedkin., 2017), junction zones (contact zones) of geo-ecosystems of urbanized territories and sites concentrations of enterprises in the mining industry (Emelyanov, Nasedkin, Kuraeva et al., 2017), transition zones within the boundaries of the "geo-ecosystem of bottom sediments – aqua ecosystem" at the junction areas of different geo-ecological systems of the shelf and continental slope of the Black Sea (Yemelianov, Dovbysh, Nasiedkin, Tsymbaliuk).

Evaluation of changes in chemical and preferably mineralogical composition of aeolian material, natural waters, substances suspended in them, as well as a number of characteristics of the "aquatic ecosystem – geo-ecosystem" boundary allows determination of source, direction and its danger degree of threat not only for biocenoses of border regions ecosystems (Yemelyanov, Mitropolskiy, Nasedkin et al., 2004) but also for bathers using the relevant areas of water.

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BOUNDARY EFFECT ROLE IN THE FUNCTIONING OF MARINE GEO-ECOSYSTEMS

The term "boundary effect" was first introduced in Ecology in the 30s of the last century (Leopold, 1933) to refer mainly existing pattern in increasing of diversity and density of organisms, i.e. complication of ecosystems, on biological communities' border. However, it should be remembered that increasing of ecosystems complexity, including marine geo-ecosystems (MGES) is caused not only by specifics of their living component, but also by peculiarities of structure formation and interaction of their non-living components, manifested in MGES medium towards their borders. The concept of "boundary effect" is closely related to the concept denoted by the term "ecotone" which was introduced into science in 19th century but it received first ecological interpretation in the mid-70s of the 20th century (Odum, 1975). In early 90s of the last century, the author introduced the term and corresponding concept of "marine geoecoton" (MGET) (Yemelianov, 1990, 1991, 2003). Naturally, the MGET concept due to the presence of boundary effect in its functional system is closely related to the concepts of "ocean barrier zones", "natural ocean barriers", "ocean boundary effects", etc., which are widely used in various directions of oceanology (Yemelianov, 1998, etc.). Moreover, certain hierarchy and multi-levelness are also noted in the structure of multi-level and multi-scale MGET, which are always spatially and functionally connected with natural barriers in the ocean. At the same time, the complexity, different scale and multilevelness of the barrier zones is not an obstacle to the preservation of boundary effect, which was mentioned above but on the contrary often only enhances it.

Great importance of various barrier zones and barriers in the ocean in geo-ecological terms becomes clear after careful analysis of existing ideas about their properties and characteristics due to boundary effect.

Marine geoecotons are those spaces in MGES where concentration of all possible (mechanical, geochemical, biogeochemical, physicochemical, physicomechanical, etc.) boundaries of barrier type reaches maximum values. The more this concentration is, the more pronounced boundary effect is through the activation of metabolic processes in MGET with the participation of various substances, types of energy and information, an increase in quantitative and qualitative wealth, the relationship of the living and inert components of the MGET, and formation of lithosphere is more noticeable. So, such geoecoton is more stable with an unexpected exposure to it from the outside, if its resources can be replenished in time with appropriate quantities of the necessary substances, energy and information, and the products of its functioning are removed in time out of its limits. At the same time, an excessive increase in barriers number of different nature in the space of MGET (increase in length of boundaries of its subsystems while simultaneously reducing their area) can cause a decrease in diversity and an increase in vulnerability of living component. This suggests that there are theoretical and practical maxima of components diversity of in MGES and MGET. Moreover, they should be found where the spaces of these geoecological systems are sufficiently large with sufficiently significant total length of their internal barriers.

Functional role of MGET corresponds to concept of geoecological membrane between different subsystems of MGES. It should be taken into account during implementation of any type of anthropogenic influence on MGES.

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ORGANIC MATTER CONTENT DURING DECOMPOSITION OF STORM WRACKS IN SANDY SUPRALITORAL OF THE DZHARYLGACH ISLAND

The influence of storm wracks (SW) on the ecological state of Black Sea was already studied at the Anapa Bay (Blinova, Saburin, 2005). However, the content of organic matter (OM), both of the algal SW and of the coastal sands, has not been practically studied.
The aim of the study was to evaluate the changes in the OM content during decomposition of algae wrack in the sediments of the sandy supralittoral and in wrack with no anthropogenic load.
Samples were collected on the Dzharylgach Island at two locations (sea and bay beaches) in July 2015. On the sea beach samples were taken at four sites (at the distance of 3.0, 5.0, 12.5 and 15.5 m from the water's edge), on the bay beach it was only one site on the water's edge.
The organic matter of the SW, the sand under all ridges of SW, as well as of the water's edge sand were studied. The sand samples from the SW-free sites were used as controls. The OM was determined by burning (Methods...,1980). The OM amount in algae was presented in mg per gram dry weight (DW), and in sand – in mg·per·sm^3 of dry sediment.
At the sea beach the OM content in the SW (*Ulva chlathrate* and green filamentous algae) has been gradually decreased from 547 to 441 mg·g^{-1} DW in distance gradient from the water's edge.
The maximum content of OM is recorded in the sand samples from the water's edge. Amount of OM in sand under SW has been 1.8 times higher than in the control sample (38.7 and 22.0 mg·sm^{-3}, respectively ($P < 0.01$). In the distance gradient from the water's edge the amount of the OM in the sand under the SW and without SW (control samples) decreased (25.7 and 17.6 mg·sm^{-3}, respectively). In the samples of the sand under SW taken at a distance of 3.0, 5.0, 12.5 and 15.5 m from the water's edge the amount of the OM was 1.4–3.4 times higher than in the control samples ($P < 0.05$).
At the bay beach the greatest amount of the OM in the samples of the SW (*Zostera* sp.) was revealed in the upper part of the wrack shaft (872 mg·g^{-1} DW), then this parameter was decreasing to average (790) and to lower part of the shaft (603 mg·g^{-1} DW).
The content of the OM of the sand sample at the water's edge under the SW was 1.5 times higher as compared with the control sample (53.1 and 35.5 mg·cm^{-3}) ($P < 0.05$).
Thus, the amount of the OM of the water's edge sand sample from the bay beach was higher as compared with the sand sample from the sea side. We recorded the increasing of the OM content in the sands beneath under the SW.

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ANALYSIS OF TRANSITIONAL WATERS ON UKRAINIAN BLACK SEA SHELF BY ZOOPLANKTON INDICATORS (ON THE EXAMPLE OF THE DANUBE DELTA)

Transitional waters are surface water bodies near the mouths of rivers that are partially saline because of their proximity to coastal waters and are largely influenced by freshwater flows according Marine Strategy Framework Directive – MSFD (2008).
The Ukrainian part of the delta (1240 km^2) is about 22 % of the total area of the delta. The long-term Danube discharge is 203-210 km^3/year, which provides 36 % of the influx of freshwater to the Black Sea and about 77 % of the freshwater runoff in its northwestern part. The Danube Delta has a salinity of 2 - 6 ‰ and up to 17 ‰ in some areas (Berlinsky, 2010).
The determination of the range of response of planktonic organisms to salinity in transit waters is particularly important. This, in turn, affects the indicators such as biomass, number, percentage of prevailing species (Noctiluca and Copepoda) and their qualitative composition (Stefanova, 2016).
The aim of the work is to identify the ecological quality class of transitional waters on the basis of the integral indicator of zooplankton, on example of marine zone infrant of Ukrainian part of the Danube Delta.
Research results: due to long-term monitoring the obtained data of hydrological and biological indicators were analyzed.
The following indicators were chosen to determine the quality of transitional waters (EQR - ecological quality ratio): total biomass of zooplankton, percentage of Noctiluca and Copepoda from total biomass and Shannon index according abundance of organisms.
The observation performed in 1967-1972 was taken as reference conditions before eutrophication. In the period between 1980-1993 the worst conditions for the existence of zooplankton were noted (Guide on the organization and conduct of biological monitoring at fixed sites, 2016).
The results of the monitoring of the Danube waters for 2004-2017 were analyzed determining the quality of water by average monthly values which included the data from 12 to 26 stations. The integral indicator was determined which identifies the ecological quality class in accordance with the methodology of the MSFD.
The Requirements of MSFD are the conclusions of the results of unified five – point grade that gives the characteristic of ecological state of water objects (High, Good, Moderate, Poor, Bad).
Good quality was in November 2004 and in autumn of 2005. Between 2006 and summer 2007, quality deteriorated. In those years there was the worst quality (ecological class – Bad). From 2008 to 2013, quality indicators grew to a Moderate. In September 2015, quality again became Good. Subsequently (autumn 2015 - summer 2016) it was observed a Moderate quality (November 2016). In addition, since 2017 the quality of the water environment improved which was reflected in the indicators of good water quality.
In conclusion, in the period from 2004 to 2017 the ecological class of the Danube Delta quality has varied from Moderate to Good.

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RARE ERPOBDELLIDS SPECIES (ERPOBDELLIDAE) OF BLACK SEA LOWLAND: BIOGEOGRAPHY AND EVOLUTIONARY HISTORY

Black Sea Lowland is an area of distribution of a number of species whose ranges extend much southerly, which is also quite applicable to erpobdellid leeches. *Trocheta danastrica* Stschegolew 1938 and *Dina stschegolewi* (Lukin, Epshtein, 1960) are rare species described from southern Ukraine. Records for the occurrence of these species in Black Sea Lowland are very limited.
Dina stschegolewi was described under the name *Erpobdella stschegolewi* from the southern part of the Crimean Peninsula (Lukin, Epshtein, 1960). This species was recorded in the Romanian part of the Danube Delta (Cristea, 1975) and western Georgia (Lukin, 1976; Kvavadze, 2002). Later, *D. stschegolewi* was found in Iran (Darabi-Darestani et al., 2016) and Azerbaijan (Khomenko et al., 2018). Previous records in Ukraine were made for Crimea (Prokopov, Utevsky, 2005). We recorded *D. stschegolewi* in two localities of the Dniester Delta. A phylogenetic analysis based on *cox1* sequences suggests close phylogenetic relationships between Crimean populations of *D. stschegolewi* and a population in the Dniester Delta. Moreover, we expect that *D. stschegolewi* may also occur in the Dnieper Delta. We hypothesize that *D. stschegolewi* is a species originated from the Caucasus that has expanded its range from Crimea to the Danube Delta
Trocheta danastrica was recorded for the first time by Prendel (1916) from the Dniester Delta under the name *Trocheta subviridis* Dutrochet, 1817. Stschegolew (1938) described this leech as *Trocheta subviridis* forma *danastrica* Stschegolew 1938. Later, the taxonomic rank of this form was raised to the species level (Epshtein, Zalivadny, 1995). The range of this species includes Southern Ukraine (Stschegolew, 1938), Romania, Hungary, Northern Greece, Anatolia (Nesemann, Neubert, 1999), Eastern Austria (Košel, 2004) and Serbia (Grosser, Epshtein, 2009). According to Stschegolew (1949), the range of *T. danastrica* includes Crimea and the South Caucasus. The occurrence of this species in Romania, Crimea, the Southern Caucasus, Anatolia and Greece was challenged by Grosser & Epshtein (2009). We recorded this species for the first time in some localities of the Danube and Dnieper Deltas, which was confirmed using DNA barcoding. Furthermore, we disproved the occurrence of *T. danastrica* in the Crimean Peninsula, the South Caucasus and Eastern Anatolia. Information on the geographical distribution of this species suggests its Pannonian origin.

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LITTORAL PHYTOECOTONE IN THE SEA OF AZOV COASTAL ZONE

While developing the classification of littoral phytoecotone of the Sea of Azov coastal zone we grounded on the basic notions of the theory of ecotones and understood the seaside as an ecotone. Based on the ecological factors (salinity and acidity of the substrate, depth of groundwater deposits and flooding of the banks, mechanical composition of the substrate, anthropogenic factors) that influence the development of vegetation within the coastal ecotone, for the Sea of Azov coastal zone we have developed a phytoecological classification of littoral ecotopes, which includes 8 types, 2 classes and 18 groups. Taking into account the known works on the classification of coastal ecotones, we have identified 5 blocks of the ecotone of the Sea of Azov coast, for each of them a modern state of phytodiversity at the species and coenotic levels is established.
Using the typology of the Sea of Azov coasts, we developed a topological differentiation of the coast vegetation, identified the corresponding ranks of phytocoenomers. Applying the relevant data at the coenopopulational, phytocoenotic and phytocoenokhoric levels, 4 groups of coast types were described (plain, mountain, accumulative, anthropogenic), which include 9 complexes (upper, middle and lower parts of slope and beach on abrasive coasts; beach, dunes and floodplains on the accumulative coasts; a complex of anthropogenic and floodplain-estuarine coasts), 6 series (a series of abrasive, mountain-abrasive, accumulative, delta-marine, dynamically neutral and anthropogenic coasts) 6 rows (xerophytic-glycophytic and submezophytic-halophytic rows of abrasive coasts, xerophytic- halophytic row of mountain-abrasive coasts, xerophytic- halophytic drained row of accumulative coasts, umbrophytic-glycophytic row of delta-marine coasts and xerophytic-halophytic row of anthropogenic coasts), 7 mezocombinations.
It has been established that modern α-phytodiversity obtained the greatest importance in preplain (1051 species, 54.6%), transit (430 species, 22.4%) and fluctuation (296 species, 15.4%) blocks. The first block combines stable, highest areas of the abrasive and partly accumulative coasts. Transit block represents a mobile-active area of abrasive coast type (altitude 2-15 m, width 20-500 m), which is characterized by loessic landslide types of coasts, with insignificant salinization and slight impact of the sea. Fluctuation block is the territory of seasonal flooding, located above the water level (altitude 0-2 m, width – 10-3000 m), which is characterized by soils of automorphous, semihydromorphous and hydromorphous regimes with a content of readily soluble salts. The least diversity is naturally characteristic of amphibious (91 species, 4.7%) and aquatic (56 species, 2.9%) blocks of phytoecotone.

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ACCUMULATION OF HEAVY METALS IN INVERTEBRATES OF CONTACT ZONES OF BLACK SEA AND PROSPECT OF THEIR USE AS BIOMONITORS OF CHEMICAL POLLUTION

Contour communities form the external biological structure of the oceans and, accordingly, are influenced by environmental factors to a much greater degree than the communities inhabiting the water column. Therefore, they can be used as biological indicators for integrated global monitoring of the marine environment (Zaitsev, 1986).
Directive 2013/39/EU provides the priority definition of water quality standards for the analytical accumulation of pollutants in biota tissues. Directive 2013/39/EU states that "some highly hydrophobic substances are accumulated in biota and are difficult to be detected in water even when using the most modern analytical methods." Separate pollutants may be present in the aquatic environment, but cannot be detected by analyzing water and sediment samples. Thus, the ability of some aquatic invertebrates to selectively accumulate pollutants allows direct measurements of water pollution.
The analysis of the total content of heavy metals in organisms and medium components was carried out by the atomic absorption method.
For the coastal silty peloconture, it was rated the possibility of bivalve *Barnea candida* (Linnaeus, 1758) bioaccumulation, which is used as environmental sentinels of the Black Sea (Alexandrov, Zaitsev, 2016).
The content of mercury in the soft tissues of *B. candida* was 127 times higher than the content in water, and copper 123 times. Comparison of mollusk accumulation of *Ni* and *Cr* ions with background indicators in sea water showed their exceedances by 80.0 and 115.1 times, respectively.
To study the contact zones of the coast-sea sandy beaches, an analysis of the metal content in the body of *Talorchestia deshayesii* (Audouin, 1826) was conducted, which also a perspective bioindicator in the estimation of marine environmental quality of the Black Sea coastal ecosystems (Сон, Кошелев, 2013).
A comparison was made of the content of heavy metals in *T. deshayesii* tissues collected on the Shabolat estuary spit (not polluted area) with Small Adzhalyk estuary (Yuzhny port area) showed that the copper content was 1.2 times greater, and cadmium was 1.3 times, nickel 2.2 times, zinc 1.4 times. In accordance with the results obtained, sandy *T. deshayesii* are able to act as biomonitors of pollution of the coast-sea contact zone, first of all its wetted part, in which the analytical measurement of heavy metals is methodologically complicated.
For the sandy beaches, *Pontogammarus maeoticus* (Sowinsky, 1894) and *Donacilla cornea* (Poli, 1791) can be considered the most promising for use as biomonitors of chemical pollution. It is these species that live in the zone of maximum concentration of substances in the coastal-sea contact zone (Zaitsev, 2012).
Bioaccumulation of heavy metals by contourbionts correlates with seawater pollution, which allows for comparative studies in different regions and determines the level of pollution of the contact zones of the sea but also traces the biological consequences of anthropogenic influence.

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DISPLAY OF THE CONTACT ZONE EDGE EFFECTS IN THE DANUBE DELTA

The demonstrations of the edge effect such as the tendency of increasing the diversity and density of organisms on the borders of two neighboring biocenoses or biotic groups and in the transition zones between them are not obligatory, that is why there are questions about its magnitude, compliance with the levels of biological systems organization, environmental factors, etc. It is known that distinct displays can be observed in contact areas of contrast biotopes. Due to their variety in the Danube Delta, we have carried out studies on the structural characteristics of hydrobiocenoses and biotic groups of different types of contact zones: joint of the freshwater branch with the brackish bay, the canal with the freshwater lake, or between two fresh lakes, or between the branch and the freshwater lake. Demonstrations of the edge effect were evaluated with the interaction of biotic groups (zooplankton, macrozoobenthos, phytophilous macrofauna) of different water objects (water bodies, watercourses) and biotopes (open waters and weed bed).

According to our results the edge effect does not appear in all of the cases. It should be noted that the emerging effects are not caused only by one, but by a number of factors of different nature and display in the interaction zone of hydrobiocenoses, therefore the results are not single-valued. Demonstration of the edge effect in hydrobiocenoses depends on the cumulative changes of the characteristics of particular communities but divergent biotic groups can react differently in the transition from the conditions of one water object to another, therefore it does not always occur.

Zooplankton predominantly demonstrates the logical changes in the ecological structure with the transition from the lotic to lentic conditions, but at the same time can maintain the same structural parameters, probably due to the "inertia" of the surrounding water mass within which it flows. The phytophilous fauna of the transition zone of the lotic-lentic system preserves the ecological structure due to the environment-forming properties of plants. Decreasing of taxa groups and the predominance of species indifferent to the flow is noticed in the macrozoobenthos structure along the line from the branch to the bay, but there are sometimes observed not always logical findings of the reophylic hydrobionts in the lotic systems; in general, strong demonstration of the edge effect is not registered. The edge effect in the contact zone of the lotic and lentic systems is more clearly displayed in the open waters, whereas in the water thickets increasing of the species richness of the biotic complexes occurs in places of optimal vegetation development, where the display of its environment-forming properties is maximal.

The structure of macrozoobenthos is characterized by the largest number of ecological groups (that is the expected edge effect) in the contact zone of fresh and brackish waters, along with this there is recorded the minimal biomass of benthic and planktonic invertebrates.

In general, a sharp decrease ("droop") of structural characteristics is possible for macrozoobenthos of transition zones, while the structure of zooplankton that constantly arrives in the contact area of neighboring hydrobiocenoses, and phytophilic complexes that live in the microenvironment among plants does not change substantially.

The missing of the expected demonstration of the edge effect in the interaction of particular hydrobiocenoses and groupings of their constituents does not contradict with the existence of classical "river-sea" delta ecotone, which is a natural phenomenon of higher order and much larger than the various contact zones that make it up, and the resulting effects within the ecotone are a component of his general manifestation.

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FEATURES OF USING STATISTICAL METHODS IN BLACK SEA SANDY COAST MACROINVERTEBRATES INVESTIGATIONS

Sandy beaches are narrow bands of accumulated sand on the border of land and sea. The feature of this complex of marginal habitats is that the most of the environmental gradients in small scales acts across the shoreline.

Because of the Black Sea have a little tidal range, its littoral communities occupy a specific pseudolittoral zone. Non-periodic wind tides can significantly influence on the width of the shores and change the position and even abundance of zones.

In account to specific conditions, sampling design for the Black Sea sandy coast macroinvertebrates is a result of a compromise between statistical needs and field study limitations and differs from common (Schlacher, et al., 2008).

The shape of the sampling device slightly affects the catch of macrofauna. It is permissible to make both square and round section. Circular cores are more useful, because of their ability to rotate, which simplifies its immersion into substrate. With an equal area of sampling stations, results remain comparable.

It is acceptable to use both transects and randomized stratified sampling (Schlacher al., 2008). Shore-normal transects must be divided on the same levels jointed with areas with different conditions; all samples from one level should be considered as one sample unit for statistical computations. Set of 1-5 transects is considered as sampling station. Different levels are spatially autocorrelated, so sampling station displays the state of whole beach related to the point of shoreline. Transect method is more simple to use, allowing to investigate more beach length at the same time, but are less comparable for beaches with different number of levels and loose a lot of spatial data. Randomized stratified sampling allows the use more statistical methods, especially for estimating spatiotemporal distribution of species.

The density of supralittoral species often significantly and non-periodically changes. Computation of quantity per length of coastlines allows abstracting from random errors caused by fluctuations of beach width.

Indices of aggregation, based on relationship between variance and mean are simple, but lack the spatial information makes it less suitable for estimation of coastal habitats. It is recommended to use more statistically powerful methods, like spatial autocorrelation coefficients (e.g. Moran`s I, Geary's C, Getis), JCA (for binary data), SADIE, and other, that use function of spatial lags to estimate intensity and range of aggregation (Fortin et al., 2002). Different methods of spatial interpolation are useful for predicting the values in unmeasured points. Relationship between spatial patterns of species from same location can be compared with Mantel test, which is useful for community investigation.

The biological diversity of macroinvertebrates of the Black Sea sandy beaches is relatively low, so unspecific fauna can significantly affect the value of some indices. For comparability of samples, it is necessary to exclude occasionally founded species. Influence of environmental factors on macroinvertebrates and their communities can be measured using logistical and multiple linear regression.

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INFLUENCE OF THE CONNECTION BETWEEN THE BLACK SEA AND KUYALNITSKY LIMAN ON THE EXAMPLE OF ZOOPLANKTON

From winter 2016 the Kuyalnitsky Estuary was connected with the sea with an artificial canal. This pipe took water at a depth of 3 meters in the sea, and has a length of 2 km. In 2017, a comparison was made between quantitative and qualitative indicators of zooplankton in the sea and at the outlet of the canal. The maximum abundance of zooplankton in the sea was 86740 ind·m^{-3} (February), and biomass was 276.376 mg.·m^{-3} (February). The minimum values of the abundance at sea were 20 ind.·m^{-3} (December), and biomass 0.700 mg.·m^{-3} (January). At the outlet of the channel, the maximum value of abundance was 1010 ind.·m^{-3} (February.), and biomass 5.634 mg · m^{-3} (March). The minimum values at the outlet of the channel were 10 ind.·m^{-3} (January), and biomass 0.141 mg · m^{-3} (December). The average values of the abundance amounted to 18372 ind.·m^{-3} at sea and 398 ind.·m^{-3} at the exit from the canal. The average biomass was 60 mg.·m^{-3} in the sea and 2 mg.·m^{-3} at the outlet from the canal. The percentage of losses also fluctuated and ranged from 41% (April) to 99% (February) by abundance, and from 27% (March) to 99% (February and December) by biomass. It should be noted that the quantitative indicators of zooplankton are affected not by the season but the average monthly temperature.

The species composition in the winter period included 11 taxa of zooplankton. Of these, *Acartia clauses + tonsa* were the most frequent (recorded every time), whereas eutrophic indicator *Noctiluca scintillans* was rarely found – only at the sea in March. Also, once a representative of the meroplankton (larvae of bivalve and *Rissoa splendida)* founded in April and the *Keratella* sp. in February. It should be noted that February and March were two months when the rotifers had a great deal of development and diversity (three families were registered). The maximum losses through the pipe were observed among *N. scintillans* (did not pass at all through the pipe) and the rotifers (losses in abundance and biomass ranged from 88.5% to 99.9%). Minimal losses in the pipe were observed for *Acartia clauses + tonsa* from 83% to 0%. Thus, when passing a connecting pipe zooplankton reduces its number, but the degree of reduction depends on the taxon and its survival in difficult conditions. The tiniest and softest representatives of zooplankton do not pass through the channel.

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PHYTOSURFACE AS A TOOL FOR ASSESSING, PREDICTING AND MANAGING MARGINAL ECOSYSTEMS

Yu. P. Zaitsev's ecological contours theory of marine ecosystems points to the fundamental differences in the life strategy in the "rarefied" space of open marine ecosystems and the "concentration" of life in the coastal biotopes of the sea (Zaitsev 1970, 1980, 2015). One of the most important ecological contours is the phytocontour of coastal vegetation, the main function of which is the production of organic matter and its transformation in areas of life concentration. The complex of morphofunctional indicators of the active surface of various life of coastal autotrophs forms (Minicheva 1998, Zotov 2003, Kalashnik, 2014) allowed to expand our understanding of the role of phytosurface as the basic ecological contour of marginal ecosystems (Minicheva et. all, 2011).

The principal advantage of morphofunctional parameters is the possibility of obtaining information about the functioning intensity of the phytocontour based on the morphological portrait of vegetation. The expression of ecological activity for any population of the phytocontour with the help of the specific surface index (S/W_p) allowed to operate with species as discrete units contributing to the total autotrophic process of the coastal zone. The transition from *r*-and *k*-strategy species to sensitive and tolerant algal species of the Black Sea ecosystem with certain S/W_p coefficients allowed to propose new morphofunctional indicators to determine the boundaries of 5 categories of Ecological Status Classes (ESC) of marine coastal ecosystems in accordance with the requirements of the EU Marine Strategy (Minicheva, 2013). Thus, under the Black Sea countries' monitoring, the morphofunctional indicators open the opportunity to assess not only the status of the phytocontour, but also the ESC of the marginal ecosystems.

Ranked on value (S/W_p), the series of autotrophic organisms for any marginal ecosystem are the basis for quantity prognoses and management of phytocommunity in conditions of changing the level of the production process related with natural or anthropogenic eu- or deutrophication. These series of organisms are opened by the sensitive macrophytes, which in the Black Sea ecosystem are represented by perennial brown and red algae, as well as flowering macrophytes, whose S/W_p is lower than 25 $m^2.kg^{-1}$ and closed by the filamentous green and colonial blue green algae S/W_p of which can be more than 1000 $m^2.kg^{-1}$. The model linking the intensity of the autotrophic phytocontour process with the ecological activity of its elements allows, on a quantitative basis, to predict the species that will disappear or have the advantage of grows in marginal ecosystems under the production process speed changes. The dependences of the phytocontour morphofunctional parameters with the concentration and exposure of the lithocontour surface open the possibility of engineering calculations of needed surface of artificial substrate (hydrotechnical constructions, biopositive reefs, recreational complexes) with the help of which it is possible to manage the autotrophic process in marginal ecosystems.

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COMPARATIVE ICHTHYOPARASITOLOGICAL MONITORING OF THE DNIESTER RIVER BIOTOPES FROM THE UPSTREAM AND DOWNSTREAM OF THE DUBASARI HYDROPOWER PLANT: SOME METHODOLOGICAL ASPECTS

The goal of current work was to identify ichthyoparasitological indicators of hydropower plants (HPP) as a part of other impacts of dams on river biota. Many issues related to this field of study, still remain unsolved and require further investigation. In this report, an attempt has been made to consider methodological aspects in a comparative study of parasite communities structure which occur in fishes of the Dubasari HPP Reservoir and its downsteam.

Important considerations when choosing the use of methods for the work were: field applicability, their simplicity, easy sampling and material preparation for analysis, relatively simple measurable indicators, the ability to carry out their mass determination for a sufficient number of fish individuals, no of special requirements for personnel qualifications, simple equipment need, relative efficiency and accuracy, reproducibility, low cost and time consuming. The work was carried out in following directions: reconnoiter of research, collection and processing of material and argumentation of the proposals for ichthyoparasitological monitoring:

- The choice of the ecological composition and size/age groups of fish that are available for fishing [bleak *Alburnus alburnus*, roach *Rutilus rutilus*, perch *Perca fluviatilis* and gobies - *Neogobius fluviatilis*, *N.melanostomus*, *Babka gymnotrachelus*, *Ponticola kessleri*; 0^{+}-3^{+}years];
- Selection of stationary and heterogeneous hydrobiotopes of concentration of the desired fish species in the upstream and downstream of Dubasari HPP [in the Dubasari Reservoir - section between Oxentea and Molovata villages; in the lower reach of the Dniester River - section between the towns of Criuleni and Vadul-lui-Voda];
- The organization of synchronous work/collaboration with other specialists [hydrologists, hydrochemists, hydrobiologists and ichthyologists];
- Selection of the effective fishing gear [dragnet, trap, fish-rod, gill net, electrofishing] and determination of the fish sample size for research [in the first year - 15 fish specimens of each species from each biotope are studied, later on, 5-7 specimens];
- The frequency of fish surveys [annually, once in each season from each station, based on the water temperature – in February-March, May-June, July-August, October-November];
- Identification of the extensity and intensity of fish invasion [by the species of parasites in each fish-host species, as well as by biotopes from the upstream and downstream of HPP];
- Revealing of the ecological groups of ichthyoparasites for monitoring [by the life cycle, host specificity, localization, prevalence and abundance, pathogenicity];
- The accumulation and statistical processing of the materials, its theoretical explanation;
- Justification of approaches to ichthyoparasitological monitoring;
- The evaluation of HPP impact on fish consumption features.

Presented directions are closely intertwined with each other in time and their selection is largely arbitrary. However, they are all aimed at identifying the impact of environmental factors in the space-time scale and the intensity of their impact on the state of fish parasitocenosis.

The preliminary processing of the collected factual material (2018-19) confirmed the correctness of research methodology chosen. The data on parasites community parameters (species richness, diversity, evenness) and the average infestation rates of the examined fish populations from different biotopes of the reservoir and lower part of the Dniester River are given. Current work was realized in frames of the EU Joint Operational Black Sea Programme 2014-2020, the Project BSB 165 „HydroEcoNex".

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NEW DATA ON THE NEUSTONIC COMMUNITIES FROM THE ROMANIAN BLACK SEA COAST

The paper presents the qualitative and quantitative structure and distribution of zooplankton neustonic communities in the NW Romanian Black Sea coastal and shelf waters. The study brings new data on the Pontellidae copepods and temporary zooplankton communities inhabiting the hyponeustonic seawater layer. The sampling was carried out in August 2018, 6 samples being collected using a horizontal net with 200 µm mesh size and the opening area of 0.028 m^2 towed by ship at 1.5 knots speed for 4 - 5 minutes at water surface. The results showed the presence of a rich zooplankton community formed of thermophilous cladocerans, copepods, meroplankton representatives of crabs, shrimps, barnacles, bryozoa, bivalves and gastreropoda, misids and ichthyoplankton ova and larvae. Among the three Black Sea pontelids species, only *Pontella mediterranea* (Claus, 1863) has been found in the period analysed, with abundances varying between 56 – 180 ind./sample. The Pontellidae species have undergone a drastic reduction of their abundances in the 70s and 80s periods on the Romanian shelf due to pollution and eutrophication as confirmed by numerous researchers. Lately, the presence of *Anomalocera patersoni* Templeton, 1837 and *P. mediterranea* has been sporadically reported in the water column samples. No up to date information exists for the *Labidocera brunescens* (Czerniavsky, 1868) species at the Romanian littoral. In the present, the ecological status of Pontellidae is poorly known, the studies on the hyponeustonic layer, which represents a singular/marginal and particular habitat of the pelagic ecosystem, being very scarce at the Romanian littoral.

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MESOZOOPLANKTON OF COASTAL WATERS OF ODESSA REGION IN SEMI-CLOSED AND OPEN WATER AREAS DURING 2017-2018

Mezozooplankton is an important part of biocoenoses. It is an important link in the food chains. The organisms of mesozooplankton are sensitive to the ecological quality of water bodies. The state of mezozooplankton community may reveal ecological status of water body. The important factor that influences on mezozooplankton communities in the Gulf of Odessa are semi-closed water areas with breakwaters which were built in the middle of the last century. Researches of the region during the past years (Koval et.al., 1976) have shown the influence of semi-closed water bodies on the qualitative and quantitative composition of mesozooplankton. The purpose of the study is analysis and comparison of mezozooplankton composition in open and semi-closed water areas in the Gulf of Odessa nowadays.

Observations were conducted year-round on two sampling sites located at semi-closed water area "Small Fontan" and open water area "Arcadia". The samples were collected by vertical Apstein net (diameter of 36 cm - 0.1 m^2 mouth opening area, and mesh aperture of 150μm) and analyzed by microscope MBS-9 according to standard methods. A total of 106 samples were collected during the 2017-2018.

Total numbers of taxa on two sites were not significantly different: 43 taxa were identified in the open water area "Arcadia" and 48 taxa in semi-closed water area "Small Fontan". Probably, the differences were due to bentho-pelagic species, which were more diverse in semi-closed water area. Shannon-Weawer diversity index in "Arcadia" was 1.151±0.709 ind*bit^{-1} in 2017 and 1.431±0.519 ind·bit^{-1} in 2018. In "Small Fontan", it was 1.164±0.581 ind*bit^{-1} in 2017 and 1.280±0.664 ind*bit^{-1} in 2018. Total biomass of mezozooplankton in "Arcadia" was 407.033±2128.901 mg*m^{-3} in 2017 and 44.479±61.217 mg*m^{-3} in 2018. In "Small Fontan", it was 146.057±529.475 mg*m^{-3} in 2017 and 24.254±58.167 mg*m^{-3} in 2018. The high level of mezozooplankton biomass at both stations in 2017 was due to the bloom of heterotrophic dinoflagellate *Noctilluca scintillans*, which indicated increased eutrophication level in this water area in 2017 year. Regarding the proportion of meroplankton in total biomass, both sites were demonstrated about the same levels: 18,3% and 17,7% of total.

Water quality on sample sites was assessed in accordance with the WFD and recommendations of EMBLAS-project on quantitative indexes of mezozooplankton: total biomass, Shannon-Weawer index and *N.scintillans* development level. According to the total biomass, the water quality in "Arcadia" was "Bad" (2017) and "Poor" (2018), in "Small Fontan", the water quality throughout the study period was "Poor". According to *N.scintillans* development level, the water quality in "Arcadia" was "Good" (2017) and "High" (2018); in "Small Fontan", it was "High". According to the index of diversity, the water quality on both sites was "Poor". So, water quality on both sites during the whole study period may be assessed as "Poor".

In general, the differences between semi-closed and open water areas are not high. State of mezozooplankton groups on both sites is depressed. This may indicate the presence of the factors not related to flowage which effect mezozooplankton, but for further clarification of them, the studies should be continued.

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HETEROTROPHIC FLAGELLATES (PROTISTA) OF SANDY COASTLINE AND SUBLITTORAL UNDER THE DNIEPER-BUG ESTUARY INFLUENCE

The marginal zones where marine, terrestrial and freshwater communities of organisms come into contact are characterized by a «contour effect»; i.e. high numbers of living organisms. Sandy beaches are an example of the concentration of organisms and detritus. Heterotrophic flagellates play a key role in the processes of destruction and transformation of organic matter in the marine environment and remain the least studied component of aquatic ecosystems. The Black Sea flagellates research began relatively recently (Tikhonenkov, 2006; Nikonova, 2012; Snigireva et al., 2014; Prokina et al., 2017).

The active protists community composition, abundance, biomass and size structure were evaluated and compared between two biotopes and three locations. Samples of sea sediment were collected in April, June, September and November 2017 at the Cape Adzhiyask (I) (the greatest influence of river masses of the Dnieper and Southern Bug rivers), on the seashore of the Grigorievsky Estuary (II) and at the Cape Small Fountain (III) (maximum distance from the mouth of the rivers) on the water's edge and on the sublittoral (depth of 3 m).

A total of 61 protist species belonging to four eukaryotic supertypes were obtained (Excavata – 23, SAR – 20, Eukaryota incertae sedis – 2, Amoebozoa – 1, and 15 species of uncertain systematic position). The greatest number of species belonged to Euglenida (22), Dinophyceae (7) and Thecofilosea (5 species). The communities of the coastline flagellates (22 species) and sublittoral flagellates (45 species) were distinguished by high specificity, only 6 species (9.7%) were common for two biotopes (*Bodo globosus, Clautriavia cavus, Colpodella perforans, Oikomonas sp., Petalomonas micra* and *Petalomonas pusilla*) and 2 species were found in one biotope in different location (*Anisonema acinus* and *Spumella socialis*), other species have single record. The active protist community composition included 21 species in the I location, 23 species in the II and 31 species in the III location.

The abundance of flagellates on coastline ranged in the I location from 47 to 156 ind.·cm^{-3}, in the II – from 15 to 425 ind.·cm^{-3}, in the III location – from 23 to 630 ind.·cm^{-3}, in the sublittoral zone, respectively, from 254 to 472; from 33 to 1063 and from 77 to 500 ind.·cm^{-3}.

In coastline, especially in the zone of river runoff influence, a simplified dimensional structure of flagellates was revealed. Small-celled species prevailed in the I and II locations, their linear dimensions not exceeding 5 – 10 microns. In the supralittoral zone the dimensional structure of flagellates differed greatly. Species with linear dimensions of 10–20 μm and more were present, and their number was the largest in the III location. In the sublittoral zone the biomas was almost 4 times higher than on the water's edge (respectively $(67.6\pm33.4)\cdot10^{-6}$ mg·cm^{-3} and $(262.8\pm93.3)\cdot10^{-6}$ mg·cm^{-3}).

Thus, river discharge exerts an important influence on the species composition, abundance, biomass and size structure of the benthic heterotrophic flagellates on coastal ecosystems.

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ODESSA COASTAL ZONE MICROPHYTOBENTHOS OF HARD GROUNDS AS MARGINAL COMMUNITY OF THE BLACK SEA

Marine substrates are contour biotopes inhabited by organisms of fouling, which undergo intensive natural and anthropogenic influences and are important objects of monitoring.
The purpose of the work – assessment of the quality of marine environment in the Odessa coastal zone and adjacent water areas on the bioindication method using systematic, quantitative, halobiont and saprobiological indexes of microphytobenthos development. Microalgae from the hard substrates of sea areas, different on the level and character of anthropogenic pressure, were studied.
During 2018 the microphytobenthos species composition of the water areas was formed mainly by diatoms (predominantly, species of genus *Nitzschia* and *Navicula*). The species number of dinophytes has doubled throughout the year, and of diatoms increased in 1,4 times.
Regarding the water salinity, meso- and polyhalobes prevailed among the microphytes. The species number of polyhalobes during the year increased in 1,7, mesohalobes – in 1,3, and indifferentes – in 1,4 times. Halophyles and indifferentes were characteristic for desalinated water areas, particularly near the Zatoka.
The total quantity of saprobiont in autumn increased in 1,4 times, mainly due to α- and β-mesosaprobes (in 1,7 and 1,4 times, respectively). Among the β-mesosaprobes dinophyta *Prorocentrum micans* Ehrenberg was dominated. During 2018, the number of α-mesosaprobes increased, particularly, in the anthropogenized sea areas – in the Grigoryevsky Estuary, the coasts of the Zatoka and Luzanivka. The most abundant were cyanoprokaryota *Phormidium limosum* (Dillwyn) P.C.Silva and diatom *Melosira moniliformis* (O.F.Müller) C.Agardh. Potentially toxic microphytes *Prorocentrum micans*, *P. cordatum* (Ost.) Dodge and *Dolichospermum flos-aquae* (Brébisson ex Bornet & Flahault) P.Wacklin, L.Hoffmann & J.Komárek developed intensively.
Compared to 2009-2017 the number of species has decreased: chrysophytes – up to 4 times in summer and up to 5 times in autumn; green – up to 5 – in summer and up to 13 in autumn.
The total abundance of microphytobenthos in the coastal zones from Dacha Kovalevskogo to «Dolphin» beach in summer 2018 was 2 323.52-7 711.56 · 10^6 cells·m^{-2}, and in autumn – 2 26.60-7 964.84 · 10^6 cells·m^{-2}. In the area of Luzanivka it decreased throughout the year from 2 631.77 to 1 375.03 · 10^6 cells·m^{-2}, in the Grigoryevsky Estuary – from 3 375.01 to 2 330.33 · 10^6 cells·m^{-2}, while near Koblevo, increased from 1 304,29 to 4 721,46 · 10^6 cells·m^{-2}. The most abundant were cyanoprokaryotes *Gloeocapsopsis crepidium* (Thuret) Geitler ex Komárek, *Leptolyngbya fragilis* (Gomont) Anagnostidis & Komárek, diatoms *M. moniliformis*, *Achnanthes brevipes* C.Agardh and *Tabularia fasciculata* (C.Agardh) D.M.Williams & Round. In the autumn seasons in 2009-2018 the abundance of microphytobenthos ranged from 830,89 to 41 726,02 · 10^6 cells·m^{-2}.
During 2018 in the total biomass of microalgae large-cellular diatoms of genus *Achnanthes*, *Melosira*, *Gyrosigma*, *Pleurosigma*, etc. dominated. In summer, in the water body from Dacha Kovalevskogo to «Dolphin» beach, it was 133.72-1 478.37 mg·m^{-2}, and in the autumn – 285.41-65 172.98 mg·m^{-2}. It grew at 2,1 times in the coast of Luzanivka, and in the Grigoryevsky Estuary – 1,3 times. Over the past 10 years biomass of the benthic microphytes varied from 46.43 to 65 172.98 mg·m^{-2}.

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MONITORING OF INFECTIOUS DISEASES IN THE BLACK SEA MARINE FISH SPECIES

Aquaculture and fishery production in Europe is responsible for the employment of 100,000 people, generating an annual turnover of 7 billion EUR. However, the outbreaks of disease in farmed and wild fish species can cost the sector up to 20 % of its production value. Viral diseases are playing one of the roles as a limiting factor in fish production and causing heavy mortalities in both hatchery and wild populations thus affecting profit negatively. The best ways to deal with viral diseases are to provide appropriate diagnosis, consequently to analyze the epizootic risks and to prevent infectious outbreaks.

A number of serious infectious diseases in fish are notifiable diseases listed in EU legislation. No efficient treatment or vaccines exist for these diseases and their control is critical. Due to close contact with surrounding water the inter-dependence between wild and farmed fish as well as the epidemiology in fish wild livestock is challenging. The identification and characterization of the viral diseases should be provided due to increasing of recent technologic advances and expertise in the aquatic veterinary field.

The main objective of our research is to establish the surveillance procedures for fish infectius diseases using molecular approaches in line with the EU animal health strategy. The research addresses this problem by developing and implementing promising innovative testing that will be achieved and demonstrated during continues investigations of marine fish samples from both the Black Sea. Our research will bring together researchers on fish biology and pathology who all shared one main interest: the health of fish livestock.

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BARNEA CANDIDA FINDS IN THE NATIONAL NATURE PARK "TUZLIVSKI LYMANY"

The National Nature Park "Tuzlivski Lymany" was created on January 1, 2010. It is located in the riverside of the Danube and the Dniester in the Black Sea Coastal Zone. The park has an area of 27,685 hectares and covers an area of 13 estuaries, their coastal protective bands, the lower reaches of the small Khadzhider and Alkaliya rivers, sand transhumance between the estuaries and the Black Sea, and the 200-meter wide Black Sea strip during a 44 km long crossing. At the same time, the water area of the park and adjoining territory are the Ramsar wetland "Shagany-Alibey-Burnas lake system", the object of the Emerald Network of Europe (UAU0000140), Important Bird Areas (UA086 and UA087).

Among the estuaries there are two great (Alibey, Shagany), three middle ones (Burnas, Karachaus, Khadzhider) and eight small ones (Dzhantsheysky, Small Sasyk, without name, Magalevsky, Martasa, Budury, Kurudiol, Soloniy) (Popova, 2016).

Currently, inventory of biodiversity of the national park, including shellfish, is carried out. Among the different species, the most original is *Barnea candida* - Wings of an angel. This species refers to bivalves, or Plastinchastozyabruses (Bivalvia L, synonyms: Bivalva, Lamellibranchia, Pelecypoda) and belongs to shellfish-drills; it can burrow deeply into substrates such as lime, clay or wood.

For the first time in Ukraine, this species was found in the Ukrainian part of the Danube Delta in 1949. In recent years *B. candida* has been registered in 2013 in the marine part of the Ukrainian Danube Biosphere Reserve (Alexandrov, 2017). According to the author's opinion (Alexandrov, 2017), the discovery of *B. candida* here over 60 years after its first registration is likely to indicate a decrease in eutrophication and the gradual restoration of biodiversity of local aquatic ecosystems.

The closest to the Danube Delta is the place where live mollusks and their shells are regularly encountered, the eastern border of the National Natural Park "Tuzlivski lymany" near the village of Lebedivka (personal message from M. Son from the Institute of Marine Biology of the National Academy of Sciences of Ukraine). It is about 100 km along the coast from the Danube Delta. B. Aleksandrov also leads *B. candida* to the eastern part of the NPP "Tuzlivski lymany". Any information about finding this mollusk in other places of the water area of the NPP "Tuzlivski lymany" is absent.

In order to identify the rare species within the NNP "Tuzlivski lymany", the scientists of the Park in 2017 and 2018 conducted surveys of some parts of the Black Sea coast and the shallow waters of the Budury, Shagany, Kurudiol, Alibey, Burnas estuaries at depths of 10 cm to 0.5 m.

Mollusks shells found on sandy marshes of secondary estuaries Magalevsky, Budury, braid near the cape Kamchatka horn on the boundary between the Shagany and Alibey estuaries, the shores of the Shagany Estuary near the estuary of Small Sasyk, on the Cape of Calf between the estuaries of Alibey and Kurudiol. The cluster of dead specimens *B. candida* in clay found in the Shagany Estuary near the Magalevsky Estuary. The settlement of live mollusks is found in the Black Sea under the Lebedivsky Forest within 1 km of the eastern border of the Park. Clams are recorded in clay deposits at a distance of 50 m from the coastline. In total, 5 settlements of the specified species, total area of 300 m^2 were found. The density of the settlement was on average 25 shells of mollusks per 1 m^2.

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MORPHOLOGICAL ANALYSIS OF BLOOD CELLS OF CERTAIN SPECIES OF GOBY FISH FROM THE GULF OF ODESSA

The morpho-physiological analysis of blood and its physical and chemical properties provides an opportunity to accurately and objectively estimate the state of the organism of fishes (Zhitieneva, Makarov et al., 2004). Reflecting the various changes in the vital activity of the organism, the composition of the blood makes it possible to judge the characteristic properties of the metabolism at different stages of development and under different conditions of existence of the organism.
The aim of the work was to determine the morphological parameters of blood of certain species goby fish from the Gulf of Odessa.
Materials for research were males and females of the round goby *Neogobius melanostomus* (Pallas), Pinchuk's goby *Ponticola cephalargoides* (Pinchuk), ratan goby *Ponticola ratan* (Nordmann), ginger goby *Ponticola eurycephalus* (Kessler) and toat goby *Mesogobius batrachocephalus* (Pallas), caught with netting during 2015-2018 in the Gulf of Odessa. Blood selection, staining and research of smears were carried out according to generally accepted methods (Methodical instructions ..., 2005).
In all blood smears, the presence of both rounded and ellipsoidal (elongated) cells was detected. For representatives of *Gobiidae* it is found that rounded cells are young, while elongated red blood cells are mature. All erythrocytes contained a well-stained core in the center of the cell. A similar feature is characteristic of fish – unlike mammals, mature erythrocytes that are non-nuclear. In all variants of research except for erythrocytes of the usual form, cells with deformations were encountered both in the whole cell and in the nucleus.
An analysis of the linear size of the blood cells of the goby fish found that the average size of the young red blood cells was the largest for the toat goby and Pinchuk's goby (the longitudinal size was 8.9 mcm and 8.25 mcm, respectively). The smallest sizes of young cells were detected for the round goby (7.55 mcm). At the same time, the largest sizes of mature erythrocytes were determined in the case of studies of the ginger goby (11.9 mcm) and the Pinchuk's goby (10.80 mcm). The volume of erythrocytes was also greater in the Pinchuk's goby and the ginger goby.
In general, for all studied species, the prevalence of young erythrocytes (round form) over the mature (ellipsoidal form) was determined. The largest number of young cells was presented for a round goby.
The conducted studies indicated that the frequency of finding erythrocytes with deformed nucleus in the blood of goby of the studied species was higher in spring than in the summer. Among the species presented, the largest incidence rate of erythrocytes with deformed nuclei was typical of the Pinchuk's goby (1.93 % in spring and 1.90 % in summer). The least frequent occurrence of cells with deformed nucleus was determined for the round goby (only 0.06 %). It is known that among the fishes of the Black Sea, the round goby characterized by a special ability to adaptation. Possibly, such high adaptive capabilities of the round goby are due to its physiological characteristics.

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ICHTHYOFAUNA OF ZMIINYI ISLAND COASTAL WATERS IN 2016-2017

The material was collected during complex surveys in the Zmiinyi Island coastal waters in 2016-2017 in the framework of the National Research Project implemented by the ONU with financial support of the Ministry of Education and Science of Ukraine and the international project EMBLAS (phase II).

Fish was caught in accordance with the standard ichthyological methods (Pravdin, 1966; Pryahin, 2008). Underwater observations, description of bottom relief and substrate in the areas of ichthyological material collecting were performed using diving outfit in accordance with the methodologies (Halford, 1994; Mochek, 1978).

In the period from April to December 2016, around 50 fish species were registered in the island coastal waters; during 2 months (May and June 2017) – 37 species. Analysis of the results received in April-December 2016 and May-June 2017 had shown that ichthyofauna biodiversity level (Shannon index calculated coming out of number) in 2016 varied within 0.86-3.06 making in average 2.06 and in 2017 – 2.40-2.54 making in average 2.47. Minimal indicators of biodiversity were registered in the end of autumn and in winter when most of fishes migrated for wintering to deep areas. Maximums of biodiversity index were registered in May-June.

In 2016 (from April to December) the following species prevailed in the catches: anchovy (36.70%), scorpion fish (16.20%), horse mackerel (12.70%), round goby (11.50%) and whiting (9.60%). The share of other species was insignificant and made 0.02 – 2.8%. In 2017 (May-June) round goby (38.76%) and horse mackerel (37.15%) prevailed. Catches of common blenny were relatively high (7.63%). Share of other species was insignificant and made from 0.10 to 2.31%.

Ichthyofauna of Zmiinyi Island coastal waters as before (Snigirov, 2011) is distinguished by its biodiversity and abundance of rare protected species of the Black Sea fish. Different habitat conditions (a variety of bottom substrates and hydrological features of this area) contribute to concentration of a large number of species of fish on a small area in the north-western part of the Black Sea.

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MARINE LITTER AS A NEW COUNTACT BIOTOPE FOR THE BLACK SEA

Since 1950s the World Ocean is being affected by new type of contamination – plastics. Nowadays this substrate becomes an inherent and constant part of the sea. It forms up to 80 % of the marine litter that floats on the surface or submerges in deeper layers of the ocean. The plastic marine litter, or debris, could be considered as a component of *anthropal*, and sometimes because of its huge accumulation, the microparticles of plastics (less than 5 mm) is called *plastisphere* (Amaral-Zettler, 2015). The researches of plastic marine debris by DNA analysis revealed the set of microorganisms (mainly bacteria, but also diatom algae) that is unique for main mid-ocean gyres. It was mentioned the variety of biodiversity in different parts of the ocean (Zettler, 2013).
The community of marine organisms that drift on the surface of marine litter is called *neistoplastics*. Kiessling with co-authors (2015) counted 387 species (including macroorganisms) on floated litter. In the Black Sea on the polyethylene that was caught near the coast we revealed 6 species of Cyanobacteria and 8 species of diatoms (Sapozhnikov et al., 2018). The most abundant diatom species were *Cocconeis* aff. *neothumensis* Krammer and *Mastogloia lanceolata* Thwaites ex W.Smith. The presence of these two genus of diatom algae is usually indicated on plastics (Carson et al., 2013).
When floating on the surface of sea the debris began to degrade under the influence of insolation, high temperatures, wave activities, and macroorganisms. It begins to separate on smaller fragments turning to microplastics with time. Nevertheless, some big particles of plastics may sink and become a part of benthic assemblages (*benthoplastics*) providing the new type of substrate and changing the bottom landscapes. In the North West Black Sea (Gulf of Odessa) on the depth of 2-6 m we found 7 species of macrozoobenthic organisms (*Mitylus galloprovincialis, Mytilaster lineatus, Amphibalanus improvise*s, Gastropoda, Bryozoa, crustaceans, worms), 14 groups of meiobenthic organisms, 6 species of seaweeds, 46 species of microalgae (including cyanobacteria) that dwell on the surface of plastic bags and bottles (Snigirova, Kurakin, 2019). The pull of species that directly colonize plastic substrate was formed by diatoms *Cocconeis scutellum* Ehr., *C. placentula* Ehr., *C.* aff. *neothumensis*, *Amphora ovalis* (Kütz.) Kütz. To compare with, in the Mediterranean Sea (near the Crete coast) on the benthic samples of polyethylene more than 30 species of diatoms and 8 species of seaweeds (including 2 species of cortical red algae that formed the community) were revealed (Sapozhnikov et al., 2019).
In the area of Zmeiniy Island on the depth of 9 m in the water column we sampled the plastic bottle that was attached by the cable on 12 m and fully covered with marine biofouling (up to 4,5 kg per item) representing the cenosis of *Mitylus galloprovincialis.* Other species *Mytilaster lineatus, Amphibalanus improvise*s, *Membranipora tenuis* were massively presented.
Under the zoofouling we identified the threads of *Leptolyngbia*, colonies of *Navicula* sp., *Berkeleya* sp., separate fragments contained scattering of *Cyclotella baltica*, *Cocconeis* aff. *neothumensis.* Other genus of diatoms *Licmophora, Amphora, Halamphora, Nitzschia* were also presented.

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EXPERIMENTAL STUDIES OF PHYTOPERYPHYTON FORMATION ON THE PLASTIC SURFACE

Previous studies on plastic impact on bottom communities (Snigirova, Portyanko, 2018; Snigirova, Kurakin, 2019; Sapozhnikov et al., 2019) revealed complex and diverse biofouling on this substrate. The 7 representatives of macrozoobenthos, 14 groups of meiobenthos and various macrophytes were registered. However, there is lack of knowledge about the processes of this community's formation. How long does it take to colonize the plastics by marine organisms? What species may be first dwellers on it? Therefore, experimental studies are needed to understand the processes of cenoses formation on this type of substrate.

We initiated the experiment in the laboratory conditions, during which we used the plates cut from a transparent 4 cm^2 polyethylene bottle. Our task was to show that plastic with a rusty surface could be overgrown with microalgae more quickly. In this regard, for the experiment, bottles were taken from the natural environment (EP), i.e. during some time they were in the sea, thrown out after spring storms and having a rough surface. On the surface of the collected plastic, there was no visible fouling. The control plates were glass plates (K) and plates of pure, smooth and transparent polyethylene (KP). The experiment lasted 26 days in April-May 2018 in three replications in the laboratory conditions, natural light. We used seawater from the natural environment (Gulf of Odessa). The three types of plates were put out for analysis every 7-10 days. The microalgae were separated from the plates by ultra sound. The periphyton form glass was cleaned with a rigid brush. Further qualitative processing was carried out according to standard methods (Nevrova et al., 2015).

At the experimental plates, after the end of the month, 11 species of microalgae were identified, of which diatoms predominate (8 species): *Achnanthes brevipes, Berkeleya rutilans, Cylindroteca closterium, Melosira nummuloides, Navicula sp. 1, Navicula sp. 2, Plagiotropis lepidoptera, Tabularia fasciculata*. Also, there were 2 species of green algae and 1 species of dinoflagellates. The most abundant species were *T. fasciculata, Monoraphidium arcuatum, M. contortum.*

The biomass on experimental plates (EP) decreased from the 8^{th} day of the experiment (2.8±0.9 $mg \cdot cm^{-2}$) till 28^{th} day of the experiment (1.3±0.5 $mg \cdot cm^{-2}$). On the surface of control glass plates the microalgae biomass was 1.24±1.1 $mg \cdot cm^{-2}$ and on smooth plastics (KP) was 0.55±0.2 $mg \cdot cm^{-2}$ in the end of the experiment.

The highest species diversity was mentioned on EP (rusty surface) and K (glass plates) (8 and 9 species, respectively). Over the 26 days of the experiment, the fouling practically didn`t formed on a smooth plastic (KP). The low development of quantitative indicators on a smooth plastic indicates that to adapt to the existence of plastic microalgae need time no less than a month. Further studies are needed with the formulation of the experiment, lasting above 2 months.

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POSSIBILITY OF OPTICAL REMOTE SENSING WATER QUALITY COASTAL AND MARINE ECOSYSTEMS

Remote methods are based on the ability of spatial objects to emit, scatter and absorb electromagnetic waves with different intensities. The value of environmental indicators based on remote sensing data (Earth remote sensing) is as a function of the amount of reflected or absorbed radiation, which contributes to its remote identification (Svidzinska, 2014). The information content of the remote sensing device is in the form of the values of the raster collars (pixels) of the spectral channels. Each spectral channel corresponds to a separate wavelength range and represents a digital raster image. Interpretation of spectral channels and their combination, such as satellite data, is most often done in the form of spectral indices (Chang, Liu et al., 2016). As remote monitoring equipment for coastal and marine ecosystems, you can use satellite data that is freely available, such as AquaModis, Sentinel1, Sentinel 2, Sentine3 and Landsat8. One of the main advantages of modern geo-information, remote and space technologies in assessing the state of coastal marine ecosystems is the ability to simultaneously cover the entire object under study, conduct regular monitoring and significantly reduce the cost of expensive expeditionary work, which allows to obtain a large array of data of the determined characteristics.

The use of remote sensing and analytical capabilities of GIS allows assessing the status of coastal and marine ecosystems and the quality of water, disturbing the ecological balance in the water bodies of these reservoirs and the level of eutrophication, namely:

- hydrodynamic features and mixing conditions of water masses;
- surface temperature, turbidity (suspension concentration) and water bloom (chlorophyll a concentration);
- trophic level;
- relief and bathymetry of the bottom;
- zones of risk of flooding in the conditions of climate change;
- oil spills and oil films;
- the transformation of coastal biotopes and the influence of artificial factors on aquatic processes.

All results can be spatially analyzed and interpreted based on GIS analysis and modeling, which gives an opportunity to:

- spatial distribution of characteristics calculated on the basis of satellite data, as well as forwarding data – construction of interpolation surfaces based on point data;
- analysis of gradients and heterogeneity of the distribution of indicators using contour lines based on interpolation surfaces, or satellite data;
- localization of anomalies of the distribution of characteristics relative to the average or background values;
- spatial correlation analysis of indicators with the allocation of areas on the surface of the study area with the strongest relationship;
- calibration of remote sensing data based on field and laboratory studies using correlation analysis;
- cartographic representation and registration of research results.

Earth remote sensing data can also be used to define water bodies with subsequent typification in accordance with the requirements of the EU WFD.

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INDICATION OF COASTAL ECOSYSTEM TRANSFORMATION BASED ON INTERTIDAL HABITAT COMPLEXITY (NWBS CASE STUDY)

The study included five stages: intertidal habitat inventory and classification, coastal types classification and mapping, characterization of primary natural habitat diversity of each type of coast, indication of intertidal habitat complexity changes, evaluation and ranking of assessment coastal units.

Studies done in the Ukrainian Northwestern Black Sea (NWBS) have shown a high habitat diversity, including 17 non-codified habitats.

To analyze the connection of habitats with geographical and other natural conditions, we classified of NWBS coasts using such hydromorphological indicators as the type of shore (accumulative or abrasive), the dominant substrate of the coastal zone, openness for waves, and desalination by large rivers freshwater influence. We identified 14 types of marine shores, which do not take into account the banks of estuaries, estuaries and estuaries, and marine edges of river deltas.

These hydromorphological types differ sharply in their distribution in NWBS. Only eight are "relevant" for the region (occupy large areas of the coast, the length of which is more than a percentage of the total coastline) and six have a point spread, for example, only on the Zmeiny Island.

Most of the types of shores presented in NWBS have a historically characteristic set of habitats, which can be typical or rare. Together with artificial habitats and habitats formed by impact of alien species, pollution, etc. they can be used as ecological indicators of coastal ecosystem transformation.

Using a five-point scale compatible with the assessments of the Water Framework Directive the results of the indications show the excessive level of anthropogenic transformation in the zones used for recreation and urban areas - the Odessa urban agglomeration and adjoining resorts and of the Kherson Region resort areas. Among the assessed sites, only 28% are classified as excellent or good.

Comparison of these results with the results of indicating the hydromorphological changes with the help of intertidal indicator species shows a direct high correlation of ecosystem status estimates with these two parameters: $r = 0.713$.

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MARGINAL EFFECT OF *ZOSTERA NOLTEI* MEADOWS ON MACROZOOBENTHIC COMMUNITIES FROM THE ROMANIAN BLACK SEA COAST

The aim of this study is to evaluate the effect of recovery of the eelgrass *Zostera noltei* beds on abiotic and biotic characteristics of the adjacent unvegetated sandy sediments from the southern Romanian Black Sea coast. For this, macroinvertebrate fauna (> 0.5 mm) was sampled in *Zostera noltei* meadows and in the surrounding bare sand (~2 m outside the seagrass-sand boundary) in the coastal area of Mangalia in 2010 and 2011. Eelgrass characteristics were surveyed in terms of area of occupancy (AOO), shoot density, blade length, above-ground and below-ground biomass. In parallel, samples of sediment were analysed for grain size and total organic carbon (TOC). Water temperature, salinity, dissolved oxygen and pH were recorded on each sampling occasion. In total 2962 individuals belonging to 45 taxa (39 species) were identified. Dominant group in terms of number of species were Mollusca (19 species), followed by Arthropoda (11 species) and Annelida (9 species). Molluscs were also the most abundant faunal group (71.6% of the total number of individuals), followed by polychaetes (16.8%) and crustaceans (10.3%). The total abundance and the number of species were considerably higher in *Zostera* samples than in adjacent unvegetated sand. Thus, the total density in *Zostera noltei* habitat was 9,506 ± 1,856 ind. m^{-2} and in sand was 2,396 ± 378 ind. m^{-2} (mean ± S.E.), whereas the mean number of species in *Zostera noltei* bed was 13.3 ± 1.7 and in sand 3.5 ± 0.3. The epifauna of the *Zostera noltei* meadow was numerically dominated by grazing gastropods *Ecrobia maritima* (25.3% of the total number of individuals), *Cerithidium* sp. (11.0%), and *Rissoa spelndida* (7.6%). Fifteen taxa were present in both *Zostera* meadow and bare sand. Differences in infaunal component between *Zostera* and sand were not statistically significant ($P > 0.05$). The highest dominance values of infauna associated with *Zostera noltei* had the surface deposit feeding polychaete *Spio decoratus* (7.3%), which was also the dominant species in adjacent bare sands (56.7%), followed by the bivalves *Angulus tenuis* (3.5%) and *Cerastoderma glaucum* (2.8%). Contrary to expectations, adjacent unvegetated sandy sediments were characterized by a finer median grain size (0.177 mm) than those of the *Zostera noltei* meadow (0.190 mm). However, total organic carbon content of sediments within *Zostera* beds (31.42%) differed markedly from that of adjacent bare sand (4.18%). The improved environmental conditions within *Zostera noltei* habitat were revealed by the enlargement of the area occupied by the meadow from 940 m^2 in 2010 to 1263 m^2 in 2018 and by a slight shift of eelgrass meadow from 0.6–2.9 m depth in 2010 to 1.2–3.3 m depth in 2018 (increase of transparency).

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THE KINEMATICS OF SWIMMING AND RELOCATION JUMPS IN HYPONEUSTONIC COPEPODS *ANOMALOCERA PATERSONI* AND *PONTELLA MEDITERRANEA*

In females and males of hyponeustonic copepods *Anomalocera patersoni* and *Pontella mediterranea*, the maximum instantaneous and average speed, duration and distance of body relocation, as well as the angular velocity and beat frequency of legs during cruising swimming and escape reaction have been recorded using a high-speed video at 1200 frames s^{-1}. The cruising swimming of both species has been shown to be due to the methachronic force beats of the first three pairs of mouth appendages, which are larger relative to body length than in other copepods. As a result, the average cruising speeds of *A. patersoni* and *P. mediterranea* at 20°C reach 4.5 and 4 cm s^{-1}, respectively, at a beat frequency of appendages of 20-25 Hz. In comparison, in mesoplanktonic copepods *Calanus helgolandicus* (*euxinus*) with similar body length, a cruising speed is up to 2 – 3 cm s^{-1} at a mouth appendages beat frequency of 30-40 Hz.
Both *A. patersoni* and *P. mediterranea*, exposed to short, non-lethal electrical impulses, perform an escape reaction, which results not only in rapid movement in the water, but also in jumps out of the water, which normally are used to escape fish predators in these species (Zaitsev, 1971). The maximum speeds of underwater escape jumps are 110 cm s^{-1} and 115 cm s^{-1} in *A. patersoni* and *P. mediterranea*, respectively, and the frequency of locomotor patterns reaches 150 Hz. Jumping out of the water occurs not only due to the inertia gained during the copepod underwater acceleration, but owing to the force generated by the thoracic limbs when breaking through the water surface. *A. patersoni* makes a jump into the air directly from a still position and from the surface film to which the copepod is attached by dorsal setae. The surface tension and a significant amount of water adhering to the body, reduce the air flying speed in pontellids. In both species the flying speed do not exceed 60 cm s^{-1}. Nevertheless, the recorded air jump distance reach up to 8 cm. During the flight, the pontellids perform the uncontrolled body rotations accelerated by repeated locomotor strokes of the swimming legs which lead to the falling of large droplets of water from the body. High-speed video data indicate that pontellids can increase the total distance of the air jump, pushing away from small particles floating on the surface of the water due to the rhythmic stroke of the swimming legs that does not stop during the flight. Since the kinematic and energy characteristics of the escape reaction in hyponeustonic and mesoplanktonic species were similar (Svetlichny, Larsen, Kiorboe 2018), it could be conclude that jumping out of the water is the result of only behavioral adaptation of copepods living near the border between the seawater and air in the high risk predation habitats.

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CONTEMPORARY STATE OF MACROFAUNA OF LITHOCONTOUR IN ODESSA MARINE REGION OF THE BLACK SEA

The boundary "water – rocky shore and the bottom" is a contour biotope with its own community of organisms. As a substrate for attachment, the natural lithocontour is characterized by a special mineral composition, rigidness, texture, and other properties that provide the success of living on it or inside it for living organisms and their communities (Zaitsev, 2015). The formation of algae settlements on the lithocontoure creates new conditions for the existence of sessile and mobile hydrobionts. Rising above the bottom surface, being near the shore or near the surface of the water, the lithocontour is most affected by the waves, which specially affect the species composition and way of life of its population. Part of aquatic organisms attache to the surface, and mobile animals have the opportunity to hide, both under stones and in their cavities.

In the 1920–1970s the litho-contour fauna of the coastal zone of the Odessa marine region was studied by a number of researchers (Загоровский, Рубинштейн, 1916; Гринбарт, 1949; Каминская и др., 1977).

To describe the macrofauna of the natural lithocontour in the area of the Marine Biological Station of the Odessa National I. I. Mechnikov University we collected 23 samples in July 2012 and 2014 at a depth of 3.0–10.7 m.

The fauna includes 57 taxa (worms – 19, mollusks – 13, crustaceans – 21, others – 4), represented exclusively by the marine euryhaline complex. The average abundance was 34263.0±7715.9 ind·m^{-2}, the biomass – 14067.539±1214.556 g·m^{-2}. The most common were typical fouling species *Mytilaster lineatus, Mytilus galloprovincialis* and *Amhibalanus improvisus* – their total input made 83.0% of the population and 98.3% of the biomass. In the population of mussels, represented by individuals up to 80 mm long, the juveniles (up to 10 mm long) prevailed by abundane (55.1%).

Among the main taxonomic groups, mollusks dominated by abundance (74.0%) and biomass (97.6%). Among the trophic groups, sestonophages dominated, accounting for 83.2% and 98.5%, respectively. The index of uniformity of food structure was 0.96. Sessile representatives of epifauna prevailed by abundance and biomass.

The distribution of quantitative indicators of macrofauna in depth was relatively homogeneous. With an increase of the depth, the average number of mussels increased 1.7 times, and the biomass remained almost unchanged. The average biomass of the feeding component for fish (1022.878±160.160 g·m^{-2}) was only 7.3% on average. In its composition, the biomass share of mollusks was 69.9%, crustaceans – 29.1%, worms – 1.0%.

The total abundance of 7 invasive species (*Diadumene lineata, Polydora cornuta, Dipolydora quadrilobata, Rapana venosa, Anadara kagoshimensis, Mya arenaria, Amhibalanus improvisus*) was 12.1%, biomass – 2.6%.

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MARGINAL EFFECT OF DANUBE PLUME AREA ON THE BLACK SEA BENTHIC COMMUNITIES

The paper aims to assess the macrobenthic diversity and habitats distribution in front of the Danube mouth along a depth gradient on the Romanian Black Sea shelf. During the reference 60 - 70's period the benthic community in the area numbered about 75 species. In the 80's (starting of eutrophication period) this has sharply decreased to about 45 species as result of the ecological collapse due to economic development of the riverine Black Sea countries'. However, the area is naturally under the influence of the riverine inputs and also under anthropogenic pressure, which create permanent stressing conditions on the benthic habitats.
The study was performed in the framework of the CORE Programme projects carried out in the period of 2012 – 2018. The results is based on the data obtained from 54 quantitative stations distributed from coast (16 m) to 50 m depth. The Bray-Curtis similarity based on macrobenthic biomasses revealed 4 clusters, corresponding to four main habitats distributed along transects from the *plume area* to circalittoral biozones: terrigenous mud within Danube *plume area*, circalittoral terrigenous mud with *Melinna palmata*, circalittoral mud with *Spisula*, *Abra*, *Acanthocardia* and circalittoral mixed sediments with *Dipolydora quadrilobata* and *Mytilus galloprovincialis* biogenic reefs. The circalittoral mixed sediments with invasive polychaete *D. quadrilobata* and the biogenic reefs of *M. galloprovincialis* were the richest in terms of diversity and abundance. This new habitat has formed after *Dipolydora* had established a permanent population on the Romanian shelf and became an engineering species on the mixed circalittoral soft bottom sediments. Based on the results an ecological state improvement has been observed at the level of benthic diversity within the last two decades. The polychaetes dominated in terms of species richness as well as density. The depth gradient linked with temperature and oxygen concentration regime as well as the trophic state of the habitats investigated contributed the most at the benthic species distribution.

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FIRST RECORD OF *PERIDINIUM QUADRIDENTATUM* (F.STEIN) HANSEN (DINOFLAGELLATA) IN THE ODESSA BAY (BLACK SEA, UKRAINE)

Relatively new species of dinoflagellates *Peridinium quadridentatum* (F.Stein) Hansen 1995 (synonyms: *Heterocapsa quadridentata* F.Stein, *Peridinium quinquecorne* T.H.Abé, *Protoperidinium quinquecorne* (Abé) Balech) was found in the Odessa Bay, Black Sea. *P. quadridentatum* is known as a bloom species in different regions of the World Ocean, especially in coastal areas with a high anthropogenic load. The abundance of cells can be so high that the color of the water changes during the bloom. In recent years, cases of fish deaths were registered in the bloom areas of *P. quadridentatum*. It is assumed that the reasons are the reduction of oxygen level and clog (damage) of gills (Claereboudt et al., 2001).

P. quadridentatum is a tropical boreal dinoflagellate species. It was discovered in the northeastern part of the sea relatively recently (Vershinin et al., 2005; Yasakova, 2007; Senicheva, 2008). *P. quadridentatum* was not found in the northwestern part and the Odessa Bay earlier. Unfortunately, a new species for the Black Sea had been mentioned in the general lists so far without a taxonomic description, drawings and photographs, and also without taking into account the hydrological and hydrochemical parameters of water.

In the summer period of 2018 *P. quadridentatum* was actively vegetated in the Odessa Bay. The maximum abundance was recorded in July: $84.11 \cdot 10^3$ cells$\cdot L^{-1}$ and biomass of 561.62 mg$\cdot m^{-3}$ (23.0 °C; 17.90 psu). *P. quadridentatum* developed in the range of temperatures 18.2–26.0 °C and salinity 12.5–17.9 psu. *P. quadridentatum* cells were studied in transmitted light and in fluorescence mode with preliminary staining of Calcofluor White Stain 18909-100ML-F (Fritz and Triemer, 1985) under "Olympus BX51" light microscope. The sizes of *P. quadridentatum* from the Odessa Bay varied from 20.4 to 28.0 µm long and from 17.8 to 22.9 µm width. Whereas, according to the author of the taxon, cells sizes were significantly larger: 56–70 µm (Abe, 1927).

It was determined that the main factors that caused the appearance of *P. quadridentatum* in the Odessa Bay were high salinity and high temperature of the sea water. The invasion of species with ship ballast waters, as well as penetration through the Bosporus during the winter intensification of its low down flow are assumed. A detailed taxonomic description of *P. quadridentatum* from the Odessa Bay, its distribution, environmental features and original photographs will be published as a separate article.

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THE INFLUENCE OF RED TIDE ON THE CONTOUR BIOTOPES OF THE SEA

Red tides are associated with the massive development of dinophytes (Dinophyta, Dinoflagellata) in most cases which have an advantage over other phototrophic organisms due to their ability to absorb organic matter. The color of the water during the red tide can be from pink, red to all shades of brown.

For the first time a red tide was recorded in the northwestern part of the sea in 1958 caused by the *Gonyaulax polygramma* F.Stein which was 98% of the total phytoplankton biomass (Ivanov, 1967). In the 1970s, red tides in the Odessa Bay was triggered by *Prorocentrum cordatum* (Ostenf.) J.D.Dodge ($224 \cdot 10^6$ cells$\cdot L^{-1}$; Nesterova, 1979). The density of the red tides reached *Heterocapsa triquetra* (Ehrenb.) F.Stein ($18 \cdot 10^6$ cells$\cdot L^{-1}$) and *Akashiwo sanguinea* (K.Hirasaka) G.Hansen et Ø.Moestrup ($140 \cdot 10^6$ cells$\cdot L^{-1}$) in 1981–1990s (Nesterova, 2001).

In October 1998, a red tide was developed by the simultaneous growth of 3 species of dinophytes in Odessa Bay: *H. triquetra*, *A. sanguinea* and *Gymnodinium marinum* W.S.Kent. The density of these species was 35.5% of the total amount and 59.3% of the total biomass (14.5°C, 10.2 psu). In March-April 1999, the red tide was initiated by the drain of nutrients into the bay from Dnieper-Bug estuary. The bloom was created by *Skeletonema costatum* (Grev.) Cl. ($6.7 \cdot 10^6$ cells$\cdot L^{-1}$), *H. triquetra* ($1.3 \cdot 10^6$ cells$\cdot L^{-1}$, 13.5 g$\cdot m^{-3}$; 14.0°C, 13.0 psu) and *Eutreptia lanowii* Steuer ($1.1 \cdot 10^6$ cells$\cdot L^{-1}$, 2.0 g$\cdot m^{-3}$; 9.0°C, 11.0 psu). In October 2000, *A. sanguinea* reached the high density of the red tides ($0.78 \cdot 10^6$ cells$\cdot L^{-1}$, 70.0 g$\cdot m^{-3}$; 10,4°C; 9,7 psu). It was developed simultaneously with the marine mixotrophic ciliate *Myrionecta rubra* Lohmann ($50 \cdot 10^3$ cells$\cdot L^{-1}$, 0.92 g$\cdot m^{-3}$; Terenko, Kurilov, 2001). In August-September 2005, the red tide was caused by *Scrippsiella trochoidea* (F.Stein) A.R.Loebl. (the maximum density was $8.00 \cdot 10^6$ cells$\cdot L^{-1}$; 23.2°C, 12.7 psu) in Odessa Bay after intense rains (Terenko L., Terenko G., 2009). In August 2016, a red tide was recorded in the Kinburnskaya Spit and the coast of the city of Ochakov, caused by the massive development of *Diplopsalis lenticula* Bergh ($1.85 \cdot 10^6$ cells$\cdot L^{-1}$, 20.11 g$\cdot m^{-3}$; 22.5 0°C, 15.2 psu). In August-September 2018, the entire coastal north-western part of the sea was engulfed by a powerful red tide caused by *Prorocentrum micans* Ehrenb. ($12.84 \cdot 10^6$ cells$\cdot L^{-1}$, 79.36 g$\cdot m^{-3}$; 24.0°C, 16.5 psu).

To date, it has been established that most of the species causing the red tides in the northwestern part of the Black Sea are not toxic. In our opinion, the death of fish in the blooming areas was due to mechanical damage to the fish's respiratory organs (gills). We believe that the coastal desalinization as a result of heavy rains, the runoff of the Dnieper-Bug Estuary which is rich on nutrients and a noticeable warming of sea water over the shelf contributed to the occurrence of red tides in this area of the sea.

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SPECIES DIVERSITY ON MIXED SUBSTRATES IN THE DZHARYLGACHSKY BAY OF THE BLACK SEA

The Dzharylgachsky Bay is located in the northern part of the Black Sea and is separated from the Karkinit Bay by the Jarylgach Island. Since 2009, a part of the Dzharylgachsky Bay has been included in the National Nature Park "Dzharylgachsky". At the depths from 3 to 12 m, the bottom of the bay is covered in various substrates: sand, shell and silt, and they comprise 31–43 % of the total area of the bay. Their combinations formed substrates of the mixed type, which cover 57–69 % of the area. With sand as their basis and depending of silt deposition, silty sand and sandy silt are formed. Such substrates as sandy shell and silty shell are formed on shell basis.

In total, 100 species of bottom animals have been recorded in the bay area. Substrate composition influences their distribution over the area significantly. The type of substrate is accountable for 12-20 % of species density and 2-12 % of species abundance. Among monosubstrates, the shelly one is notable for the highest indices of zoobenthos development. On it, 54 animal species have been recorded; species density was, on the average, 11.9±1.6 species·0.025m-2, and abundance was 1480±240 ind.·m-2. Sand community in terms of species richness was poorer. Only 30 animal species have been recorded on sandy substrate. In terms of other parameters, these two communities were more or less matching. Species density on sand substrate was, on the average, 9.8±2.1 species·0.025m-2, and the abundance was 1090±180 ind.·m-2. The lowest indices of zoobenthos development have been demonstrated, among monosubstrates, by silt. Silty substrate was accountable only for 18 species; their density was 6.0±1.7 species/0.025m2, and their abundance was 1030±600 ind./m2. When silt deposited on sand to the point the substrate became silty sand, species richness remained almost on the same level (29 species). Along with that, species density increases up to 12.7±0.7 species/0.025m2, and species abundance increases too, up to 1750±510 ind./m2. If the share of silt is further increasing up to the point that the substrate becomes sandy silt, species richness decreases to 27 species, as well as species density and abundance, down to 6.7±1.2 species/0,025m2 and 1280±560 ind./m2, respectively. When the sand share in shelly substrate increases to the point that sandy shelly substrate is formed, zoobenthos species richness increases up to 69 species. Species density remained more or less the same and, on the average, was 11.8±1.6 species/0.025m2, and the abundance increased up to 2530±790 ind./m2. When the substrate of silty shell is formed, species richness decreases to 37 species, and species density decreases to 7.8±1.8 species/0.025m2. Abundance remains almost the same and, on the average, is 1270±493 ind./m2.

Estimations show that, in terms of the general density of zoobenthos species, the most favourable is the substrate, consisting of 60 % shell, 36 % sand and 4 % silt, namely sandy shell. In terms of zoobenthos abundance, the most favourable is the substrate, consisting of 65 % shell and 35 % sand, i. e. also sandy shell. Sandy shell also shows the most diversity in sponges, cnidarians, polychaetes, and gastropods. Bivalves were the most diverse on the substrate, consisting of 60 % shell, 10 % sand and 30 % silt, namely on silty shell. Crustaceans were the most diverse on the shell substrate due to the fact that this substrate is favourable for red alga Phyllophora crispa (Hudson) P.S. Dixon 1964, which thickets present the best environment for them. There, species richness of crustaceans depends more on algal beds than on substrate composition. Indirectly, Ph. crispa beds also make shelly substrate the most favourable for polychaetes.

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COMPARATIVE ANALYSIS OF THE MASS GOBIIDAE SPECIES NUTRITION SPECTRUM FROM THE BILOSARAYSKA BAY OF THE AZOV SEA

The Azov Sea is one of the most strategically important and unique water bodies of Ukraine by its resource potential. According to the statistics, about 34179±4677 tons of fish resources are withdrawn during the active fishing period per year (Demchenko, 2012).
Round goby (*Neogobius melanostomus* (Pallas, 1814) is the most mass species in the commercial fishing. But there are other gobies species, such as syrman goby (*Neogobius syrman* (Nordmann, 1840), monkey goby (*Neogobius fluviatilis* (Pallas, 1814) and ginger goby (*Neogobius eurycephalus* (Kessler, 1874) that are often found in catches – 77 %, 69 % and 23 % respectively (Tkachenko, 2017).
Gobies were sampled by a dredge in the 5 km coastal zone of Bilosarayska Bay, Azov Sea, through July-September 2016 till 2018. Sample collection, fixation and processing were carried out according to standard hydrobiological and ichthyological methods (Jadin, 1960; Guide…, 1961; Pravdin, 1966; Anistratenko, 2011).
Nutrition spectrum of the round goby (n=134) was represented by 19 taxons of hydrobionts. The dominant frequency of occurrence among all feeding objects belonged to *Abra segmentum (Récluz, 1843)* – 31.7 % and *Lentidium mediterraneum* (O.G. Costa, 1829) – 26.1 %. Notable, *L. mediterraneum* and *A. segmentum* are also dominated in all intestines – 35.8 % and 29.1 %. Polychaeta sp. – 50.4 % and *Rhithropanopeus harrisi* (Gould, 1841) – 44.8 % were dominated by biomass. Average total energy equivalent of round goby's nutrition objects was 4.3±0.6 kJ. The most energy-efficient were *R. harrisi* – 13.6 kJ and Polychaeta sp. – 7.8 kJ.
Feeding spectrum of syrman goby (n=59) was represented by 10 taxons of hydrobionts. Dominant occurrence frequency belonged to *R. harrisi* – 33.9 % and Abra sp. – 19.4 %. Herewith, *R. harrisi* and *Amphibalanus improvisus* (Darwin, 1854) were prevailed in all intestines – 53.3 % and 30.5 % respectively. By biomass *R. harrisi* – 74.6 % and Pisces sp. – 22.6% were prevailed. These objects were also the most energy-efficient – 4.5 kJ and 19.8 kJ. Average total energy equivalent of syrman goby's nutrition objects amounted 7.0±1.2 kJ.
The monkey goby's (n=15) nutrition spectrum was represented by 7 taxons of hydrobionts. The dominant frequencies of occurrence among all feeding objects were belonged to Polychaeta sp. – 38.5 %, *A. improvisus* and Cerastoderma sp. – 15.4 % each. By biomass Pisces sp. – 55.4 %, Polychaeta sp. – 33.3 % and *R. harrisi* – 11.1 % were dominated. The same objects were also the most energy-efficient – 19.8 kJ, 7.7 kJ and 5.0 kJ respectively. Average total energy equivalent of monkey goby's nutrition objects amounted 6.3±1.9 kJ.
Nutrition spectrum of the ginger goby (n=5) was represented only by 2 taxons of hydrobionts – *R. harrisi* and *A. improvisus*. The most predominant object by biomass and energy-efficient was *R. harrisi*. Should be noted, that average total energy equivalent of ginger goby's nutrition objects was the highest among all species – 11.0±2.9 kJ.
The highest similarity (Bray-Curtis similarity) was notified between spectrums of monkey goby and syrman goby – 73.7; round goby and syrman goby – 67.7. The less similarity was found between nutrition spectrums of round goby and ginger goby – 18.2.
Accordingly, mollusks are the most typical for round goby's nutrition spectrum, but they are not the most energy-efficient in contrast to other species, where more high-calorie taxons dominated, such as crustaceans, fish and bristle worms. Thus, further studies of mentioned species nutrition spectrum in terms of age and geographical variability are relevant.

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STATUS OF BENTHIC GROUPS OF THE BERDYANSKA SPIT

Berdyanska Spit is an important part of Priazovsky National Park, it is a wetland of international importance according to criteria 3, 5. The coastal part of the Berdyanska Spit is heterogeneous in terms of siltation of the soil, flowage regime and salinity of water. This is due to its geographical location and wind activity. Thus, the psammocontour of the spit from the side of the Berdyansk Gulf and on the top was distinguished by the presence of insignificant siltation, which was absent from the sea. The salinity in the gulf was 11,82‰ from the sea side 12,89‰. On the Berdyanska Spit, we carried out researches in 3 sample sites (1 - on the spit tip, and 2 - near the "Solnechnyy" Beach in the middle part of the spit from the side of Berdyansk Gulf and from the open sea) in the summer and autumn of 2018.

As a result of research, we have identified heterogeneity in the qualitative and quantitative composition of the fauna of the psammocontour of the coastal part of the Berdyanska Spit. Thus, in the near-shore zone from the side of Berdyansk Gulf in the middle of the spit, we identified 31 taxa of meio- and macrozoobenthos. The number and biomass of macrozoobenthos here in September amounted to 16,621 org·m^{-2} and 283,22 g·m^{-2}. In macrozoobenthos biomass was dominated by bivalve mollusks *Mytilaster lineatus* (45,7%) and *Cerastoderma glaucum* (14,3%), among gastropods *Rissoa venusta* (12,33%) and *Hydrobia acuta* (6,57%). In the samples of meiobenthos, the most numerous were *Canuella sp.* (24,19 %) and *Tisbe sp.* (57,82%).

On the opposite part of the spit (open sea), we found 20 invertebrate taxa, the qualitative composition of which was significantly different from the gulf part. No live gastropods were found in the macrozoobenthos. Mitillides *Mytilus galloprovincialis* (2533,08 g·m^{-2}) and *M. lineatus* (189,31 g·m^{-2}) dominated, constituting 99,79% of macrozoobenthos. In samples it was found a lot of *Polydora ciliata* (4355 org·m^{-2}), but we did not find perforated mollusk shells. In samples of meiobenthos, the most numerous species were *Harpacticus sp.* (48,28%).

On the spit tip we identified 31 taxons. The number and biomass of macrozoobenthos here in September amounted to 2,886 org·m^{-2} and 1527,63 g·m^{-2}. In terms of biomass, *M. galloprovincialis* (755,48 g·m^{-2}), *Mya arenaria* (622,16 g·m^{-2}), *M. lineatus* (62,4 g·m^{-2}) and *C. glaucum* (54,93 g·m^{-2}, which amounted to 97.86%. In the samples of meiobenthos, the most numerous species were *Ectinosoma sp.* (33,7%).

Thus, we have found that on the sides of the spit at the psammocontour there are at the same time 2 different bottom complexes, the spit tip fauna looks transitive. The similarity index of Chekanovsky, Sørensen for complexes on the sides of the spit was 0,33, for the gulf and the tip was 0,34, for the tip and the open part of the spit 0,51.

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THE EUROPEAN MUDMINNOW *UMBRA KRAMERI* WALBAUM, 1792 FROM THE LOWER DNIESTER AS A "CONTOUR BIOTOPE" FOR ITS SYMBIONTS

The *Umbra krameri* is a Tertiary period relict and endemic freshwater fish species for Danube and Dniester basins, included to the European RDB. Its extremely small populations of the Dniester basin inhabiting lowlands/wetlands neighboring drainages are located at the most eastern marginal part of the species range, where species is now highly endangered. To find out the causes of this threat, extensive knowledge about its ecology is required. In addition to abiotic impacts, a significant role in survival of its populations is assigned to such biotic factors as its parasitic and commensal organisms. Data on parasites of *U.krameri* are very scarce.

Ichthyoparasitological investigation of 89 of *U.krameri* individuals caught within the Lower Dniester wetland lakes and irrigation network as well as the Dniester Delta in 2000-2018, led to finding 119 species of commensal and parasitic symbionts: Ciliophora – 45, Plathelminthes – 21, Euglenozoa – 16, Sporozoea & Nemathelminthes – 8, Cnidaria – 7, Arthropoda – 3, Acanthocephales, Annelida & Mollusca – 2, Metamonada, Amoebozoa, Microsporidia, Oomycota & Chytridiomycota – 1.

Analysis of collected data demonstrated that composition of the symbionts' fauna of the Lower Dniester *U.krameri* populations is much richer and looks unique compared with those of the Danube basin (according to the literature and the authors' data): almost all species discovered present a novelty for this fish species and 12 of them were described as previously unknown. In addition, the parasite fauna of the examined *U.krameri* includes 18 host-specific species, one species common with *U.limi* and 12 species common with relative fish pike *Esox lucius*. The rest of species are common and widely-spread in the Dniester River waterbodies.

The total extensity of infestation was 100%, with variable intensity of invasion, which depends from the biotopes. However, it should be noted that lower species diversity of the symbionts and lower intensities of invasion of *U.krameri* in restored and newly created hydrobiotopes ("cold eco-points") of the delta were discovered.

We have not conducted a special study of the pathogenic effects of the documented parasites on *U.krameri*, however, more than a third of the species (38.5%) may be considered pathogenic for its fish-host. However, it is difficult to assume that such high values of infestation in "hot eco-points" did not cause severe damage and even mortalities among fish, especially for its fry.

Thus, despite the fact that a relatively small sample of *U.krameri* from the Lower Dniester has been studied, nevertheless, their diversity of symbionts can be assessed as rich and is distinguished by originality. Its composition structure is characteristic for highly eutrophic and degradable hydrobiotopes. Therefore, the parasitological situation of *U.krameri* populations inhabiting the Lower Dniester River is unfavorable, too. In this regard, the future survival of these fish populations depends on the pollution of watersheds and mainly – the hydrological regime of the Dniester River and its Turunchuk branch, which in turn depends on how optimal the spring ecological water releases from the Dnestrovsk Hydropower Complex are, and on improvement of water exchange/connectivity between the near-river floodplain habitats (channels, marshes, oxbows & lakes) and the Dniester mainstream. This might be the last chance to provide refuge for the shrinking *U.krameri* populations. So the hydropower facilities management should bring whole responsibility on the survival of the *U.krameri* unique population in Dniester.

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TECHNOGENIC LITHOCONTOUR OF THE COOLING POND OF NUCLEAR POWER PLANT

Water bodies of technoecosystems are characterized by vast areas of engineering structures: dams, rock reinforcement, pipelines etc. Coast-protective structures are considered lithocontour (Zaytsev, 2015) and serve as appropriate substrate for periphytic organisms.

Cooling pond of South-Ukrainian Nuclear Power Plant (CP) is characterized by vast lithocontour area – coast-protective enrockment enforce the entire perimeter. CP is characterized by specific conditions, particularly by high temperature (above 40ºC at the discharge, mean 34.4ºC in the summer 2018) and increased mineralization (above 1000 mg/dm^3).

In 2018 zooperiphyton of CP lithocontour was relatively poor in species (only 23 taxa, with domination of Naididae) and had a mosaic distribution of invertebrates (density within 333–51833 spec/m^2, biomass within 0.001–5837.49 g/m^2).

The peculiarity of CP lithocontour consisted in significant development of invasive gastropods *Melanoides tuberculata* (Müller) and *Tarebia granifera* (Lamarck) (Mollusca, Gastropoda, Thiaridae). Both species are of tropical origin and are widely used in aquariums. *M. tuberculata* was firstly registered in CP in 2005 (Lyashenko, Slepnyov, 2006), *T. granifera* was firstly registered in 2018.

Aquarium mollusks' invasions are widely spread (Yanygina, Vinarski, 2010). They form stable populations in ponds with modified thermal regime, i.e. cooling ponds of power plant. Thiaridae are practically resistant to water hardness, pH, oxygen concentration and other chemical parameters. Temperature below 7–10ºC is considered critical for them.

Thiaridae distribution in depth and CP perimeter was uneven, one- and two-species colonies were noticed. In two-species colonies (depth of 0,2 m) with substrate coverage up to 90%, density was equal to 51 800 spec/m^2, biomass – 5837,5 g/m^2. However, most part of lithocontour was significantly less inhabited by mollusks. In colonies with coverage up to 20% density was equal to 21,200 spec/m^2, biomass – 283.6 g/m^2 with prevalence of *T. granifera* (up to 90%). Population consisted of specimens 2–20 mm long.

Two-species populations were noticed at a depth of 4 m, with density up to 16 400 spec/m^2, biomass – 1880.1 g/m^2, here *M. tuberculata* was prevalent (more than 95%).

One-species populations were presented by *M. tuberculata*. Density in these populations was equal to 6–1200 spec/m^2, and biomass 18.7–1739.4 g/m^2. Population consisted of specimens 2–27 mm long.

These species population were also noticed in technoecosystem of the Zaporizhzhya Nuclear Power Plant (Marenkov, 2017, Yakovenko and others, 2018). In Thiaridae settlement dominated *T. granifera*. According to ZNPP personnel, Thiaridae cause significant hindrances in power units water supply since 2015 (Yakovenko and others, 2018).

So, CP lithocontur is characterized by a low species variety and relatively high abundance, created by of two invasive tropical mollusks. Biomass of more than 5 kg/m^2 can be compared to the biomass of *Dreissena* communities in periphyton of many water bodies.

The presence of juveniles and different-size specimens indicates the successful naturalisation of Thiaridae in CP.

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MOLECULAR DYNAMIC INVESTIGATION OF INTERMEDIATE LIQUID-GAS LAYERS AND NEAR-WALL INTENSTITIAL LIQUID-SOLID LAYERS

A special technique for studying intermediate liquid-gas layers and near-wall intermediate layers liquid-solid body .has been developed/ This technique based on the previously developed molecular dynamics study of the supramolecular structure, particle dynamics and physical and chemical properties of real gases, liquids, solutions of both simple and complex molecular substances and liquid crystals, A special form of the basic sample is proposed, in which «the plane of symmetry» and «the plane of specular reflection» are used, allowing to ensure acceptable accuracy of modeling intermediate liquid-gas layers and intermediate near-wall layers liquid-solid when using a limited number of particles in the main sample (about $8 \bullet 10^3$), which is quite affordable for modern computer technology. In the simplest case, the well-known intermolecular interaction Lennard-Jones potential (12–6) was used (in the study of simple substances consisting of one- and two-atom molecules); In the study of water a special potential for the interaction of water molecules was used, taking into account the specific features of the structure of this molecule, the presence of a dipole moment in it, and the effect of hydrogen bonds.

The interaction of molecules with a solid wall was taken into account by means of the Mie potential, which satisfactorily describes the real interaction of particles with an energetically uniform wall. In particular, this potential describes well the interaction with the solid wall - the hexagonal layered structure of graphite. However, the developed technique allows using more complex and realistic potential interaction functions (for example, Crowel potential), and also provides, if necessary, the possibility of direct consideration of the molecular structure of a solid bounding wall (for example, a particular crystalline or amorphous structure).

Based on the molecular dynamics experiments performed, the following conclusions can be made. An intermediate layer gas (for example, atmospheric air) - a liquid (for example, water) can be represented by the following qualitative phenomenological model:

I. Upper, adsorption sublayer, directly adjacent to the gaseous phase (for example, to the atmosphere). This sublayer contains particles and objects, mainly adsorbed from the atmosphere under the influence of the attraction of liquid phase particles.

II The surface sublayer of a liquid, the particles of which are under the influence of the joint (collective) attraction of the molecules of the liquid phase. This sublayer is characterized by the greatest local density; it precisely causes the surface tension of the liquid. On the external surface that is in contact with the gas phase (atmosphere), sublayer I is formed, on which adsorption from the gas phase (for example, the atmosphere) is observed.

Both the objects of inanimate nature and biological objects) from the underlying sublayer III and from the bulk phase of the liquid can be attracted to the lower surface of the sublayer II.

III. A transitional sublayer characterized by varying density (from the highest local density of sublayer II to the density of the bulk phase of the liquid, which corresponds to the state of thermodynamic equilibrium of this liquid at given temperature and pressure).

The peculiarity of the near-wall intermediate layer is a liquid consisting of complex non-spherical molecules (for example, elongated ellipsoidal or disc-like molecules) - solid is, as shown by the results of molecular-dynamic experiments, the possibility of the formation of local anisotropic structures of non-mesogenic substances This feature was experimentally investigated earlier by B. Altois and M. Popovsky.

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FIRST REVISION ON OSTRACODS (CRUSTACEA, OSTRACODA) OF PLASTIC SUBSTRATE IN ODESA MARINE REGION

Contour biotopes with specific communities of organisms play a key role in the functioning of aquatic ecosystems, in the reproduction of hydrobionts and are highly sensitive to external influences (Zaitsev, 2006). Meiobenthos taxa of ostracods is an important group in bioindication of ecological state of the environment. Various pollutants affect the coastal zone of the sea. One of them is plastic, which affects not only chemically on the environment, but also become a substrate for the formation of biocenoses (Snigirova, Portianko, 2018).

The most common invertabrate groups on marine litter are crustations, bryozoans, molluscs and cnidaria. From crustaceans taxa of Ostracoda, Malacastraca and Maxillapoda were registered (Kiessling et al, 2015). Species of ostracoda weren't indicated. The purpose of present work was to make first revision of ostracod fauna on a plastic substrate in Odessa marine coastal region.

Collection of material carried out in July 2018 in the Cape Malyi Fontan of the Odessa coast. The 30 meiobenthos samples were fixed with 4 % formaldehyde and were stained with "Bengal rose" (Hullings, Grey, 1971, Vorobyova, 1999). Samples were collected on transects at depths of 1-2, 3-4 and 5-6 m. Plastic substrates were divided into solid (bottles) and soft (plastic bags). For comparison, samples from artificial (hydrotechnical constructions) and natural solid substrates were studied.

Analysis of ostracods fauna showed almost similar species composition in different types of investigated substrates. The most widespread species were *Xestoleberis cornelii* Caraion, 1963, *Xestoleberis acutipenis* Caraion, 1963, *Hemicytherura bulgarica* (Klie, 1937), *Leptocythere multipunctata* (Seguenza, 1883) Ruggieri, 1950, *Paradoxostoma intermedium* Mueller, 1894, *Semicytherura calamitica* Schornikov, 1969. However, distributions and quantitative characteristics of ostracods differed significantly. Density and biomass of ostracods were lowest on plastic substrate, especially on soft type of it (average 2154 ind.$\cdot$m^{-2} and 14 mg$\cdot$m^{-2} respectively). The highest values of these parameters were on natural solid rocks. The results of first revision of ostracods on plastic substrate show that their distribution depends on character of fouling and types of substrates.

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INFLUENCE OF THE SALINITY GRADIENT ON THE STRUCTURE OF THE BLACK SEA FOULING COMMUNITY

In the process of development of the Black Sea fouling community, located on the boundary between solid substrate and seawater, the features of the edge effect were especially manifested. The basis of this community consists of the bivalve mollusks *Mytilus galloprovincialis*, which were fixed on a solid substrate, shows their edificatory properties, creating favorable conditions for the development of other invertebrate species.

These invertebrates have varying degrees of tolerance to the parameters of seawater salinity. In the coastal zone of the Black Sea, the salinity changes in the process of transformation of fresh water coming here with river runoff. To study the nature of the influence of the salinity gradient on the structure of the fouling community, three regions in the northwestern part of the Black Sea were selected to varying degrees remote from the mouth of the Dnieper. The first of these, under the direct influence of the river flow, is located near Cape Adzhiyask, the second is near the Grigorievka village, which is south of the Grigorievsky estuary, and the third is in the Odessa Bay near the Biological Station of Odessa National University.

As shown by research results, the largest quantitative development of invertebrates of fouling community is reached in the spring. At this time, most of them were concentrated in the coastal zone of the sea and proceeded to reproduction. In addition, in the spring, it is the sharpest expressed salinity gradient of seawater in the direction of Adzhyask – Grigorievka – Biological Station. Thus, in April 2018, the surface salinity in these sampling sites was 4,07 – 7,79 – 16,5 ‰, respectively. In this case, the gradient of bottom salinity was much less pronounced (12,75 – 14,49 – 16,4 ‰).

These circumstances influenced the quantitative parameters of certain species living in the studied areas of the sea. Thus, the representative of Polychaeta worms *Alitta succinea* reached abundance (N) 1600 sp.·m^{-2} and biomass (B) 33,52 g·m^{-2} in the area of Adzhyask. Other species of *Hediste diversicolor* and *Nereis zonata* were most developed quantitatively in the Biostation area (N = 334 and 625 sp.·m^{-2}, B = 52,03 and 13,6 g·m^{-2}, respectively). The representative of Cirripedia crustaceans *Amphibalanus improvisus*, was most developed in the Grigorievka area (N = 4050 sp.·m^{-2}, B = 363,95 g·m^{-2}).

Euribiotic species of Isopoda crustaceans *Lekanesphaera monodi* and *Idotea balthica* were found in all studied areas. Their maximum abundance recorded in the region of Adzhyask was 1275 and 875 sp.·m^{-2}, and biomass was 18,27 and 10,0 g·m^{-2}, respectively. Most species of Amphipoda crustaceans lived in all three areas of the sea. The most massive of these, *Melita palmata* and *Microdeutopus gryllotalpa*, reached the maximum abundance of 567 and 1350 sp.·m^{-2} and biomass 2,37 and 2,62 g·m^{-2}, respectively, in the Biostation area. Thus, the transformed river waters entering the Black Sea affect not only the species composition of studied invertebrates, but also their quantitative development.

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MEIOFAUNA OF CONTOUR BIOTOPES OF THE BLACK SEA

The regions of the hydrosphere at the boundaries of various environments were called contour biotopes (Zaitsev, 2006). Contour biotopes (Zaitsev, 1985; Zaitsev, 2006) are populated with specific contour biocenoses and classified as follows: aerocontour (the surface of the sea bordering with the atmosphere), psammocontour (sea-sand beach and sea bottom), lithocontour (sea-rocky shore and sea bottom), pelocontour (sea - silt and bottom), potamocontour (sea-river water masses), biocontour (Zaitsev, 1986, 2002). In marine ecosystems, meiofauna is of great importance (large species diversity, high abundance, food supply for larvae and young of commercial fish, indicator of ecological state of the environment).

Up to date, extensive information is available only on the meiofauna of the psammocontour (Vorobyeva, Zaitsev, Kulakova, 1992; Kulakova, 2012). Studies have found that sandy beaches are a typical ecotone of the sea. Here, representatives of the marine, freshwater and soil fauna take part in the formation of biota. The sandy contour of the sea is one of its active surfaces, where various and intensive physical, chemical and biological processes take place. For the first time, it was proved that the rich marine meiofauna lives on the supralittoral zone, its diversity depends on the mechanical structure of the sand. It is most diverse in the pseudolittoral and in the supralittoral on the horizon 30-50 cm. On the sublittoral zone, there are representatives of the epi-, endo- and mesofauna.

For the lithocontour, meiofauna is preferring marine fouling. Its biodiversity is poorer than on loose substrates, but has a higher abundance and biomass.

In marine fouling, the lithocontour dominates in the number and biomass of crustaceans (harpacticoids and ostracods). Kinoryncha and Gastrotricha are absent, the number of oligochaetes and foraminifera is very low. Meiobenthos community of marine fouling is characterized by high biomass and species diversity.

The zone of influence of river waters (potamocontour) is characterized by the presence of both freshwater and marine fauna. This mainly applies to planktonic organisms. Fresh water has little effect on benthos. The biodiversity and quantitative characteristics of meiobenthos in the zone up to 5 km from the mouth of the Danube are influenced by a strong bottom flow. In meiobenthos, the harpacticoid-nematode complex dominates – 72% of the total population. In the second zone, the total abundance and biomass of the temporary and permanent components increases sharply. The density of the harpacticoid increases nearly fourfold. Together with nematodes, they occupy a leading position. In the second zone, the total abundance and biomass of the temporary and permanent components increases sharply. The density of the harpacticoid increases nearly fourfold. Together with nematodes, they occupy a leading position (87.1%). A sharp increase in the number of foraminifera and oligochaeta indicates that the bottom flows significantly reduce their speed.

The main biomass is formed by harpacticoids (73.4%) and representatives of pseudomeiobenthos (23.3%). In the second zone, a good feed base is formed for young fish. In the third zone, small-sized forms (foraminifera, nematodes, etc.) account for about 80% of the total number of organisms, and therefore the quality of the meiobenthos as a feed object falls, their share in the total number reaches 87.1%. The abundance of foraminifera and oligochaetes increases dramatically. It indicates that the bottom flows significantly reduce their speed. In the second zone, a good feed base is formed for young fish. In the third zone, small-sized forms (foraminifera, nematodes, etc.) account for about 80% of the total number of organisms, and therefore the quality of the meiobenthos as a feed object falls.

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RESULTS OF INVESTIGATIONS OF ICHTHYOFAUNA IN THE COSTAL ZONE OF THE SEA IN THE GULF OF ODESSA IN 2016-2017

Monitoring of the status of ichthyotsenoses remains an important component of marine hydroecological research for many decades. The Gulf of Odessa, as a unique Black Sea water area, is constant studied since the beginning of the 20th century. The purpose of our research was to analyze the composition of the net fishing catches in the Gulf of Odessa in 2016-2017.

The studies were carried out in the coastal waters of the Gulf of Odessa near the Cape Small Fountain from May to October 2016 and from April to December 2017 during the research catches that were held jointly by Odessa National I. I. Mechnikov University and Odessa Center of the Southern Scientific Research Institute of Marine Fisheries and Oceanography. Fish was caught with bottom gill nets 10-75 m length (mesh size 12-30 mm, distance from the coast 200-500 m, depth 4.5-14.5 m). The nets were exhibited from the boat in the evening and checked the next day. In total 55 catches were analyzed: in 2016 – 24 and 2017 – 31 catches.

Taxon of fish is given by the species guide by Yu. V. Movchan (2011). During the two years of research, 23 species of fish were found in catches: *Acipenser stellatus* Pallas, *Engraulis encrasicholus* (L.), *Alosa tanaica* (Grimm), *Sprattus sprattus* (L.), *Gaidropsarus mediterraneus* (L.), *Merlangius euxinus* Nordmann, *Scorpaena porcus* L., *Pomatomus saltatrix* (L.), *Trachurus ponticus* Aleev, *Mullus ponticus* (L.), *Symphodus cinereus* (Bonnatterre), *S. ocellatus* (Forsskål), *Ophidion rochei* Muller, *Trachinus draco* L., *Uranoscopus scaber* L., *Mesogobius batrachocephalus* (Pallas), *Neogobius eurycephalus* (Kessler), *Neogobius cephalargoides* Pinchuk, *Neogobius melanostomus* (Pallas), *Neogobius ratan* (Nordmann), *Psetta maeotica* (Pallas), *Platichthys luscus* (Pallas), *Pegusa lascaris* (Risso).

Perciformes is represented by the largest number of taxa (7 families, 8 genera and 12 species), the family Gobiidae and Clupeidae dominate be the number of genus (2 and 2, respectively), and family Gobiidae by number of species (5).

Most of fish found in fish catches are actually marine (in 2016 – 66.7%, and in 2017 – 58.3%) and brackish species (23.8% and 41.7% respectively). Anadromous species were noted in catches only in 2016 (9.5%). For two years, there were no catches of freshwater and semi-anadromous fish in catches.

In 2016 and 2017 round-goby (38.8% and 42.2%, respectively), sand sole (26.8% and 16.1%, respectively) and Pinchuk's goby (13.5% and 26.5%, respectively) were the most abundant species in the nets` catches. The round-goby has the largest number in May (24.8% and 35.1%, respectively) and October (27.4% and 16.7%, respectively), sand sole – in July 2016 (47.2%) and June 2017 (67.3%), Pinchuk's goby in July 2016 (29.4%), as well as August and September 2017 (20.6% and 20.9% respectively).

For more than 10 years of ichthyological studies in the Cape Small Fountain, there has been a decrease in catches of the total number of fish species: in 2016 – 21 and 2017 – 12 species. This is the smallest number of recorded species of ichthyofauna in the area for all years of observation.

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ASSESSMENT OF THE GENETIC STRUCTURE OF *NEOGOBIUS FLUVIATILIS* (PALLAS) GROUP IN THE KHADZHIBEI ESTUARY BY LOCUS OF BIOCHEMICAL MARKERS (IN 2018)

The idea of the homogeneity of the population-genetic structure of many species of fish in the last decades has changed significantly (Ovenden, 2015). Molecular and genetic population surveys covering almost all the areas of many commercial species show a complicated picture of spatial genetic differentiation. This is identified on macrogeographical scale, as well as, in many regions, on micrographic scale, but the degree of differentiation by neutral molecular markers is very little (Beaumont, 1996; Nielsen, 2001). However, species that do not have direct commercial significance remained out of sight. These species include the *Neogobius fluviatilis* (Pallas), which is an important link in the trophic chains of coastal ecosystems and a competitor in the feeding for commercial fish.

The purpose of this work was to study the genetic structure of polymorphic loci, which encode multiple molecular forms of biochemical markers in a group of monkey goby in the Khadzhibei Estuary.

The material was collected in spring 2018 at the lower region of Khadzhibei Estuary. To detect the spectrum of molecular forms of esterases and myogens, the muscle tissues of each individual were used (20 females and 20 males). The fractionation was carried out by electrophoresis in 6% polyacrylamide gel. Classical histochemical techniques were used to detect the molecular forms of enzymes and myogens in the gel after termination of electrophoretic separation.

The study of the electrophoretic spectrum of the multiple molecular forms of the biochemical markers of monkey goby in the Khadzhibei Estuary revealed the presence of 5 isozymes of esterases and 14 forms of myogenic, in the muscle tissues, each of which was encoded by a single locus. Polymorphs among them were the genes of esterase 2 and myogen 9. The analysis of electrophoregram showed that fish from the studied locality S-allele locus of the esterase 2 that encoded less mobile alozym met much less frequently (0.05) in the group than the second allele. By polymorphic locus of myogen 7 the frequency of the F-allele in the studied locality of the monkey goby was significantly higher (0.775) than the second variant of the gene that encoded the less mobile variant of soluble muscle proteins. There was no significant difference between the detected frequencies and the theoretically expected frequencies of genotypes calculated according to the Hardy-Weinberg formula for two polymorphic loci in the studied sample of the monkey goby.

In general, the analysis showed that the genetic variability of the monkey goby group in the Khadzhibey Estuary in 2018, which was estimated by two indices – polymorphism and heterozygosity, was rather low compared with the mean values for fish populations. In addition, the balance of genotypes indicates the absence of migrations of monkey goby from other sites. Taking into account the geographical isolation of the estuary, the data obtained may indicate that the group of this species in this reservoir may be considered as a separate population.

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ACTIVE SURFACES AS CHARACTERISTIC OF ENVIRONMENTAL PROCESSES IN THE PHYTOPLANKTON COMMUNITY

One of the most pressing issues of the EU Water Framework Directive and Marine Strategy Framework Directive is to develop and implement indicators for assessing the quality of the aquatic environment based on the state of phytoplankton communities (Directive 2000/60/EC; Directive 2008/56/EC). Indicators used in assessing the Ecological Status Class should reflect the response of the Biological Quality Element to the variability of environmental factors in a predictable form. The relationship of such quantitative indicators of phytoplankton as biomass and the concentration of chlorophyll a with the content of nutrients is well studied. This allows them to be used in the analysis of such an environmentally significant process as eutrophication. However, the multitude of qualitative characteristics of the structure of unicellular algae communities does not sufficiently predictably respond to the variability of environmental factors. This creates problems for their use as phytoplankton indicators. An alternative to numerous qualitative structural indicators can be phytoplankton surface indicators. The processes that cause the variability of these indicators have a clear interpretation. This allows you to determine the ecological meaning of their use to characterize eutrophication processes in accordance with the objectives of the Marine Strategy Framework Directive.

Active surface indicators characterize the intensity of nutrient transformation by phytoplankton in the course of primary production. The characteristic of this process is no less important for the assessment of processes in an aquatic ecosystem than the analysis of its result (based on biomass, or chlorophyll concentration). The duration of the "water bloom" is one of the most important components of the processes caused by eutrophication. The increase in the intensity of the production process determines the reduction of the transformation period of a nutrient. This determines the increase in the maximum value of phytoplankton biomass. It is the maximum biomass that forms during the "blooming of water" that determines the negative effects of eutrophication.

Thus, the introduction as indicators of the specific surface area of unicellular algae allows to solve the problem of insufficient predictability of ecological interpretations of phytoplankton quality indicators and corresponds to the tasks of implementing the Marine Strategy Framework Directive standards in national research.

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BOOK OF ABSTRACT