LEPL ,,Batumi Shota Rustaveli Universiteti”

Faculty of Natural Sciencies and Healthcare
Department of Biology

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,,Biodiversity of Epifauna of South-eastern Coastal Line of the Black Sea (Sarfi-Poti)”

(Presented for granting the PhD quality)

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A u t o r e f e r a t

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Common description of the thesis

Applicability of the thesis.

The negative impact of anthropogenic factors on the functioning of water ecosystems has led to undesirable changes in the biodiversity of seas and oceans. The increase in demand for dietary protein has pushed humanity to the level of the world's oceans. The importance of the seas, including the Black Sea, plays a major role in solving this problem. The protein supply in the hydrosphere includes not only fish, but also molluscs, crustaceans and other hydrobionts that have nutritional value. The largest part of benthofauna, which includes epifauna, i.e., invertebrates growing on a hard substrate, with attached living forms, plays an important role in the creation of bioproduction of ecosystems. Epifauna is considered not only as a constituent system of edible hydrobionts, but also as an active participant in the process of coastal biofiltration. The **applicability** and **importance** of the research topic is clear from all of the above mentioned.

It should be noted that many scientific studies of almost all constituent components of the Black Sea ecosystem have been conducted. It is very interesting to study the biodiversity of the hydrobionts of the Georgian shelf of the Black Sea, which is still ongoing. A number of interesting papers and articles have been published on ichthyofauna, zooplankton, benthos, ecological and physical condition of water, but epifauna is studied less intensively, as evidenced by the scarce literature about it.

Aims and tasks of survey.

Based on the importance of the issue, **the aim** of the dissertation thesis is to determine the structure of living organisms attached to the hard substrate in the southeastern coast of the Black Sea, conducting those primary basic studies, which have not been conducted so far in the direction of epifauna research in the southeastern coast of the Black Sea.

In accordance with the purpose of the survey, the **tasks** were determined:

- species identification of hydrobionts composing the epifauna;
- Determining the annual dynamics of the number and biomass of epifauna;
- Comparison and analysis of five-year average annual data of epifauna quantity and biomass;
- Determination of interconnection between species;
- Identification of dominant species;
- Size-weight correlation of A. succinea, which is important in fish nutrition and one of the epifauna species;
- Detection of invasive species;
- Creating a database.

Research object and methods.

The object of research was the epifauna spread in the southeastern coast of the Black Sea - a set of organisms that live on a hard substrate - artificial and natural formations. Sampling was carried out seasonally at different depths in the southeastern coastline of the Black Sea (Kvariati, Green Cape, Tsikhisdziri) for 5 years. A total of 60 samples were collected and treated (12 samples per year). Researches were conducted seasonally in 2017, 2018, 2019, 2020 and 2021.

The initial treatment of the samples was carried out on the shore, and finally the survey was completed in the laboratory of the Department of Ichthyology, Aquaculture and Water Biodiversity of the National Environment Agency of Georgia within the framework of the memorandum of Batumi Shota Rustaveli State University. Organisms were differentiated by species, thus creating appropriate databases. Collection of epifaunal samples was carried out at different depths using a special frame with an area of 324 cm^2 and a scraper shovel.

After the initial visual examination of the samples, individuals were differentiated into groups (molluscs, arthropods, worms, porifera, phoronids, bryozoa, foraminifera) and fixed in 40% formalin solution. For the identification of species, the following were used: the three volumes of the Black and Azov Seas Identifiers, by V. A. Dogel (1981) and B. The textbooks of Kurashvili (1996), the data of the Internet website WoRMS, we determined the number of hydrobionts by the method of counting individuals in the sample.

Species were counted with a Bogorov camera through binoculars, and finally the number and biomass were determined for an area of 1m^2. We determined the biomass of species and the raw weight of the research individual according to Borutsky's method. We determined the dry weight using the Exact Weight Determination method. After calculating the body length, raw and dry weights, we determined the size-weight correlation, during which we used: for the systematization of the length data - a row of numbers indicating a combination of random values. After ranking the size and weight values, the frequency of their meeting was calculated; The indicators of the variation of the values were studied and calculated using the methods of statistical analysis: Average length, dispersion or variance, standard deviation, coefficient of variation were determined by the distribution curve of the mentioned quantities; Since our aim was the correlation analysis of the size-weight characteristics, the correlation coefficient between the values was calculated using the Sokal method. Based on the regression analysis, the regression coefficient was calculated, the so-called by Kramer's formula. In order to calculate the correlation coefficient and regression equation, using the M.Excel program, we compiled the empirical rows of 111 individuals (number of species).

Material and technical base. The material was processed in the laboratory of the Department of Fisheries, Aquaculture and Aquatic Biodiversity of the National Environmental Agency of Georgia. We used the tools available in the laboratory to determine the biomass and quantity.

Sampling was carried out in Adjara, Department of Emergency Situations Management of the Ministry of Internal Affairs with the help of rescue training and response service specialists. The divers were equipped with the so-called MARES breathing equipment.

The scientific innovation of the thesis is as follows:

- In the south-eastern coast of the Black Sea, we studied for the first time the species composition of the species attached to the hard natural substrate - rocky formations;

- Seasonal and annual dynamics of the number and biomass of survey objects were determined;
- Dominant species were identified, their role in the functioning of the marine ecosystem was assessed;
- For the Georgian shelf of the Black Sea, for the first time we studied the size-weight characteristics of one of the species of epifauna (artificial substrate) - Polychaeta A.succinea, their correlation and bioproductivity;
- Outlines of the role of natural epifauna in the development of mariculture were outlined

Theoretical and practical significance of the work

Due to the relevance of the topic, scientific innovation, the volume of the experiment and the level of conclusions, the performed work is of great theoretical and great practical interest.

The results of the five-year (2017-2021) research of the thesis work provide enough basis to fill the gap that has been left in the assessment of the coastal ecosystem mentioned above.

In the future, this will be a kind of guideline for their comparative analysis, conclusions and recommendations.

Artificial reproduction of the biofilter molluscs - mussels, as representatives actively participating in the biofiltration process of the coastline, through the development of mariculture, is noteworthy.

Dissertation thesis structure. The main text of the thesis includes 226 printed pages and consists of an introduction, a literature review and an experimental part, which includes the characterization of the research material and methods and the analysis of the research results. Conclusions are presented with 11 points and 2 recommendations. The list of literature is represented by 37 sources. The text includes 24 tables, 7 diagrams and 18 photos. The work is accompanied by a 43-page appendix, in which the results of the biometric analysis and mathematical research are described in detail, represented by 13 tables and 8 figures.

Approbation and publication of research results.

5 scientific works have been published around the research material: 2 conference materials and 3 journals with impact factor classifiers:

1. Biodiversity of the fouling-epifauna distributed in the south-western part of the Black Sea –Proceedings ICAE-2015, pp271-274. Tbilisi 2015;
2. Weight-size characterization of Alitta siccinea (Leuckart, 1847) distributed in the south-eastern part of Georgian Black Sea – International Journal of Fisheries and Aquatic Studies. New Delhi, India, 2017;
3. Distribution and Quantitative Characteristics of Four Invasive Alien Species of the Black Sea Coast of Georgia - ACTA ZOOLOGICA BULGARICA; ESENIAS and DIAS Scientific Reports 4 Research Article Acta Zool. Bulg. 72 (4), December 2020: 539-544;
4. Biodiversity, species composition and current trend of the benthic invertebrate community of the rocky infralittoral habitats of the Georgian Black Sea Coast – International scientific conference. Marine Ecosystems: Research and Innovations. Book of abstracts. October 2021: pp 39. Odessa, Ukraine;
5. Biodiversity of Macrozoonebthos in the Black Sea Coast of Georgia - International conference. Research and Assessment for Sustainble Use of the Black Sea Shellfish Resources. Book of proceedings ISBN 978-619-90271-3-4. Maritime and Fisheries Program. October 2021: pp.22.

Also, the paper was approved at the meeting of the Faculty of Natural Sciences and Health, Biology Department of BSU.

Content of the thesis

Chapter I. Literature review

The paper analyzes 37 literary sources, where the analysis of information sources related to the dissertation topic, the main results and concepts related to the research problem are discussed.

The paper also includes a literature review on epifauna and Mediterraneanization, during which we mainly relied on the articles of various scientists.

Experimental part

Chapter II. Survey object and methodology

The object of survey was the epifauna spread in the southeastern coast of the Black Sea - a set of organisms that live on a hard substrate - artificial and natural formations. Sampling was carried out seasonally at different depths in the southeastern coastline of the Black Sea (Kvariati, Green Cape, Tsikhisdziri) for 5 years. A total of 60 samples were collected and treated (12 samples per year). Studies were conducted in 2017, 2018, 2019, 2020 and 2021 seasonally.

The material was treated in the laboratory of the Department of Fisheries, Aquaculture and Aquatic Biodiversity of the National Environmental Agency of Georgia. To determine the biomass and number, we used the tools available in the laboratory.

Sampling was carried out with the help of the specialists of the Adjara rescue training and response service of the Emergency Management Department of the Ministry of Internal Affairs. The divers were equipped with the so-called MARES breathing equipment. Epifaunal samples were collected at different depths using a special frame with an area of 324 cm^2 and a scraper shovel. After the initial visual examination of the samples, individuals were differentiated into groups (molluscs, arthropods, worms, porifera, phoronids, bryozoa, foraminifera) and fixed in 40% formalin solution. For the identification of species, the following were used: Trilogy of Identifiers of the Black and Azov Seas (Водяницкий, 1972), by V. A. Dogel (1981) and B. Kurashvili's (1996) guideliness, for crustaceans we used the updated classification (An Updated Classification of the Recent Crustacea, 2001) and the data of the Internet website WoRMS (www. World Register of Marine Species), we used binocular Leica MS 5 and microscope Leica DMLS. We determined the

number of hydrobionts by counting individuals in the sample. Species were counted using Bogorov's camera and binoculars, and species biomass was determined using Borutsky's method with torsional and electric scales (TREE HRB 103). Finally, the number and biomass were determined for an area of $1m^2$. A ruler made of organic glass was used to measure the body length for measuring the size-weight characteristics of the polychaete worm A. Succinea. Dry weight was determined by the method of determining the exact weight - using boxes and a drying cabinet.

Chapter III analysis of survey results

III.1. General description of epifauna

On the basis of literary data, the information about the species obtained as a result of the research was carried through the desktop study.

Class Tubothalamea (Tubothalamea, Pawlowski, Holzman & Tyszka, 2013) – Protozoa which are characterized by a small number, but being significant part of the epifauna diversity. One of them is representatives of the Foraminifera type (shelly amoebas) Quinqueloculina pseudoseminula (Mikhalevich, 1968) and Quinqueloculina laevigata (Deshayes, 1831). They are primitive organisms whose soft, protoplasmic body is covered by a shell of various structures and compositions. Foraminifera are mostly marine animals. Most of them are benthic forms, but sometimes they also choose a hard substrate - rocky formations. Widespread in the oceans, Marmara, Mediterranean and Black seas.

Class - Gymnolaemata (Gymnolaemata, Allman, 1856). Zooids are large in size. They are typically multicellular forms of saline water, but they tolerate its variation well. It is the most common form in the Black Sea. Bryozoa are classified into 3 groups: marine, freshwater and fully marine bryozoa. Gymnolaematas belongs to the third group, i.e. representatives of our sample class. A large number of species belong to this class, possibly due to the presence of specialized zooids. They feed mainly on phytoplankton, protozoa, small nematodes and microscopic arthropods.

Class - representatives of Phoronis (Wright, 1856) are the primitive animals. They are good filters. They live in the marine environment, both on hard and soft sediments. They are not very

sensitive to environmental conditions, that's why they are considered eurythermic and euryhaline animals. Therefore, they are widely distributed in the Atlantic, Pacific and Indian oceans. In general, Phoronis species are characterized by benthic larvality. Embryo development of some of them takes place in the water column. There is a kind of correlation between the size of the egg and the stage of development, in particular, the embryo placed in the water column needs less energy for development and, accordingly, lays more eggs.

Class - Demospongia (Demospongiae, Sollas, 1885). Porifera are multicellular organisms whose bodies are covered with pores and channels that allow water to circulate throughout the body, forming a jelly-like mesohylum between the cells. They have lack of nervous, digestive and circulatory systems. Porifera, like other animals, are heterotrophic and sperm-producing individuals. All porifera are sessile, meaning they attach to the surface beneath the water and remain attached. Despite the fact that they are freshwater species, they are mainly marine animals, the area of distribution of which is quite large, starting from the zone of circulation of the sea, ending up to a depth of 8,800 m.

Class Rhabditophora (Rhabditophora, Ehlers, 1985). In the samples, Stylochus pilidium (Goette, 1881) was found in sufficient quantity. They are parasites or free-living invertebrate animals. Their length reaches from 0.1 mm to several meters. The body is leaf-like or ribbon-like. The spaces between the organs are filled with parenchyma, which is why they are called parenchymal worms. The species do not have a body cavity, nor do they have circulatory or respiratory organs. Excretory organs are protonephridia. The nervous system is ganglionic. They are mostly hermaphrodites.

Type Nemertines - Nemertea (Margulis, L.; Schwartz, K.V. (1982). A representative of the Nemertine type (could not be identified to species due to injuries) was recorded in the winter sample of Green Cape. Nemertines are marine animals that choose shells, stones, algae and other substrata as their habitat. Their body is bilaterally symmetrical, undivided. Their length is from 10 cm to 20 cm, and sometimes even more than 2 m. The body is covered from the outside with a single-layered epithelium, under which the skin-muscular cover is placed. Most nemertines are

predators, some are parasites and symbiotes of molluscs. Nemertines are common in all oceans and seas. They are mostly benthic animals and are considered valuable food for many species of fish.

Nematoda type - Nematoda Diesing, 1861. A representative of the type of Nematodes was observed in the samples (it was not possible to determine the class and species due to damage of the organisms). Nematodes have elongated or finger-like bodies from 80 μm to 8 m long. The body cavity is filled with fluid. They are widely distributed. Some of them are parasites, while others live freely in soil and water.

Class polychaeta (Polychaeta, Grube, 1850) - Representatives of this class are combined into two subclasses - wandering (Errantia, Audouin & H Milne Edwards, 1832) and sedentary (Sedentaria Lamarck, 1818). More than 10,000 species are counted in the subclass. Representatives of the Clitellata (Clitellata, Grube, 1850) class - oligochaetes - were also observed in the samples.

The dominant forms of the epifauna of the Black Sea are molluscs. Among them, representatives of the classes of Polyplacophora, Gastropoda and Amphipoda live on the Black Sea shelf. In general, molluscs count more than 107 thousand species. Most of them live in the ocean, sea, and fresh water, relatively less - on land.

Class Polyplacophora (Polyplacophora, Gray, 1821). Representatives of this class have a shell, which consists of 8 plates and protects the animal from physical damage. Polyplacophora are widespread organisms, they adapt well to both cold and tropical waters and live on hard substrates. Most of them choose the coastal zone, however, there are species that reach depths of up to 6000 m in deep waters. Polyplacophora are completely marine animals, unlike bivalves, which are adapted to fresh water as well. We have recorded a small amount of a mollusk - Lepidochitona cinerea (Linnaeus, 1767).

Class Gastropoda (Gastropoda, Cuvier, 1795). Representatives of this class live in both fresh and sea waters. They are the most numerous molluscs and inhabit a wide variety of habitats, from the Arctic and Antarctic to the tropics. According to the variety of species, gastropods take the second place after insects. They mainly feed on plants and detritus.

Class Bivalvia (Bivalvia, Linnaeus, 1758). Bivalves are one of the most diverse groups of invertebrates in terms of diversity. They play a primary role in the formation of the bottom biocenosis, they occupy a prominent place among marine invertebrates.

Class Shell crustaceans (Ostracoda, Latreille, 1802). In our sample, we found the Amphibalanus improvisus (Darwin, 1854).

The class Hexanauplia/Thecostraca (Oakley, Wolfe, Lindgren & Zaharof, 2013) was recorded as a crustacean Harpacticus flexus (Brady & Robertson, 1873).

From the class Higher Crustaceans (Malacostraca, Latreille, 1802) we recorded in our sample the amphibians (Amphipoda), small individuals up to 10 mm in size.

III.2. Species composition of epifauna, systematic structure

According to the five-year results of the samples taken during the research, the epifauna was formed by 10 types, 2 subtypes and 16 classes of different species.

According to the data obtained as a result of research, epifauna is represented by the following systematic units:

1. Type - Foraminifera, Margulis, L.; Schwartz, K.V. (1998)
   - Class - Tubothalamea, Pawlowski, Holzman & Tyszka, 2013
     - ✓ Quinqueloculina pseudoseminula (Mikhalevich, 1968)
     - ✓ Quinqueloculina laevigata (Deshayes, 1831)
2. Type - Bryozoa, Margulis, L.; Schwartz, K.V. (1998)
   - Class - Gymnolaemata, Allman, 1856
     - ✓ Einhornia crustulenta (Pallas, 1766)
     - ✓ Membranipora sp.
3. Type - Phoronidae, Hatschek, 1880
   - Class - Phoronis, Wright, 1856
     - ✓ Phoronis sp.
4. Type - Porifera, Grant, 1836
   - Class - Demospongiae, Sollas, 1885

- ✓ Halichondria (Halichondria) panicea (Pallas, 1766)

5. Type - Platyhelminthes Minot, 1876
   - Class - Rhabditophora Ehlers, 1985
     - ✓ Stylochus pilidium (Goette, 1881)
6. Type - Nemertea Margulis, L.; Schwartz, K.V. (1982)
   - Class - Hoplonemertea, Hubrecht, 1879
     - ✓ Emplectonema gracile (Johnston, 1837)
7. Type - Nematoda, Diesing, 1861
8. Class - Annelida Margulis, L.; Schwartz, K.V. (1998)
   - Class - Polychaeta Grube, 1850
     - ✓ Amphicorina armandi (Claparède, 1864), Dorvillea rubrovittata (Grube, 1855)
     - ✓ Fabricia stellaris (Müller, 1774), Harmothoe imbricata (Linnaeus, 1767)
     - ✓ Heteromastus filiformis (Claparède, 1864)
     - ✓ Hydroides norvegica (Gunnerus, 1768)
     - ✓ Pholoe inornata (Johnston, 1839)
     - ✓ Phyllodoce maculata (Linnaeus, 1767)
     - ✓ Platynereis dumerilii (Audouin & Milne Edwards, 1833)
     - ✓ Polycirrus jubatus (Bobretzky, 1868)
     - ✓ Polydora ciliata (Johnston, 1838)
     - ✓ Polydora limicola (Annenkova, 1934)
     - ✓ Prionospio cirrifera (Wirén, 1883)
     - ✓ Pseudomystides limbata (Saint-Joseph, 1888)
     - ✓ Nephtys hombergii (Lamark, 1818)
     - ✓ Nephtys cirrosa (Ehlers, 1868)
     - ✓ Nereis pelagica (Linnaeus, 1758)
     - ✓ Nereis zonata (Malmgren, 1867)
     - ✓ Sabellaria taurica (Rathke, 1837)
     - ✓ Schistomeringos rudolphi (Delle Chiaje, 1828)

- ✓ Serpula vermicularis (Linnaeus, 1767)
- ✓ Syllis gracilis (Grube, 1840)
- ✓ Hediste diversicolor (O.F. Müller, 1776)
- ✓ Alitta succinea (Leuckart, 1847)
- ✓ Syllides longocirratus (Örsted, 1845),
- ✓ Eulalia sp.

- Class - Clitellata, Grube, 1850
  - ✓ Olygochaeta sp.

9. Type - Mollusca Margulis, L.; Schwartz, K.V. (1998)

- Class - Polyplacophora Gray, 1821
  - ✓ Lepidochitona cinerea (Linnaeus, 1767)
- Class - Gastropoda Cuvier, 1795
  - ✓ Cerithiopsis minima
  - ✓ Cerithidium submammillatum
  - ✓ Patella ulyssiponensis
  - ✓ Parthenina terebellum
  - ✓ Rapana venosa
  - ✓ Spiralinella incerta
  - ✓ Steromphala divaricata
  - ✓ Tricolia pullus
- Class - Bivalvia Linnaeus, 1758

✓ Anadara inaequivalvis
✓ Lentidium mediterraneum
✓ Modiolula phaseolina
✓ Mytilus galloprovincialis
✓ Mytilaster lineatus
✓ Ostrea edulis Linnaeus, 1758

10. Type - Arthropoda Margulis, L.; Schwartz, K.V. (1998)

- Subtype - Crustacea Brünnich, 1772,
  - Class - Ostracoda Latreille, 1802
    - ✓ Amphibalanus improvisus (Darwin, 1854)
  - Class - Hexanauplia/ Thecostraca, Oakley, Wolfe, Lindgren & Zaharof, 2013
    - ✓ Harpacticus flexus (Brady & Robertson, 1873)
  - Class - Malacostraca Latreille, 1802
- Subtype - Hexapoda
  - Class - Insecta
    - ✓ Chyronomida sp.

III.3. Seasonal Dynamic of the Number of Epifauna in the Georgian Shelf of the Black Sea

Based on the analysis of five-year studies of epifauna, together with species identification, the number of hydrobionts growing in the natural substrate per square meter of area was determined.

According to the data of 2017, the variety of growths was represented by 66 species, the number of which is equal to 152,854 ind/m² on average. The dominant hydrobionts are molluscs, the average number of which is 105,009 ind/m² (69%). Polychaeta is next with number of 33,649 ind/m² (22%). Sessile forms *S. taurica* are the main part of Polychaeta population with 20,094 ind/m² units, which is 13% out of 22% of this population this year (Diag. 1). The average number of Crustaceans was 7,628 ind/m² and made 5% of the entire population. As for the artificial substrate hydrobiont Polychaeta *A.succinea*, spring-summer was considered the most favorable season for it, where 142 ind/m² and 201 ind/m² were recorded respectively. These species were not observed in winter and autumn samples.

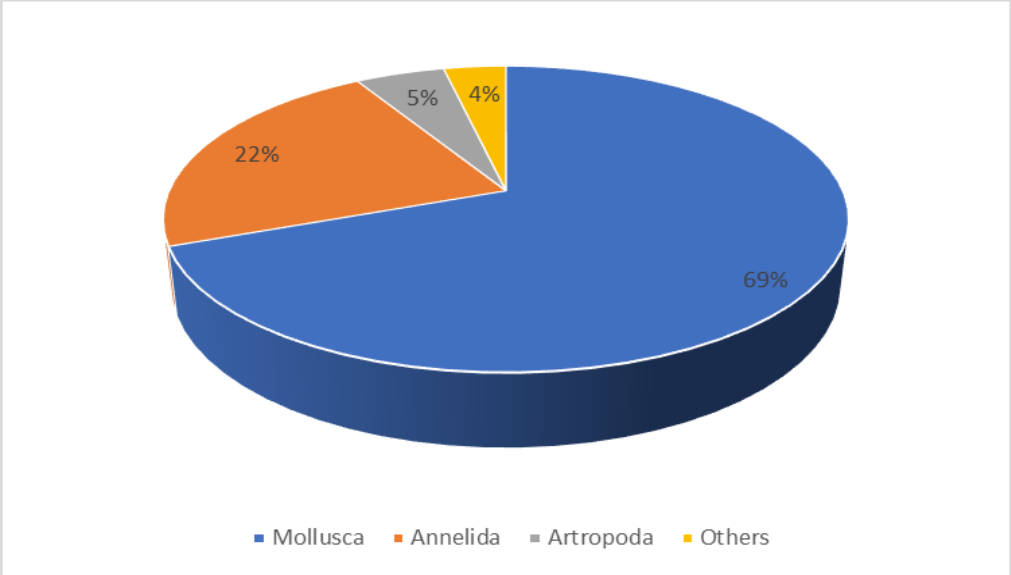

Diagram 1. Percentage ratio of number of epifauna species composition in the Georgian Shelf of the Black Sea, 2017.

In the samples of 2017, bivalve molluscs (69%) occupy the first place in terms of abundance, followed by polychaetes (22%), arthropods (5%), and others (4%) (Diag. 1).

As a result of the seasonal samples in 2018, 59 species were registered in the epifauna, the average annual abundance which is 83,064 ind./m² molluscs dominate, the average number of which is 69 400 ind./m², which is 83.5% of the entire rock settlement. Among the molluscs the bivalve ones are the most numerous - 67,495 ind./m², which is 81% of the entire epifauna. After molluscs polychaeta is distinguished by the number of annelids, the average annual number of which is 5365 ind./m². The dominant form is the polychaete *S.taurica* - 2658 ind./m² and *N.zonata* - 767 ind./m². The average annual abundance of the total number of arthropods is 4308 ind./m², which in turn is very small and amounts to 5.3% (Diagram 2). Among them, the shelly arthropoda *A.improvisus* is presented in terms of abundance - 1687 ind./m². As for the hydrobiont of the artificial substrate *A. succinea*, it was not either observed in the winter samples of this year. They were found in the greatest number in summer (121 ind./m² - with an average annual rate of 63 ind./m²). The dominant species in 2018 were characterized by high abundance mainly in Summer samples and Autumn. As for bivalves, there was a difference in their seasonal distribution. In particular, a high abundance of *M. galloprovincialis* was observed mainly in Spring and Autumn and *M. lineatus* in Spring and Winter.

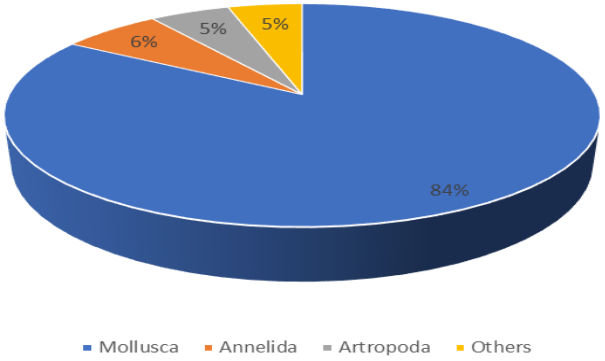

Diagram 2. Percentage ratio of number of epifauna species composition in the Georgian Shelf of the Black Sea, 2018.

In the samples of 2018, bivalve molluscs (84%) still occupy the first place, followed by polychaetes (6%), arthropods (5%), and others (5%) (Diag. 2).

The diversity of the epifauna of hydrobionts in 2019 was presented by 29 species, which in itself led to a downward trend in the seasonal dynamic of abundance and ultimately to a low abundance. In total, the epifauna was noted with an average annual abundance of 11,774 ind./m². Molluscs dominated in the amount of 10 106 ind./m², which is 86% of the epifauna (Diag. 3). It's interesting, that, in 2017, the annual abundance of the dominant bivalve mollusc *M. lineatus* - 93,559 ind./m² - decreased by almost 2 times and by 2018 amounted to 49,472 ind./m². By 2019, we are seeing a 10-fold decrease in the abundance of *M. lineatus* to 4762 ind./m². The downward trend is probably due to the influence of a natural enemy - the predatory purple snail *R.venosa*, whose population increased in 2017-2018-2019 (257-409-424 ind./m²). The specified period of survey is marked by an abundance of gastropoda mollusca *P.ulyssiponensis*. The average annual indices for all four seasons was 1116 ind./m². Also, at an average annual abundance (905 ind./m2), *P. terebellum* was observed in summer and autumn samples, among arthropods, only in summer and autumn samples were *H. pontica* (410 ind./m²) and *T. Dulongii* (244 ind./m²). As for Q. laevigata (279 ind./m2) and Q. pseudoseminula (159 ind./m²), they were presented in reasonable amount. Porifera and Bryozoa were presented as colonies in all seasons. It should be also noted that *L. cinerea*, a member of the Polyplacophora class of molluscs, was first observed in summer samples, the number of which in Autumn was 22 ind./m² (on average, 6 ind./m² year). Spring and autumn samples were the most numerous for dominant bivalves. As for the gastropoda molluscs - *P.ulyssiponensis* and *P.terebellum*, a high abundance was observed mainly in Spring, Summer and Autumn.

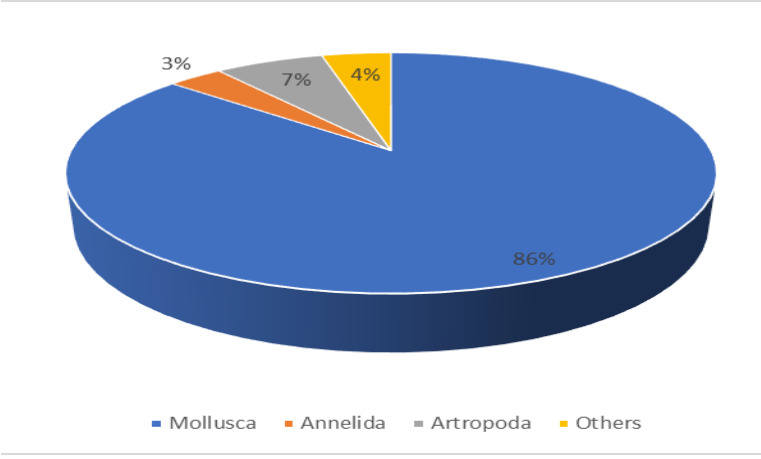

Diagram 3. Percentage ratio of number of epifauna species composition in the Georgian Shelf of the Black Sea, 2019.

In the samples 2019 the percentage of abundance is highest in bivalves (86%), polychaeta (4%), arthropoda (7%), and others (3%) (Diag. 3). Compared to the previous year, the number of arthropoda increased and exceeded the number of polychaeta.

The average annual abundance of epifauna in 2020 is 22,282 ind./m². The dominant group includes molluscs - 13,666 sp/m², which is 61% of the epifauna composition. Among the molluscs, the main individuals of the samples are bivalve molluscs - 91.4%. As for gastropoda, they make up 8.6% of molluscs (Diag. 4). The next position in terms of number is polychaeta - 5163 ind./m², which is equal to 23%. The dominant species is *S.taurica* 2863 ind./m², which is 13% of the epifauna. Also important are *S.gracilis* (388 ind./m²) and *P.dumerilii* (375 ind./m²), which make up 7.6% and 7.3% of the polychaeta population. *H. norvegica* (average - 13 ind./m²) occurs in summer and autumn samples. The average annual abundance of arthropodaa - *A.improvisus* was 9,112 ind./m², and of crustaceans - *A.diadema* (325 ind./m²), *C.olivii* (180 ind./m²) and *M.gryllotalpa* (average 113 ind./m²). Crustaceans are presented in spring, summer, and autumn samples with low values: *A. dentipes* (13 ind./m²) and *C. erythropus* (3 ind./m²). The number of nematoda was quite high (500 ind./m2) in spring, summer and autumn samples. Based on the quantitative analysis of samples in 2020, autumn is considered the most abundant season, since epifauna composition was more numerous at that time. Bivalves, like other years, were identified in Spring and Autumn and to a lesser extent, in Winter.

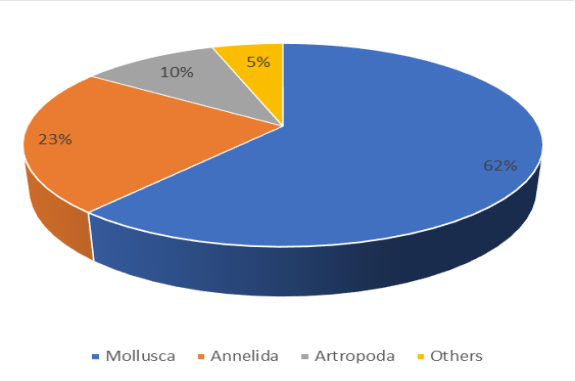

Diagram 4. Percentage ratio of number of epifauna species composition in the Georgian Shelf of the Black Sea, 2020.

In the samples, 2020, bivalve molluscs (62%), polychaeta (23%) again dominated in terms of abundance, which distinguishes their abundance from the samples of the previous year and arthropods (10%) and others (5%) are presented in the corresponding ratio (Diag. 4).

The average annual number of species in samples, 2021 is 26,745 ind./m², which is distributed among the samples as follows: molluscs, 14,281 ind./m² (53%), polychaetes, 7,703 ind./m² (28.8%) , crustaceans - 2,278 ind./m² (8.5%) and other hydrobionts - 2,483 ind./m² (9.3%) (Diag. 5). Molluscs are represented by 2 classes of species that differ in abundance by almost 10 times: bivalve mollusks predominate with a number of 12,889 ind./m² (90.2% of the total number of molluscs), the rest is represented by gastropods - 1393 ind./m² (9,8 %). In the samples of this year, in fact, there are no significant changes compared to last year - the dominant molluscs are still considered to be bivalve molluscs *M.galloprovincialis* and *M.lineatus*. According to the seasons of the year, they were most numerous in Autumn. As for gastropods, *P. terebellum* was presented in high quantities. Autumn was also the most favorable time of the year for this molluscs. The second place was taken by polychaeta worms (7703 ind./m²), the number of which is 29% of the total annual epifauna index. Dominant species: *S.taurica* (3177 ind./m²), *N.zonata* (936 ind./ m²), *P.limbata* (635 ind./ m²), *P.dumerilii* (622 ind./ m²) and *S.gracilis* (546 ind./ m²). Among the few polychaeta, *S. Rudolphi* was found only in autumn samples in the amount of 51 ind./ m². In terms of abundance, autumn samples were the most diverse; however, there were cases when the number of several species in summer samples exceeded autumn ones. During the research period of 2021, the average annual number of arthropods was 2278 ind./ m². A. improvisus (806 ind./m²) and Ch. olivii (281 ind./m²) were dominated among crustaceans. The following species were noted in the smallest quantities in winter samples: *A. dentipes* and *B. sexdentatus* (18 ind./m2, 52 ind./m²). Nematodes were presented in fairly large numbers in all seasons of the year, except for Winter. In spring samples, polychaeta was not observed. They were found in the summer samples in the greatest number. As for foraminifera, they were not included

in the winter collections, and were most numerous in Summer. The number of phoronids was 67 ind./m² and 54 ind./m² in Summer and Autumn. Bryozoa and rhodophyte colonies were presented in Winter, Summer and Autumn.

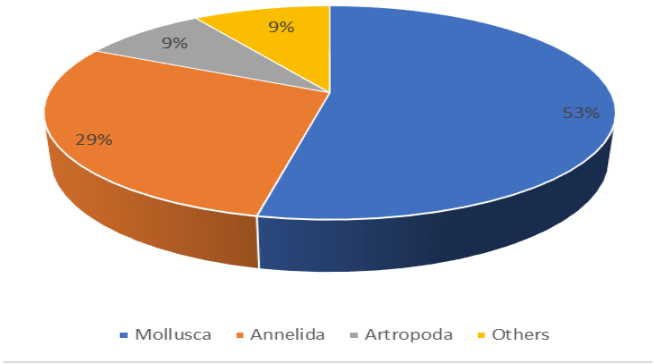

Diagram 5. Percentage ratio of number of epifauna species composition in the Georgian Shelf of the Black Sea, 2021.

Although the percentage of abundance in the 2021 samples still belonged to bivalves (53%), their abundance was significantly reduced compared to samples from previous years. Instead, the number of polychaeta increased (23%) and the number of arthropods slightly decreased (10%). The number of the others reached 9% (Diag. 5).

III.4. Seasonal dynamics of epifauna biomass

Based on the research objectives, the biomass of the sampled species was calculated. In accordance with the above methodology, species were weighed by groups, and accordingly, extrapolation of weights per 1 sq.m was set up based on the area of the sample equipment (sample species biomass was multiplied to 30.8 coefficient). Also, the annual average weights were

Calculating the biomass of the 2017 samples, we obtained the following results: The average annual biomass of species of all groups in total amounted to 7,731 g/m². As expected, the dominant bivalve molluscs were *M.galloprovincialis* and *M.lineatus*, with an average annual biomass - 456.20 g/m² and 2913.75 g/m2 m². The above-mentioned molluscs accounted for 10.85% and 69.3% of the annual average biomass of the entire sample. Also, the gastropoda molluscs *R.venosa* (652.10 g/ m²) and *P.ulyssiponensis* (160.20 g/ m²) were characterized by a rather large weight, which made up 15.5% and 3.81% of the annual average weight of the entire sample.

Among the crustaceans, *A. improvisus* (43.4 g/ m²) was dominated. accounting for 66.56% of the annual average biomass of crustaceans (65.2 g/ m²) and *I. balthica* (13.4 g/ m²), which occupied 20.55%. For crustaceans, the highest biomass indicator was recorded in Autumn and Summer, and the lowest in Winter (0.04 g/ m²). As for polychaeta, *S.taurica* (40.19 g/ m²), *P.dumerilii* (16.77 g/ m²) and *N.zonata* (13.23 g/ m²) were characterized by high average biomass. In terms of biomass index, winter and summer samples were quite poor. Several species were observed in winter samples *D.rubrovittata* (0.08 g/ m²), *H.diversicolor* (0.53 g/ m²) and *N.zonata* (2.33 g/ m²). The highest average weight was found in the case of *S.taurica* (40.19 g/ m²), and the lowest in the following species: *P.jubatus, P.maculata, N.cirrosa, H.imbricata* (0.04 g/ m², 0.05 g/ m², 0.03 g/ m² and 0.04 g/ m²). The total average biomass of polychaetes was equal to 79.97 g/ m², of which 50.2% was *S.taurica*, 20.9% - *P. dumerilii*, 16.5% - *N. zonata*. It can be concluded that in the samples of 2017, the largest share of the total number of biomass of epifauna representatives came from molluscs 98%, polychaete - 1% , Arthropods - 1%. (Diag. 6).

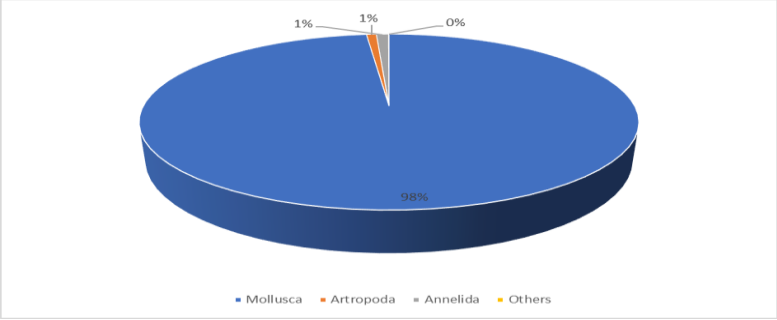

Diagram 6. Percentage ratio of biomass of epifauna species composition in the Georgian Shelf of the Black Sea, 2017

Bivalve molluscs *M.galloprovincialis* and *M.lineatus* are dominant in 2018 samples with an average biomasses of 7 339.06 g/m². Their average weights are: 4310.9 g/ m² and 1540.8 g/ m². The gastropoda mollusc *R. venosa* (1036.4 g/ m²) was also obvious with reasonable massive weight. The lowest average weight was fixed in the case of *S. incerta*, which weighed 0.01 g/ m². The annual average weight of all molluscs was equal to 7297.7 g/ m², 59% of which belonged to *M.galloprovincialis*, and 21% to *M.lineatus*. Among arthropoda, the highest average annual rate was recorded in the case of *A. mprovisus*, which was 16.87 g/ m². Chyronomida sp. was found to

have the smallest weight. (0.01 g/ m^2). Its average annual weight was 26.57 g/ m^2, where 63.4% came from *A. improvisus*, and 16% - on I. *balthica*. As for polychaeta, in the sample, their annual average rate was -12.69 g/ m^2, *S.taurica* and *N.zonata* were dominant in weight according to the data, 4.85 g/ m^2 and 1.85 g/ m^2. *F.stellaris, Eulalia sp., E.naidina, H.imbricata, H.norvegica, P.limicola* - 0.01-0.08 g/ m^2 were presented with a small mass. Average annual rate of *S.taurica* accounted for 38.2% of the biomass of polychaeta, and *N.zonata* - 14.5%. We can conclude that: Molluscs were distinguished by the highest rate of biomass in 2018- 99.4%, Arthropods were - 0.36%, Polychaete - 0.17% (Diag. 7)

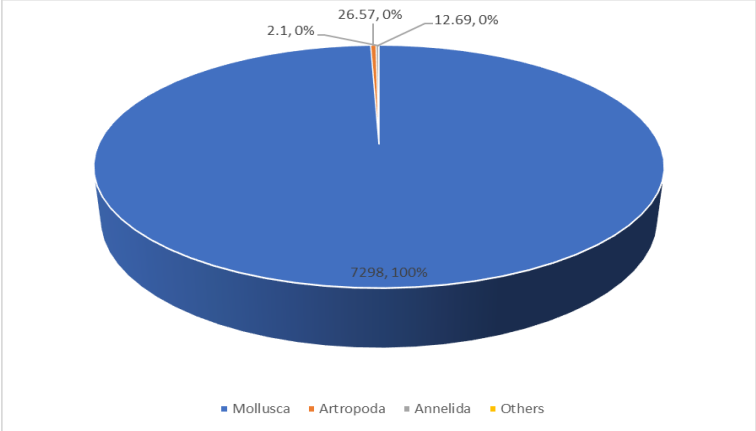

Diagram 7. Percentage ratio of biomass of epifauna species composition in the Georgian Shelf of the Black Sea, 2018

The average annual rate of the 2019 samples was 2,875 g/m^2. As expected, Bivalve molluscs *M. galloprovincialis* and *M. lineatus* were characterized by abundant weights. Their average weight was 123.53 g/ m^2 and 148.31 g/ m^2. *L.mediterraneum* had the lowest biomass. Biomass of the gastropoda *P.ulyssiponensis* was 1447.63 g/ m^2, and the weight of *R.venosa* - 1072.44 g/ m^2. Among the arthropoda the most visible was *H. pontica* with an average annual biomass - 10.65 g/ m^2. the maximum rate recorded in the spring samples (28.58 g/ m^2). The smalles weghts had

N.guttatus (0.03 g/ m²) and *P.maeoticus* (0.03 g/ m²). They appeared only in Spring. The annual average biomass of arthropoda was equal to 11.15 g/ m², where the highest share - 96% came from *H.pontica*. Among polychaeta *N.hombergii* was distinguished with an average weight 3.8 g/ m², the maximum weight of which was found in spring samples and it reached 10.30 g/ m². The average weights of *N. cirrosa* and *N. zonata* did not exceed 1 gram (0.01 g/ m², 0.5 g/ m²). The average annual biomass of polychaeta was equal to 7.2 g/ m², in which 53% came from *N.hombergii* and 31% from *H.diversicolor*. Nematodes were also recorded only in Spring with 0.06 g/ m² and the average annual rate of 0.01 g/ m² and *S.pilidium* was found to be a winter inhabitant (0.13 g/ m²; annual average mass 0.03 g/ m²). As for *Q. laevigata* and *Q. pseudoseminula*, their proportion in the total biomass was 50% and 36.4%. By summarizing the epifauna biomass indicators in 2019, we can conclude that the largest part came from molluscs with 99.3%, arthropoda 0.39%, polychaeta was 0.25% . (Diag. 8).

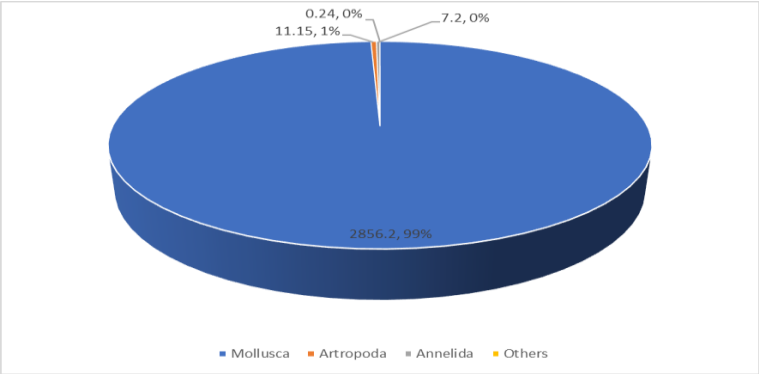

Diagram 8. Percentage ratio of biomass of epifauna species composition in the Georgian Shelf of the Black Sea, 2019

The average annual rate of the 2020 samples was equal to 1063.3 g/m². The dominant species were: *P.ulyssiponensis, M.galloprovincialis, M.lineatus* and *R.venosa*. Their ratio against the average biomass of molluscs (1063.3 g/m²) is as follows: *P.ulyssiponensis* - 30.5%, *M.galloprovincialis* - 30.4%, *M. lineatus* – 18% and *R. venosa* – 12.4%. *O.edulis* was revealed with weight (56.4 g/m²), whose part was 5.54%. The average annual biomass of arthropoda was 21.95 g/m² where the largest share - 62% came from *A. improvisus* (13.62 g/m²). They were distinguished by their weights: *P.marmoratus* (2.65 g/m²) and *I.balthica* (2.22 g/m²). The lowest

weight index was recorded in the case of *A. bispinosa* and *D. bidentata* (0.03 g/m²). Among multicellular worms, *P.maculata* dominated with a weight of 7.77 g/m², which was 34.7% of the average annual total data of polychaeta (22.33 g/m²). The next place was occupied by *P. dumerilii* with 16.7% (3.75 g/m²). *H. norvegica* and Olygochaeta sp were characterized by the lowest weight. 0.01-0.01 g/m². *P.maculata* was mainly observed in summer and autumn samples, where the maximum weight index was shown by the summer samples. The highest nematoda biomass was also found in summer samples -0.45 g/m², which was 51% of the average annual indicator. Both representatives of foraminifera, *Q. laevigata* and *Q. pseudoseminula*, shared their part of total weight - 52.2% and 47.82%. They were mainly residents of spring and summer samples. Analyzing epifauna biomass figures for 2020, we can conclude that the largest share came from molluscs with 95.8%, polychaete - 2.1% and arthropods - 2.06% (Diag. 9).

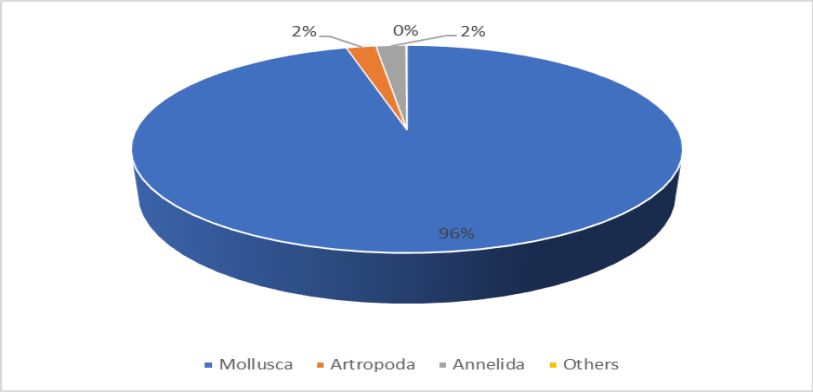

Diagram 9. Percentage ratio of biomass of epifauna species composition in the Georgian Shelf of the Black Sea, 2020

The average annual rate of 2021 was to 1355.99 g/m². From this, the average annual mass of bivalves and gastropoda was to 1315.57 g/m². where most of the part came from: *R.venosa* (37%), *P.ulyssiponensis* (27%), *M.galloprovincialis* (24.3%) and *M.lineatus* (8.9%). Insignificant weights were recorded in the cases of *S. incerta* (0.01 g/m²), *C. minima* (0.02 g/m²) and *L. mediterraneum* (0.03 g/m²). *M. galloprovincialis* and *M. lineatus* were the species of all four seasons, however their

maximum weights were recorded in autumn samples (510.36 g/m^2, 296.25 g/m^2). A high weight index of *P.ulyssiponensis* (671.81 g/m^2) was detected in the spring samples and *R. venosa* was characterized by overweight in summer (1043.32 g/m^2). Among arthropoda, *A. improvisus* had the highest average biomass (8.06 g/m^2), which made up 47.2% of their total average data (17.07 g/m^2). Also, *I. balthica* was distinguished with 3.79 g/m^2 and *C. erythropus* with 1.81 g/m^2 (relatively with percentage - 22.2% and 10.6%). The maximum weight of the dominant species *A. improvisus* was recorded in the summer samples. *D.bidentata* (0.02 g/m^2) and *M.gryllotalpa* (0.03 g/m^2) were characterized by the lowest weight index. The average annual biomass data of polychaeta worms was to 21.83 g/m^2. In this year, a high rate of biomass was recorded in the case of *P.dumerilii* (6.22 g/m^2), which was to 28.5% of their total average annual weight. According to the data, the dominant species of previous years, *S.taurica*, was slightly behind with 6.21 g/m^2, and the average annual weight of the other species did not exceed 3 grams. The annual data of nematoda was 0.71 g/m^2, and flat worm *S.pilidium* -0.45 g/m^2. Representatives of foraminifera - *Q.laevigata* and *Q. pseudoseminula* distributed their weights equally (0.16 g/m^{2}and 0.15 g/m^2). The analysis of the biomass data of 2021 allows us to conclude that the largest share came from molluscs with 97%, followed by polychaeta with 1.61%, and arthropoda with 1.25% (Diag. 10).

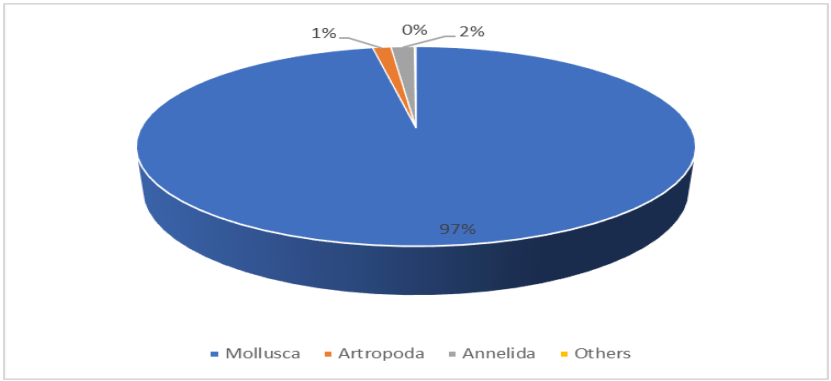

Diagram 10. Percentage ratio of biomass of epifauna species composition in the Georgian Shelf of the Black Sea, 2021

Based on the results of 5 years surveys, we can conclude that: bivalve molluscs are the dominant species in terms of biomass and quantity at each station during seasonal surveys of all years, and with the alternation of years, the next places are occupied by polychaeta and arthropoda (Diag. 11).

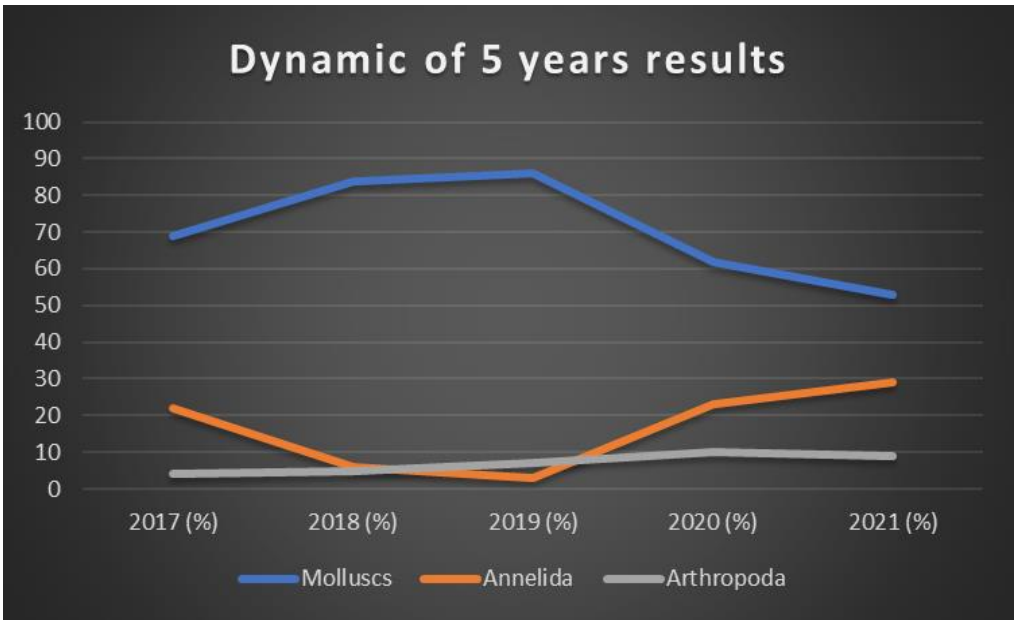

Diagram 11. Dynamic of epifauna species composition in 2017-2021 (percentage index)

Looking at the above diagram (Diag. 11) We note that the lowest rate of bivalve molluscs was recorded in 2021, and the highest - in 2019. There is an increase in the percentage of annelida (polychaeta) and arthropoda having a relatively stable position.

III.5. Biometric characterization of dominant species of epifauna Alitta succinea (Leuckart, 1847)

In the epifauna of the artificial substrate of the south-eastern coast of the Black Sea of Georgia, the dominant species of the polychaete *A. succinea* was observed. We decided to study the biometric data of this species, which was a scientific innovation, and the results of the biometric analysis would later lay the foundation for determining the bioproductivity of the mentioned species.

For this purpose, a certain set of individuals, a total of 111 individuals, were examined. Based on the analysis of the obtained results, the generalization of the results of the observation was made as a whole, which is called extrapolation. Statistical information was obtained based on the analysis of collected samples with three characteristics: 1. Body length (L-cm); 2. Raw body weight (W1-gr per unit); 3. Dry weight of the body (W2-gr per unit).

In order to study the size-weight composition of *A.succinea*, field work was carried out in March, May and July 2021 (Tables 1,2,3).

Table 1

Field work data on size-weight composition of *A. succinea* , March 2021

N	L, Length, cm	W_1, Rw weight, gr	W_2, Dry weught, gr
1	4,6	0,31	0,29
2	4,8	0,32	0,30
3	5,7	0,62	0,52
4	8,3	1,32	1,25
5	8,4	1,33	1,30
6	6,5	0,82	0,72
7	8,6	1,34	1,02
8	4,7	0,16	0,14
9	4,6	0,16	0,13
10	6,2	0,79	0,77
11	7,8	0,83	0,79
12	8,1	0,90	0,82
13	7,2	0,72	0,70

14	8,8	0,42	0,38
15	4,6	0,29	0,25
16	4,5	0,30	0,29
17	6,4	0,46	0,39
18	8,3	1,12	1,10

Table 2

Field work data on size-weight composition of *A. succinea* , May 2021

N	L, cm	W_1, gr	W_2, gr	N	L, cm	W_1, gr	W_2, gr
1	8,2	1,32	1,25	26	6,9	0,83	0,73
2	2,5	0,06	0,04	27	6,9	0,75	0,67
3	5,1	0,37	0,33	28	5,5	0,23	0,21
4	5,5	0,34	0,29	29	5,9	0,26	0,23
5	5,5	0,60	0,50	30	7,5	0,80	0,62
6	8,1	0,46	0,39	31	4,1	0,35	0,31
7	7,5	0,37	0,26	32	3,4	0,06	0,05
8	7,2	0,07	0,06	33	7,2	0,82	0,62
9	5,2	0,31	0,29	34	5,9	0,60	0,50
10	6,4	0,37	0,26	35	6,2	0,63	0,51
11	5,8	0,37	0,32	36	8,1	1,30	1,19
12	8,2	1,00	0,90	37	3,9	0,05	0,04
13	7,6	0,81	0,70	38	6,6	0,32	0,27
14	7,2	0,80	0,69	39	7,1	0,51	0,46
15	5,0	0,18	0,12	40	6,3	0,34	0,32
16	5,5	0,27	0,19	41	6,3	0,29	0,26
17	5,8	0,07	0,06	42	8,3	0,70	0,61
18	7,8	0,80	0,62	43	7,9	0,51	0,46
19	8,2	0,93	0,88	44	7,2	0,44	0,34
20	7,4	0,80	0,62	45	7,3	0,73	0,70
21	7,3	0,83	0,60	46	6,4	0,34	0,30
22	5,5	0,07	0,06	47	5,5	0,23	0,21
23	6,3	0,32	0,30				
24	8,1	0,92	0,88				
25	8,1	0,05	0,04				

Table 3

Field work data on size-weight composition of *A. succinea* , July 2021

N	L, cm	W_1, gr	W_2, gr	N	L, cm	W_1, gr	W_2, gr
1	3,6	0,05	0,04	24	6,5	0,59	0,50
2	7,4	0,80	0,62	25	8,3	1,03	0,78
3	13,5	4,18	3,44	26	7,3	0,81	0,61
4	12,0	3,65	3,03	27	1,5	0,05	0,04
5	6,5	0,07	0,06	28	7,3	0,50	0,41
6	6,5	0,27	0,19	29	6,5	0,37	0,26
7	7,5	0,28	0,20	30	6,5	0,28	0,21
8	7,4	0,27	0,21	31	7,5	0,82	0,62
9	6,5	0,27	0,19	32	7,3	0,80	0,59
10	6,5	0,37	0,26	33	7,3	0,73	0,67
11	8,5	1,00	0,82	34	9,0	1,23	1,00
12	5,5	0,09	0,06	35	9,2	1,43	1,02
13	7,5	0,80	0,62	36	9,1	0.52	0.49
14	7,4	0,69	0,60	37	8,5	0,89	0,79
15	7,4	0,72	0,70	38	9,2	1,40	0,89
16	6,5	0,07	0,06	39	9,2	1,38	1,29
17	1,0	0,03	0,01	40	8,6	0,88	0,80
18	7,3	0,69	0,59	41	10,5	1.43	1.02
19	8,3	1,35	1,25	42	10,5	2.43	2.33
20	7,4	0,83	0,75	43	8,5	0,91	0,86
21	7,2	0,70	0,61	44	9,5	0,79	0,71
22	7,4	0,72	0,59	45	9,5	0,80	0,67
23	6,5	0,81	0,70	46	6,6	0,27	0,19

As for the biostatistical analysis of the correlation between the size of the artificial substrate *A.succinea* and the raw and dry weights, we obtained by mathematical calculations sa follows:

1. The length of the organism, as a random variable, reached an average of 7.04 cm; The variance index is 3.45 cm; standard deviation 1.86; The coefficient of variation is 26% and is close to the average level of variation; The absolute error rate of the arithmetic mean is 0.18;

The relative error of the arithmetic mean is 3%, which means that the accuracy of calculating the arithmetic mean is satisfactory.;

2. The average raw body weight is 0.65 g, and the dry weight is 0.56 g;
3. The correlation relationship between body length and raw and dry weights is strong, therefore, the value of the correlation coefficient reaches 0.76 and 0.75 units; The value of the correlation coefficient between raw and dry weights of the organism, and vice versa, between dry and raw weights, reaches 0.97 and 0.99 units, respectively;
4. Regression analysis between body length and raw and dry weights shows that an increase in length by 1 cm leads to an increase in raw weight, on average, by 0.25 g and dry weight, on average, by 0.15 g;
5. Regression analysis between raw and dry weights indicates that an increase in the raw weight of an organism by 1 g leads to an increase in dry weight, on average, by 0.85 g. The correlation error is low and amounts to 0.006 g;
6. A 1 g increase in body dry weight would theoretically lead to an average 1.16 g increase in raw body weight. In this relationship, the correlation error is even lower and amounts to 0.002 g

IV. The role of epifauna in the ecology of the Georgian shelf of the Black Sea

IV.1. Dominant Epifauna Bivalve Species as Biofilters and Sediment Producers

Redox reactions are considered the basis of all life processes that determine the intensive movement of electrolytes. From this point of view, natural marine water is an open redox system in which some substances are oxidized and others are regenerated. Along with physicochemical factors, aquatic living organisms play an important role in the redox regulation of marine water. The community of growths due to filtration activity and metabolic exchange with the environment leads to the occurrence of redox processes.

One of the clear examples is the effect of bivalve molluscs - *M.lineatus* and *M.galloprovinicalis* on the chemical composition of marine water. In the process of population growth of these species, oxidative reactions are activated (the level of H_2O_2 rises). Along with the intensity of reproductive processes, there is an increased consumption of oxygen and, accordingly, the release of acidic products as a result of metabolism, i.e., a decrease in the level of H_2O_2. Consequently, the period of reproduction of mussels contributes to the existence of regenerative reactions in marine water (Таможняя, 1989: 66). From this we can conclude that different life processes of bivalve molluscs affect the chemical composition of marine water in different ways.

In the case of our samples, the dominant epifauna species were mainly bivalves and polychaeta. According to the number of species, bivalves are one of the main groups of invertebrates. They are found in especially large numbers in the Black Sea coast, where they rank first among the animals living here in terms of biomass and population density. Molluscs play a primary role in the functioning of benthic biocenoses and occupy a prominent place among marine invertebrates.

Among bivalve molluscs, *M.galloprovincialis (L.1819)* and *M.lineatus (Gmelin, 1790)* were observed in the sample. The role of these molluscs as filter feeders is very great, especially on the Black Sea shelf, where the ecosystem experiences various levels of anthropogenic influence. As widespread species, they can be used as an indicator of the ecological state of the sea, especially in a part of the marine area that is promising for the development of mariculture.

It is difficult to determine the source of Black Sea pollution, but it should be noted that they are the primary prerequisite for determining the development of the ecological situation.

Lots of scientific data indicate that the ecological state of our planet is undergoing dramatic changes that are manifested in all its components. Anthropogenic pollution of the world's oceans in some cases exceeded the permissible limits. In this regard, the study of water bodies as a biological self-purifying system, as well as individual components of this system - zooplankton and epifauna, is of particular importance. Bivalve molluscs are filter feeders, their participation in the cleaning of water bodies is very high, which allows them to be used as monitoring objects.

In the process of self-purification of water from various pollutants in the hydrosphere, marine organisms themselves are of great importance. They take various elements, including petroleum (oil), from marine water and store them in their body. For example, according to Piatakova (Пятакова, 1975: 45-46), the mollusca *M. Lineatus* collects 0.0003 to 0.037 mg of oil in its body per day.

In general, the filter-sorting apparatus of bivalve molluscs is quite complete. For example, mussels can filter particles ranging in size from 40 to 1.2 μm. Bivalves filter very large volumes of water. For example, oysters can filter 10 liters of water in one hour, and mussels - 2-5 liters (more at a higher water temperature, and less at a lower one). Filtration is a continuous but adjustable process. The intestinal ganglia enhance filtration, while brain ganglia - on the contrary, inhibit it. Along with this, the nervous system controls numerous factors that affect the filtration process, the selective ability of the ciliary tract, the opening of the valves, etc. The intensity of filtration also depends on the age of the mussel. Small mussels filter more intensively than larger individuals.

Bivalve molluscs are able to filter 20-40 liters of water per day, filtering out dense particles of organic and inorganic origin from it. Filtered microorganisms and dense particles of organic origin reach the digestive system of the filter-feeding mollusca, while unsuitable particles, including droplets of petroleum (oil) products, are deposited on the mucous layer of the mantle surface.

Depending on the contamination, the mucus is collected in groups and expelled through the discharge siphon. These waste products of filter-feeding molluscs, along with mucus, also contain a certain amount of organic compounds and represent a complex concentrate for feeding microorganisms.

Thus, filter-feeding molluscs remove pollutants from the water, some of which they use for their own nutrition, and the rest is collected for microorganisms. The latter, in turn, are food for detritus-eating animals. These include some gastropods.

The capacity of the self-purification system of the reservoir is strongly depended on the number and activity of filter-feeding molluscs in it, since the ability of microorganisms to mineralize organic waste and oil products can be fully realized by molluscs, which, therefore, represent significant part of the water self-purification system.

With anthropogenic pollution of the hydrosphere, domestic and industrial wastes get into the water. They represent two groups of substances: mineral salts and organic compounds, both in the form of suspended particles and in a dissolved state. These wastes get into the water body in large quantities, change the quality of the water, which becomes unusable and therefore can be considered as primary pollution. In order to protect the aquatic environment, we must prevent its primary pollution. To do this, we must ensure production with efficient technology and improve wastewater treatment methods.

Primary and secondary pollution of water bodies brought to the filter-feeding animals. These are zooplankton and molluscs. Zooplankton is a food object for secondary utilizers - fish, the biomass of which is not only easy to remove from the reservoir, but also necessary. Under conditions of slight pollution, the role of zooplankton in the self-purification of inland waters is great, but one cannot forget that under conditions of strong primary and secondary pollution, zooplankton and its consumer fish are completely excluded, or there are a few species that are resistant to oxygen deficiency.

A decrease in oxygen concentration during pollution of water bodies leads to the oppression of many species, so the focus is shifting to the type of filter-feeding animals, which are not only primary consumers of secondary pollution, but also have the ability to survive. under conditions of low oxygen concentration. These are molluscs, the extraction of which from a reservoir is not only technically feasible, but can also be useful in terms of their use (as an additional source of proteins).

Shellfish filters can be used in measures to protect the aquatic environment from pollution. Molluscs are benthic animals that are less mobile and/or attached to a solid substrate. By filtering a significant amount of water, they collect in their bodies various organic substances present in this area of the reservoir. After 1-2 weeks, these substances almost completely enter the body of animals, or are excreted from it. Therefore, the chemical, biochemical and immunological analysis of the tissues of molluscs separated from the water pond provides an opportunity to determine the hydrochemical and microbiological condition in a given area of the water body in the next 1-2 weeks and to close the shell valves tightly in case of adverse factors in the environment, which can be used to quickly detect the contamination of the water body. The movement of mollusca valves is transformed into an electrical signal, and the mollusca itself - into a special indicator of the state of the water body, which gives a signal when unfavorable conditions occured.

IV.2. Epifauna - natural food resource for hyfrobionts

Among the epifauna species of the Black Sea, bivalve molluscs dominated as a food base for hydrobionts. The industrial weight of shellfish meat is 38 g and depends on the season of the year. 15-20% of the meat is the molluscs valve and 36-45% is the mantle liquid (Иванов, 1963: 23-27).

Mussels have many enemies in the form of marine fish, birds and mammals. Birds hunt them in the littoral at low tide. Mussel settlements are heavily damaged by marine turbots and cod, and in the Black Sea by sturgeons. Their constant enemies are large starfish, which usually inhabit areas inhabited by molluscs. A starfish eats one or two species up to 2 cm in size daily. They are a

favorite food of young crabs. In recent years, the gastropoda molluscs – Rapana, has become the most dangerous enemy of bivalve molluscs. Mollusc populations are heavily damaged by polychaeta and burrowing sponges. Polychaeta are found along the entire coast of the Black Sea.

Representatives of some species of epifauna - molluscs, crustaceans - are of economic importance. In particular, they are used for animal feed, and individuals larger than 50 mm are used by humans. Natural populations of mussels are used in mariculture. Along with the substrate of natural growths, an artificial substrate can be created on which they can freely spawn (in order to attach larvae). This, in turn, will create a reliable shelter for fish larvae and other animals, especially when they are artificially bred. In addition, natural growth is a kind of biofilter for water cleaning from pollutants.

IV.3. Ecological groups of epifauna following the substrate types (biotopes)

To study ecological groups by substrate, the material was collected and processed at the laboratory of Fisheries, Aquaculture and Water Biodiversity of the National Environmental Agency of Georgia.

The following hydrobionts were observed in the samples: rhodophytes, bryozoa, porifera, (in the form of colonies), foraminifera, phoronids, from flatworms – rhabditophora; nemertea, nematodes, annelida (mostly a class of polychaeta); from arthropoda: a class of crustaceans – balanus and from the higher crustaceans - members of the malacostraca class; from molluscs - polyplacophora (Chitons), gastropoda and bivalves.

From the type of foraminifera, we observed representatives of the class of tubothalamea (multicellular valves amoebae). The sample also consisted of representatives of the class of Demospongiae of the porifera type, which appeared in the form of colonies.

We observed foraminifers in samples of three seasons (except Winter) of the studied years (2017-2021), however, they were not found in samples of 2019. As studies have shown, their habitat in the form of free-floating hydrobionts is mainly algae, and they use algae as a biotope.

Foraminifera are semi-phytophilic or plant-loving organisms. Modern foraminifera are marine organisms, but they are also found in freshwater and even terrestrial habitats. Most of them are benthic organisms, but there are also planktonic forms.

Representatives of flatworms - Stylochidae are free-swimming organisms, whose abundance are variable and subject to seasonal dynamics. The biotope of Nemertea, the living environment - is algae, which caused their phytophilic nature.

The polychaeta biotope can be considered the next area of the study region. They lived both on stones, inside stones, and on algae, where they built so-called "houses" in the form of limestone pipes. Therefore, polychaetes are considered as lithophiles and phytophiles.

Gastropoda and bivalves are the dominant forms of molluscs for the mentioned region, occurring in all seasons of the year. Their living environment was mostly rocks, man-made structures, and sometimes algae. They constituted the largest population in epifauna samples. Depending on the habitat of these organisms, molluscs are divided into lithophils and phytophils according to biotopes.

The range of arthropods - shelly crustaceans (lower crustaceans - Balanus), mainly consisted of bivalve molluscs and gastropoda molluscs (especially surface of the rapana shell) - they live on masse on shells and lead a symbiotic lifestyle. Balanus are considered zoophilic organisms.

As for the representatives of higher crustaceans, they were mainly presented in the form of amphipods and decapods and were free-swimming, that is, they did not lead an attached lifestyle. On the basis of the foregoing, according to ecotopes, the epifauna is divided into: phytophiles, zoophiles and lithophiles.

Conclusions and reccomendations

1. As a result of the systematic analysis of the epifauna of the coastal zone of the Georgian shelf of the Black Sea, it was found that the epifauna of the coastal shelf zone of the sea is quite diverse. Based on the samples of 2017-2021, 11 types, 2 subtypes and 16 different classes of epifauna were registered by us within the mentioned zone. Among them, polychaeta (25 species), arthropoda (17 species) and bivalve molluscs (13 species), which are the dominant forms of the hard ground of the shelf, are distinguished by their relative diversity.
2. In the shelf zone, depending on the stationary stations, the species composition of the epifauna is somewhat different. Green Cape samples were distinguished by species diversity, the results of Tsikhisdziri and Sarfi samples were equal. So, for example, if the samples of Tsikhisdziri were distinguished by the abundance of polychaeta worms, the representatives of molluscs prevailed in the samples of Sarfi. However, mytilasters were recorded in the largest quantity in samples from Tsikhisdziri. As for arthropoda, they were mostly found in the samples of Green Cape, however, the samples of Tsikhisdziri stood out quantitatively. The abundance of polychaeta is caused by the absence of their so-called consumer fish at the depths where our samples were taken (4-6m). This means that the bottom fish that feed on bottom-attached animals (eg: Red mullet, Turbot, Sturgeon, etc.) inhabit mainly below 10 m.
3. It should be noted that a sharp difference between the stations was not observed, except for the winter sample of 2019 (Sarf), where for the first time during the entire 5-year surveys, a representative of the class of mollusca, *L.cinerea*-22, was recorded. with a total weight of 4.31 g/m^2.
4. Based on visual observation and existing literary sources, we identified bioecological groups such as: lithophiles, phytophiles and zoophiles, among which lithophiles dominate.
5. To determine the productivity of the epifauna, the quantitative composition of individual species of hydrobionts of the epifauna, population density (eg/m2) and biomass (mg/m^2) per 1 m^2 area were calculated. Their seasonal dynamics were determined. In this regard, the

dominant species of epifauna - bivalve molluscs were identified, which, based on the results of the entire five-year period, accounted for 53 to 90% of the samples. The remaining share is set out almost equally by polychaetes (from 3 to 29%) and crustaceans (from 4 to 10%).

6. The highest number of bivalve molluscs was recorded in 2019 with a share of 86% of the entire sample, the lowest - in 2021 - with a share of 53%..
7. The highest number of polychaeta was observed in 2021 with a share of 29% of the entire sample and the lowest - in 2019 with a share of 3%.
8. The largest number of arthropoda was recorded in 2020, with a share of 10% of the total number of samples, and the least - in 2017 - with a share of 4%.
9. Biometric aspects of A. succinea species of one artificial substrate were calculated. Regression analysis between body length and raw and dry weights shows that a 1 cm increase in length leads to an average 0.25 g increase in raw weight and an average 0.15 g increase in dry weight. The regression analysis between the raw and dry weights indicates that an increase in the raw weight of the body by 1 g leads to an increase in the dry weight, on average, by 0.85 g.
10. While working on the thesis, the ecological condition of the Georgian shelf was evaluated. It was found to be quite stable in this regard, except for 2019, during which there was a sharp deterioration in the biodiversity index of arthropoda and polychaeta worms. If in previous years (2017-2018), the variety of species of the mentioned types was 17-25, in 2019 it dropped to 5 units. In the same year, there was also the absence of nemertines, phoronids and foraminifera, which had a certain impact on the number and biomass of species in the samples. However, we got a convincing picture from the samples of the following years, in which the loss of species diversity was almost restored. According to our assumption, one of the reasons for the sharp changes in 2019 might have been a reverse-proportionate change in the number of the natural enemy - Rapana, in particular, this year there was an increase in the number of this specie.

11. It is noteworthy that the natural self-cleaning process of dirty water takes place in water reservoirs. In the case of a particular sea, in this regard, they play a special role, the so-called Biofilters - bivalve molluscs.

Recommendations

Based on the analysis of the research results, some recommendations can be made:

1. Inasmuch as the hydrobionts that make up the epifauna create biocenoses on the uninhabited solid ground of the reservoir, participate in the creation of biodiversity and play an active role in the exchange of common substances and compounds in the ecosystem. In addition, they represent a natural food base for other hydrobionts and also delicate food (mussels) for humans, we consider it appropriate to include them in industrial mariculture production as the best object.
2. We consider it necessary to pay special attention to the artificial reproduction of biofilter molluscs - mussels through the development of mariculture, as they play an important role in the process of self-purification of water.