REVIEW ARTICLES

PRESENTABILITY OF THE UTRISH NATURE RESERVE'S BENTHIC COMMUNITIES FOR THE NORTH CAUCASIAN BLACK SEA COAST

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An assessment of the presentability of the biotopes and benthic communities of the northwestern part of the Utrish Nature Reserve marine area for the Caucasian Black Sea coast has been conducted. The literary and original data on the state of benthos in the area from the Kerch Strait to Adler were examined. The studied area of the Utrish Natural Reserve included habitats that are common along the coast (an active cliff, a narrow pebble beach, boulder deposits, rock bench and soft sediments). Only two of the three well-known Black Sea belt macrozoobenthic biocoenoses were observed along the northeastern Black Sea coast: the shallow-water «venus sand» and the deep-water «phaseolina silt». The third biocoenosis («mussel mud») was not noted neither in the reserve's area nor in the studied part of the shelf to the south of Novorossiysk. Of these three belts only «venus sand» was found in the Utrish Nature Reserve's marine area. The absence of the mussel belt in the studied area of the reserve is typical for the southern part of the North Caucasian coast in the current period and thus does not affect the presentability of the reserve's benthic ecosystem. The biocoenosis of the bivalves *Pitar rudis – Gouldia minima* was common at the muddy sand with shells in both reserve's and reference sites' middle-depths complex instead of the mussel belt which was typical for the 20th century. Its boundary was 10 m deeper in the reserve compared to the reference sites. The absence of the *Modiolula phaseolina* belt in the area of the reserve could be explained by the insufficient width of the protected marine area (up to 52 m depth); due to this the deep-water complex in the reserve is actually represented by a narrow strip. Extension of the reserve's boundary over the depth of 70 m will include this biocoenosis into the Protected Area, which would significantly increase the presentability of the reserve's marine part for the North Caucasian coast. The biogeographical composition of the reserve's flora, its species diversity and structure in general corresponds to that of the whole region. The macrophyte zone consists of four belts: upper (0–2 m, *Dictyota fasciola* f. *repens* + *Polysiphonia opaca* + *Ceramium ciliatum* + *Ulva compressa*), upper mid (2–12 m, *Cystoseira crinita* + *Cystoseira barbata – Cladostephus spongiosus – Ellisolandia elongata*), lower mid (12–18 m, *Phyllophora crispa*, *Codium vermilara* and *Bonnemaisonia hamifera*), and the lower belt (below 18 m) formed by a recent invader, *B. hamifera.* The majority of species found in the reserve's marine area are common species of the Black Sea macrophytobenthos. However, the Utrish Nature Reserve includes more favourable habitats for macrophytes than most of the North Caucasian coast, because the typical macrophyte *Cystoseira* spp. have been noted at greater depths in the reserve, in comparison to the remaining shelf.

Key words: biocoenoses, biotopes, macrophytobenthos, macrozoobenthos, marine reserve

Introduction

In total, there are about 3000 marine reserves in the world (Marine Protected Areas, 2011). There are over 20 Marine Protected Areas (MPAs) of international importance along the Black Sea shores (Alexandrov et al., 2017), and the Utrish Nature Reserve is the only one situated on the Caucasian coast. The system of terrestrial Protected Areas existing at the beginning of the 21st century can be considered fully representative based on the zonal-landscape principle (Krever et al., 2009). Contrary to that, the spatial structure of marine ecosystems played subordinate role or was just not taken into account when determining marine reserves' boundaries (Mokievsky et al., 2012a). An assessment of the species and landscape diversity in the marine areas of the reserves has not been fully implemented or has not been carried out yet.

The creation of Protected Areas on the Caucasian coast is complicated due to a permanent increase of recreational impact on the coast. The first reserve that included a marine area has only appeared in 2010. It is the Utrish Nature Reserve, which is situated on the Abrau Peninsula (Chestin, 2009). The main goal of its foundation was to preserve and restore unique natural complexes of dry subtropics of the Black Sea Caucasian coast (Statute on the State Nature Reserve Utrish. Approved by the Order of the Ministry of Natural Resources and Ecology of the Russian Federation No. 145 of 3 March 2011; hereinafter – the Statute) whereas the marine part was created to preserve biological diversity of the coastal zone of the North Caucasian coast ecosystem, which underwent significant changes driven by the climate and anthropogenic impact at the end of the 20th century – beginning of the 21st century (Chestin, 2009).

From the beginning of the 20th century until the end of the 1970s, the Black Sea ecosystems were considered stable (Zenkevich, 1963; Kiseleva & Slavina, 1966; Kiseleva, 1981, 1992). However, since the 1970s, species diversity has decreased, the dominants of communities have changed, the lower boundary of macrophytobenthos' habitats has shifted to shallower depths (Blinova et al., 1991; Maximova & Luchina, 2002; Maximova & Moruchkova, 2005; Afanasyev, 2008; Minicheva et al., 2008; Simakova & Maximova, 2009; Kucheruk et al., 2012) and the role of invasive species has increased as a result of anthropogenic eutrophication, introduction of new non-indigenous species and climate change (Shushkina & Vinogradov, 1991; Zaitsev & Oztürk, 2001; Chikina, 2009; Llope et al., 2011) (Fig. 1). In the North Caucasus, these changes mostly affected the coast to the south of the Abrau Peninsula (Chikina, 2009). In the northern part, the changes were not so catastrophic, although a siltation of vast bottom areas has been noted in the Kerch Strait area (Chikina, 2009; Terentyev, 2013). The area of the Utrish Nature Reserve, located at the border of these two zones, remained comparatively understudied during these years.

Marine ecosystem studies of the Utrish Nature Reserve vicinities began in the early 20th century. Zernov (1913) was the first to collect macrozoobenthos samples in the area. He found «very poor phaseolina silt» (silt with domination of the bivalve *Modiolula phaseolina* (Philippi, 1844)) at a 72 m depth (station 127). Later, as reported by Kiseleva & Slavina (1965), zoobenthos at 59–103 m depths was presented by a community dominated by *Modiolula phaseolina*. Shallower depths were not considered. In 1989, within the framework of the study of the Caucasian shelf coast, the Odessa branch of the Institute of the Biology of the Southern Seas conducted a survey in the region of the Abrau Peninsula (Alekseev & Sinegub, 1992). The presence of common Black Sea communities with domination of *Chamelea gallina* (Linnaeus, 1758) (usually referred to as the «venus sand», after the old name of the species), *Mytilus galloprovincialis* Lamarck, 1819 and *Modiolula phaseolina* has been observed. However, large areas were occupied by the *Terebellides* cf. *stroemi* Sars, 1835 community. Macrophytes in the vicinity of the Cape Utrish (northern part of the Abrau Peninsula) was described by several authors (Kalugina-Gutnik, 1975; Blinova et al., 1991; Afanasyev, 2005, 2008; Blinova & Saburin, 2005; Vilkova, 2005a; Teyubova & Milchakova, 2011) since the 1960s. The three main zones (or belts) of macrophytes were present in the area, which is typical along the Caucasian coast from Anapa to Tuapse. A unique feature of the Utrish Nature Reserve was that *Cystoseira* spp. was found here at unusual depth (up to 32 m) whereas it had never inhabited depths more than 20 m at the north Caucasian Coast (Kalugina-Gutnik, 1975). Some authors later noted that the waters near cape Utrish are clear and the macrophytes inhabit deeper biotopes here (Blinova et al., 1991; Afanasyev, 2005, 2008).

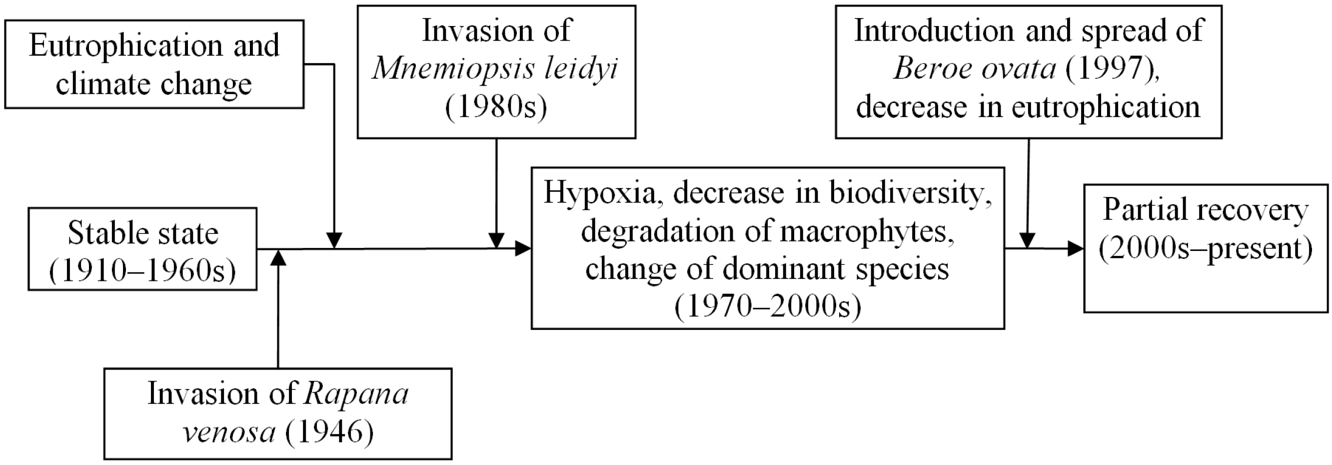

Fig. 1. Diagram of the bottom communities' dynamics in the Black Sea in the 20th – beginning of the 21st century (adopted from Kucheruk et al., 2012, extended according to recent data as in Kolyuchkina et al., 2017c).

In 1999 and 2001, an environmental impact assessment of the construction of the Caspian Pipeline Consortium (CPC) structures in the South Ozereyevka area (Fig. 2) (Lobkovskiy et al., 2001) was carried out in this area. When justifying the creation of the Utrish Nature Reserve (Chestin, 2009), these data were included into the total dataset used. According to these, two communities inhabited soft sediments at depths of 20–35 m: *Chamelea gallina* and *Anadara kagoshimensis* (Tokunaga, 1906); and *Pitar rudis* (Poli, 1795). Their distribution reflected local conditions of sedimentation. Deeper, at 35–50 m the *Mytilus galloprovincialis* community was noted. Depths below 50 m were dominated by *Modiolula phaseolina*. Three macrophyte zones were found on hard bottom: shallow (0–2 m), medium (2–10 m), and lower (10–20 m). Such vertical distribution of benthos was typical for the narrow shelf of the Black Sea before the eutrophication period of the 1970s.

Compared to the significantly transformed southern and northern parts of the Caucasian coast, the area of the Utrish Nature Reserve turned out to be one of the least affected by anthropogenic impact. Therefore, it has been recommended as a reference area that preserved the initial state of coastal biocoenoses of the northeastern part of the Black Sea to the greatest extent (Chestin, 2009). Since the establishment of the reserve and until 2016 no studies of benthic biodiversity have been carried out in the marine part of the reserve. The surveys performed in the neighbourhood were not so numerous either. In the course of complex ecological monitoring conducted by the Research Institute of the Azov Sea Fishery Problems in 2010–2012, a study of benthos, zoo- and phytoplankton has been accomplished in the coastal regions to the west and to the east of the Utrish Nature Reserve. Its emphasis was on macroalgae; zoobenthos was only investigated to the depth of 15 m (Afanasyev et al., 2013). In 2013, a significant area of the sea near the Abrau Peninsula in the region of the River Sukko confluence was described within the framework of the South Stream project (ESIA Russian Sector, 2014). Studies conducted in course of this project did not cover the area of the reserve. In 2016, the Institute of Marine Biological Research (Sevastopol) carried out a survey of fish and decapods populations' state in the coastal zone of the reserve (Boltachev et al., 2017). Thus, before the surveys analysed in this paper (Kolyuchkina et al., 2017a,b) the latest work concerning the quantitative distribution of benthos in the area of the reserve dates back to 2001 (Lobkovskiy et al., 2001; Chestin, 2009).

The creation of any reserve, including marine, involves not only the restriction of use and ecosystem protection within its borders, but also the organisation of long-term monitoring. In particular, according to the Statute, the Utrish Nature Reserve «ensures the preservation and restoration of unique and typical natural complexes located on the territory of the state natural reserve «Utrish», the organisation and carrying out of environmental education of public, development and implementation of scientific methods of nature protection and environmental monitoring». To fully implement this, it is necessary to conduct surveys assigned to obtain an understanding of the current state of the protected water area; especially since no studies of quantitative distribution of benthos have been done in the reserve area after the disastrous transformation of bottom communities of the Caucasian Black Sea coast at the beginning of the 21st century.

The aim of the study is to evaluate the presentability of the Utrish Nature Reserve for the regional benthic communities and to estimate the adequacy of the reserved marine area to main goals of the reserve's organisation (the preservation and restoration of unique and typical biotopes). The main goal splits into several particular issues: the evaluation of habitat presentability of the reserve; estimation of species diversity within the borders; evaluation of the diversity of communities and their similarity to adjacent shelf associations in terms of species composition and quantitative structure. It is critical to estimate the rate of concordance in communities' dynamics inside and outside the reserve for extrapolation of the results of monitoring to adjacent shelf areas. The present study is an analytical extension of benthic surveys undertaken in 2014–2017 (Kolyuchkina et al., 2017a,b,c)

Methods

In 2016–2017, a pilot study of the current state of bottom ecosystems of the northwestern part of the reserve's marine area was carried out in the area of the River Zhemchuzhnaya confluence during a coastal marine expedition of the Institute of Oceanology of RAS «Black Sea 2016–2017». These studies were performed within the marine boundaries of the Utrish Nature Reserve, which are located at the 50 m isobath (Fig. 2).

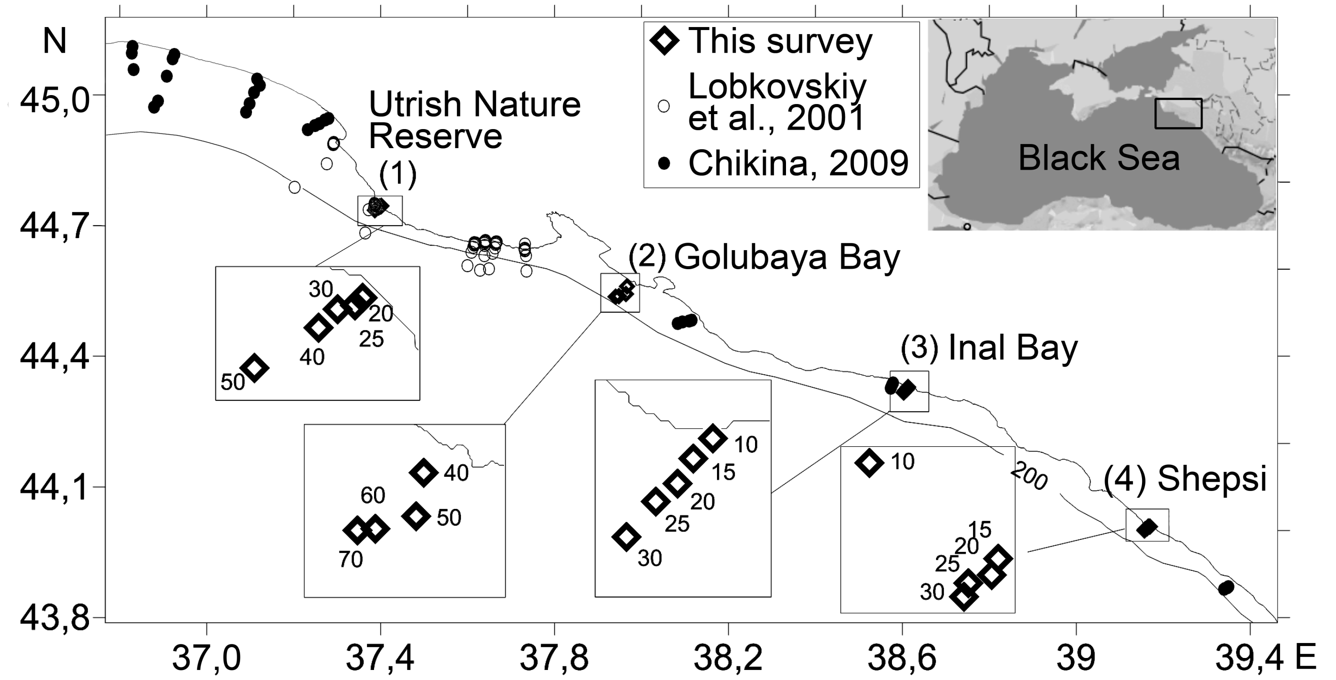

Fig. 2. Map of the studied (Utrish Nature Reserve macrozoobenthic transect), reference areas (Golubaya Bay, Inal Bay and Shepsi macrozoobenthic transects) and historical macrozoobenthic data: 1999–2001 (Lobkovskiy et al., 2001) and 2001 (Chikina, 2009) (adopted from Kolyuchkina et al., 2017c, extended according to historical data).

The survey included a standard habitat mapping (Mokievsky et al., 2012b) using a side-scan sonar (data were collected and provided by the Marine Research Centre of the Lomonosov Moscow State University); remotely operated underwater vehicle (ROV) GNOM PRO (12 sites); diving and video transect survey of hard bottom with macrophytes; a bathymetric survey. Additionally, aerial photography (using a Fantom 4 drone) of the coastal zone (from the cliff to the depth of 1–2 m) was performed. Methods and preliminary results are described in Svasyan et al. (2017) (Fig. 2).

Samples of zoobenthos and bottom sediments to determine particle size distribution were taken from the board of the research vessel «Ashamba» (Institute of Oceanology of RAS) at five stations. Material of annual expeditions of the Institute of Oceanology of RAS «Black Sea 2014–2017» was used for comparison. These are 32 stations with depths 10–50 m from the transects on the traverse of the Golubaya Bay (March 2017), the Inal Bay (July 2014, 2015, 2016 and 2017) and near Shepsi settlement (July 2014) (Fig. 2b). The sampling and analysing procedures were analogous for all the stations and are described in detail in the work of Kolyuchkina et al. (2017c). The analysis of grain size composition was performed in the Analytical Laboratory of the Institute of Oceanology of RAS using the wet sieving method (Petelin, 1967). Preliminary results of the work and a list of recorded species are presented in the works of Kolyuchkina et al. (2017a,b,c).

We tried to assess the diversity and presentability of the macrophyte communities using very preliminary published and unpublished data: underwater video surveys together with bottom vegetation descriptions of five videos and diving 200–1500 m long, 0–25 m deep transects (Smirnov, Papunov, Simakova, unpublished); ROV video analysis (Simakova & Shabalin, unpublished); qualitative (10 samples) and quantitative (15 samples, metal frame 33 × 33 cm or 0.1 m^2) collections at depths of 0.5–17 m (Kolyuchkina et al., 2017b; Simakova et al., 2017; Simakova & Smirnov, 2017). Transect survey, ROV video samples (point, approximately 10 m in diameter or less) and video transects were analysed by U.V. Simakova; depth, bottom type (pebble, hard bottom, soft bottom), macrophyte species list and dominant species were determined at each point. Continuous video transects were divided in sections according to depths (2–5 m, 5–10 m, 10 m and more). Species lists and dominant species were determined for each section.

For comparison, we used previously published data on macrophytes from other regions of the North Caucasian coast (Kalugina-Gutnik, 1975; Lobkovskiy et al., 2001; Mitjaseva et al. 2003; Simakova, 2009, Simakova, 2011; Teyubova & Milchakova, 2011). Biogeographical classification of algae species and syntaxon names were carried out in accordance with Kalugina-Gutnik (1975).

Statistical processing of the data was performed using Primer v. 6.1.16. An assessment of the species number of macrozoobenthos was carried out using the expected number of species index – Chao2 (Chao, 1987). For the analysis of species richness and diversity, the Shannon biodiversity index (H'), the Margalef's species richness (d), the Pielou's evenness (J') and taxonomic diversity (Delta) (Clarke & Warwick, 2001) were used. The reliability of groupings was estimated using the ANOSIM method and the Taxonomic Distinctiveness Test; SIMPER algorithm was implemented to evaluate the contribution of species to the differences between the groups (Clarke & Warwick, 2001).

Results and Discussion

Presentability of biotopes of the Utrish Nature Reserve

The northeastern shelf of the Black Sea can be divided into two regions: the region of the ancient River Kuban delta on the North and the Black Sea Mountain Chain stretching from Anapa to the border with Georgia (Blagovolin, 1962; Petrov, 1999; Vilkova, 2005b). In the Kuban paleodelta, the bottom is composed of sand or silted sand; deeper than 15 m the share of shells in the composition of silted sand increases with a maximum share at a depth of 20–25 m (Petrov, 1999). In the area of the Black Sea Chain, the shore is mostly abrasive. It is characterised by active cliffs, a narrow pebbly beach (up to about 2 m deep) bordered by an inclined bench composed of flysch deposits of Upper Cretaceous and Paleogene age (Zenkovich, 1958). The continuous abrasion of rocks of unequal resistance to destruction in the flysch leads to the formation of an intersected sculptural relief of the bottom (Loginov, 1951; Petrov, 1999; Vilkova, 2005b). At depths of 10 to 30 m, a flat bottom with soft sediments of different particle sizes (Vilkova, 2005b) underlies a complex relief of the bench. The regular belts with different types of sediment along the depth gradient are disturbed by landslides of various ages and canyons in the river mouths. South of the village Dzhanhot, the bench narrows and to the south of Tuapse rocks are found only opposite protruding capes. The rest of the bottom is occupied by soft sediments (Kalugina-Gutnik, 1975). The natural appearance of the shoreline and the distribution of sediments in the southern part of the region are transformed by shore protection structures.

The Abrau Peninsula is located in a transition zone between the narrow southern shelf and shallow water near the Kerch strait. In the coastal zone of the reserve, there is an active cliff followed by a narrow pebble beach. Deeper, there is a boulder bench of a stepped profile with a shallow inclined upper part and a sharp bend at a depth of more than 7 m. It passes into a flat, slightly inclined bottom, covered with soft sediments (Vilkova, 2005b). In addition, unlike most areas of the North Caucasian coast, the relief is significantly complicated by landslides of different ages here (Popkov et al., 2015).

In the reserve's marine area seven main types of acoustic signal were obtained using the side-scan sonar. Matching them with the descriptions of the bottom landscapes made in the 2016–2017 expeditions (Svasyan et al., 2017) allowed to distinguish between two fundamentally different bottom biotopes: soft sediments and bench (Fig. 3A). The distribution of soft sediments within the investigated water area ranged from 17 to 52 m. The bottom sediments at depths of 20–25 m were represented by pure black terrigenous sand; at depths of 30–40 m – by sand with an admixture of silt; and at a depth of 50 m and deeper – by silt. The content of silty fractions (less than 0.1 mm) varied with depth from 31.8% to 99.1%. At the 50 m horizon, the silty fractions were mainly represented by pelite (less than 0.01 mm, up to 82.7%). Fine sand fractions dominated at shallow depths where they comprised up to 84.3%.

The hard bottom biotope of the northern part is represented by a section of a bench formed by an almost undamaged flysch. It forms horizontal, slightly inclined steps with a few stone blocks on the surface. The eastern part of the area is composed by a landslide body formed by blocks and boulders, their roundness decreases with depth. Bulks of coarse material form a labyrinth of flat sites, steep slopes (20° and more), and sedimentary traps, which are local depressions filled with sandy and silty sediments together with rocky material (Fig. 3B).

Based on the analysis of aerial photography of the coastline sector of the reserve and its vicinities (from the cliff to a depth of 1.5 m, 3979 m in length), two types of biotopes were identified: boulder and block areas (total length 1248 m) associated with capes and pebble and boulder concave sections of the shore (2731 m). Boulder and pebble deposits extend to a depth of 2–4 m (Svasyan et al., 2017).

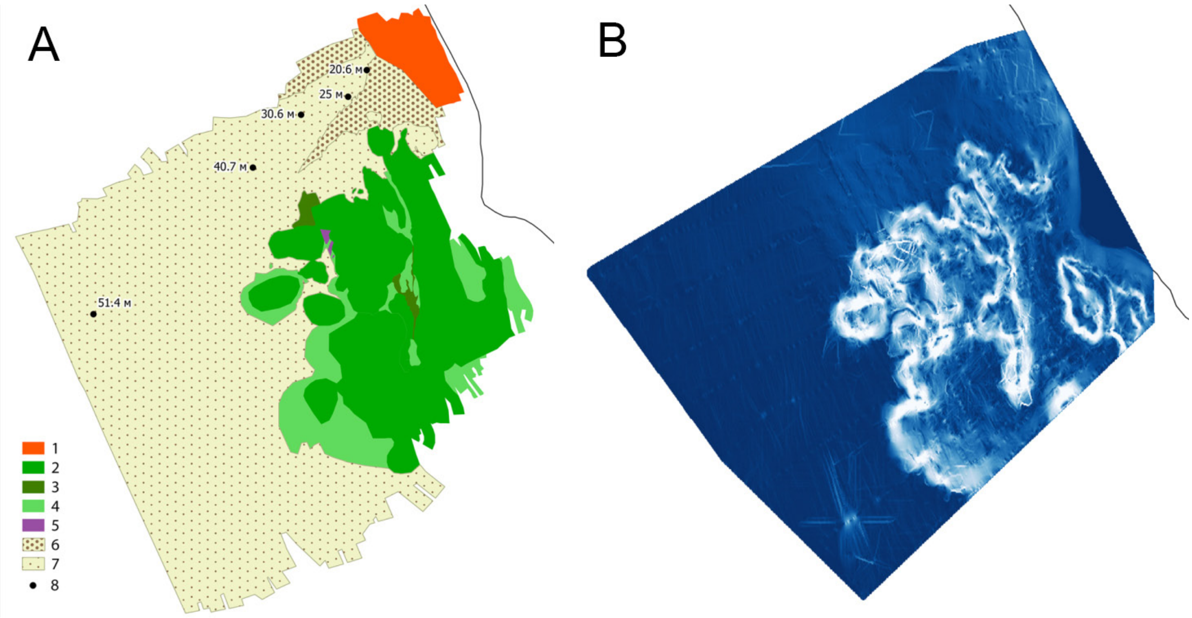

Fig. 3. A: Main types of acoustic signal of side-scan sonar and their preliminary interpretation (after Svasyan et al., 2017) for the western part of the Utrish Nature Reserve marine area: 1 – section of the bench, with an intact structure; 2, 3 – boulder deposits; 4 – boulder deposits, possibly covered by soft sediments; 5 – presumably soft sediments; 6 – gravel/pebble; 7 – sand/silt; 8 – location and depth of points of the long-term monitoring transect. B: Map of the slopes of the bottom of the investigated marine area. The higher the bottom slope value for a pixel (the lighter the pixel), the greater the angle of slope at a given point.

Thus, the northwestern part of the reserve's marine area is a biotopical representative of the area of the Black Sea Mountain Range (from Anapa to Tuapse). However, biotopes of accumulative shores and adjacent underwater slopes with agglomeration of shells and clay outcrops (widespread south of Cape Idokopas) are not represented here. The main difference between the soft sediments of the reserve and the more southern parts of the coast is the presence of a sand belt to 30 m depth both in historical and in recent time (Chestin, 2009; Chikina, 2009; Kolyuchkina et al., 2017c). According to Kiseleva (1981), in the mid-20th century, sandy sediments with a very small admixture of silt (up to 3%) predominated at depths of 10–30 m along the whole coastline. Thus, the marine part of the Utrish Nature Reserve is a unique area that apparently retained siltation at the mid-20th century level and was not subjected to eutrophication at the end of the 20th century. Perhaps this is due to the general pattern for the Black Sea, when «opposite large capes with steep slopes of the shelf, the sands descend to greatest depths» (Barkovskaya, 1961), associated with intense hydrodynamics and the absence of a constant freshwater outflow.

General characteristics of macrozoobenthos

According to our data, 74 species of higher macrozoobenthos taxa were found at the five stations in the Utrish Nature Reserve. The expected number of species calculated using the Chao2 index was 106 ± 21. This value, however, is an underestimation, since the identification of some organisms was possible only up to their genus (*Rissoa* sp.), family (Edwardsiidae gen. sp.), class (Oligochaeta gen. sp., Turbellaria gen. sp.), and type (Nemertea gen. sp.) level (Kolyuchkina et al., 2017b). With a similar approach, 117 species (130 ± 8 being the expected number of species) of invertebrates have been recorded at 32 stations to the south of the Abrau Peninsula. This is 11% of the total number of benthic invertebrate species for the northeastern coast of the Black Sea (Table 1). Thus, the total number of species found in the reserve was lower than in the southern part of the coast as a whole. However, each separate transect in the southern part of the coast had less species than the Utrish Nature Reserve transect. In addition, a comparison of macrozoobenthos diversity indices in the Utrish Nature Reserve and the above mentioned regions shows that, in general, the species richness in the reserve is higher than in more southern regions (Table 1). It also turned out to be higher than the average along the coast found in 2001 (Chikina, 2009).

Presentability of contemporary biocoenoses

Biocoenoses recorded in the area of the Utrish Nature Reserve in 2016 were also found at all transects south of the Abrau Peninsula in the current period, but in the area of the reserve they were shifted to greater depths. Along the coast from the Golubaya Bay to Shepsi village *Chamelea gallina* community occurred at depths of up to 15 m (shallow-water community), and *Pitar rudis – Gouldia minima* (Montagu, 1803) – *Anadara kagoshimensis* – at depths of 20–30 m (medium-depth community). But in the Utrish Nature Reserve's marine area *Chamelea gallina* was found to be a dominant at 20–25 m depths, and codominant in *Chamelea gallina – Gouldia minima – Pitar rudis* community at 30–40 m depths. The coldwater species communities with a dominance of *Parvicardium simile* (Milaschewitsch, 1909) and *Modiolula phaseolina* were noted at depths of 40 m and more in the southern areas (the deep-water complex) (Fig. 4B). In the Utrish Nature Reserve the *P. simile* community was found at 50 m depths, and the *M. phaseolina* community was not found in the studied area (up to 52 m) (Fig. 4A).

In the shallow-water complex («venus sand»), 28 species were noted in the reserve (about 22 per station), whereas in the remaining transects this number ranged from 24 to 46 species (76 in total, 27 per station, on average). There were 25 species common between the stations in the reserve and in the southern part of the coast as a whole (32% of the total number of species in the community), and 14–21 species were common between the Utrish Nature Reserve transect and Golubaya Bay, Inal Bay and Shepsi transects (southern, or reference, transects, hereinafter) separately. Thus, in the Utrish Nature Reserve marine area this community turned out to be relatively poor compared to other transects. Among the species characteristic of this community at all transects were *Magelona rosea* Moore, 1907, *Donax semistriatus* Poli, 1795 and *Mytilus galloprovincialis*. The main difference between macrozoobenthos of the Utrish Nature Reserve in this zone was the absence of *Lentidium mediterraneum* (O.G. Costa, 1830) and *Amphibalanus improvisus* (Darwin, 1854), abundant at all other transects, and the presence of a characteristic species *Parthenina interstincta* (J. Adams, 1797), that was noted at these depths only in the reserve.

The remaining two communities found in the reserve exceeded those of reference transects both in terms of number of species per sample and species richness (Table 2). In the medium-depth communities, 61 species (about 45 species per station) were recorded from the Utrish Nature Reserve transect, while the reference transects contained 41–52 species (79 species in total, about 29 per station). 43 species (45%) were common between the Utrish Nature Reserve and the southern part of the coast as a whole, 31–34 species were common between the reserve and each reference transect separately. The greatest species diversity in the reserve was in this community, considerably exceeding the diversity of the reference transects. *Prionospio multibranchiata* Berkeley, 1927, *Apseudopsis ostroumovi* Bacescu & Carausu, 1947 and *Gouldia minima* were characteristic species of this complex in general, while the polychaetes *Leiochone leiopygos* (Grube, 1860) and *Sigambra tentaculata* (Treadwell, 1941) were typical of the reference transects, not of the reserve.

Table 1. Species diversity of macrozoobenthos in different regions of the Black Sea in the 21st century

Character	Caucasian Black Sea coast species list (Volovik et al., 2010)	North-Caucasian Black Sea coast, 2001 (Chikina, 2009)	Golubaya Bay – Shepsi, 2014–2017	Utrish Nature Reserve, 2016
Number of stations	–	30	32	5
Species number per station	–	14–35	12–38	22–53
Shannon diversity index	–	0.1–2.8	1.0–2.6	1.5–2.0
Margalef's species richness	–	1.6–5.1	1.69–6.0	4.1–7.6
Species number: total	1032	81	117	74
Anthozoa	11	1	3	2
Nemertea	47	1*	1*	1*
Turbellaria	151		1*	1*
Oligochaeta	78	–	1*	1*
Polychaeta	204	28	54	24
Loricata	3	–	–	–
Bivalvia	92	17	16	15 (1)
Gastropoda	161	6	16	8 (2)
Crustacea	272	23	27	19 (6)
Ostracoda	117	–	–	17
Phoronida	3	1	1	1
Echinodermata	10	2	1	1
Chordata	10	2	1	1

Note: * – organisms were not identified to species level; number of species found in 2016 on rocky substrates are given in brackets.

In the deep-water community, there were 32 species at Utrish (18–23 species per sample), while the other transects contained 28–38 species (51 in total, 11–16 species per sample). Nineteen species (30%) of them were common between the reserve and the southern part of the coast as a whole, and 14–15 species were common between the Utrish Nature Reserve transect and each reference transect separately. It is likely that the reserve's deep-water complex is considerably less patchy in comparison, e.g., with that of the Golubaya Bay. At the Golubaya Bay transect, despite the lower species number per sample, the total number of species at 50 m was high due to significant differences between individual samples, while at the Utrish Nature Reserve transect, with its high similarity between individual samples, the number of species per sample was higher. In the deep-water complex, *Terebellides* cf. *stroemi*, *Parvicardium simile*, *Modiolula phaseolina* and *Phtisica marina* Slabber, 1769 were typical in the reserve's and reference transects.

Table 2. Biodiversity indices of macrozoobenthos communities located at shallow (10–15 m), medium (20–30 m) and deep-water complexes (40–50 m). For the area of the Utrish Nature Reserve, the ranges of 20–25 m, 30–40 m and 50 m, respectively, are considered

Area	S	d	J'	H' (log_e)	Delta
Shallow-water complex					
Utrish	22.5 ± 0.7	4.193 ± 0.071	0.5212 ± 0.0079	1.623 ± 0.041	42.65 ± 0.76
Golubaya Bay – Shepsi	26.7 ± 7.9	4.450 ± 1.195	0.4986 ± 0.0992	1.614 ± 0.371	38.74 ± 10.28
Medium depths' complex					
Utrish	45.5 ± 10.6	7.003 ± 0.875	0.5106 ± 0.0640	1.935 ± 0.124	51.46 ± 0.27
Golubaya Bay – Shepsi	29.3 ± 6.1	4.930 ± 0.659	0.6223 ± 0.0957	2.076 ± 0.257	54.63 ± 7.32
Deep-water complex					
Utrish	32	4.955	0.4424	1.533	39.86
Golubaya Bay – Shepsi	20.7 ± 5.0	4.051 ± 1.236	0.6154 ± 0.0715	1.840 ± 0.068	50.09 ± 5.76

Note: S-species number, d – Margalef's species richness, J' – Pielou's evenness, H' – Shannon Index, Delta – taxonomic diversity.

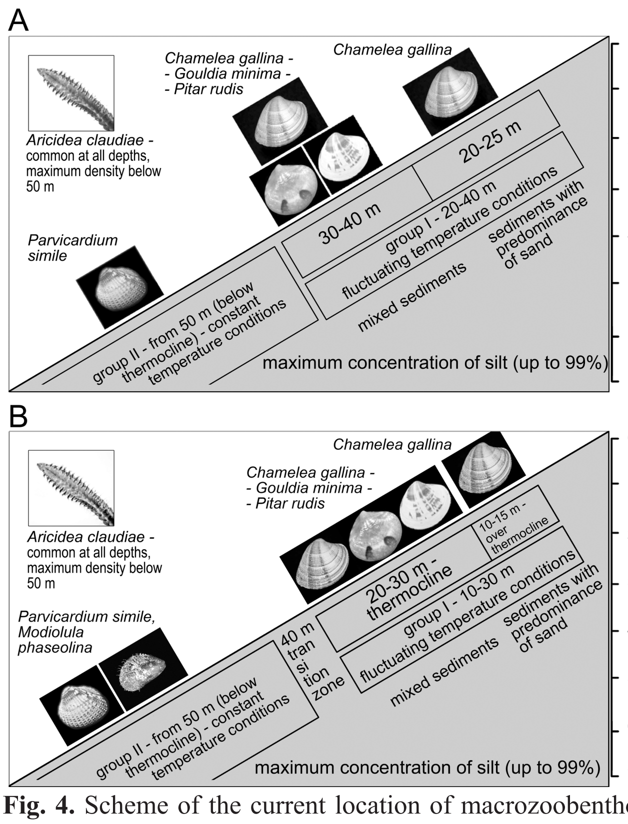

Fig. 4. Scheme of the current location of macrozoobenthos communities along the northeastern coast of the Black Sea. A: Utrish Nature Reserve macrozoobenthic transect; B: Inal Bay, Shepsi and the Golubaya Bay macrozoobenthic transects (adopted from Kolyuchkina et al., 2017c).

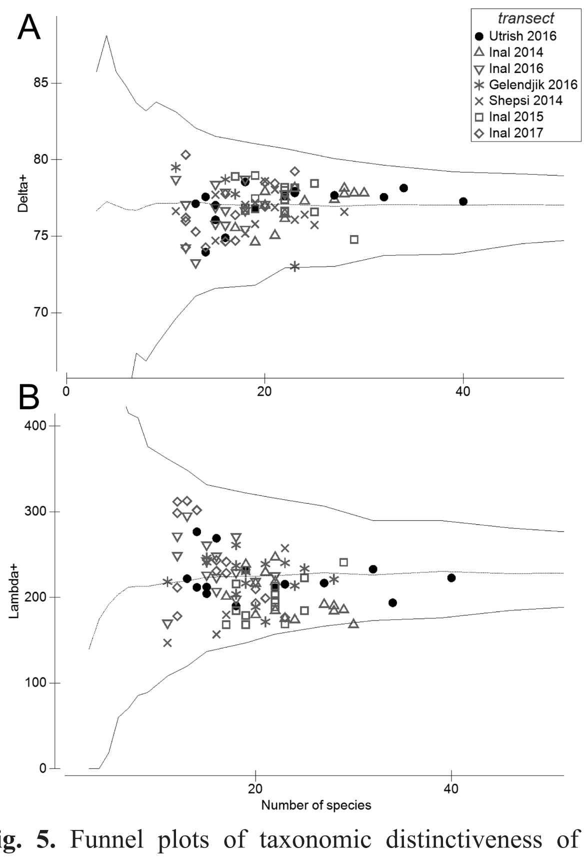

Fig. 5. Funnel plots of taxonomic distinctiveness of the Utrish Nature Reserve transect's macrozoobenthos against that of the reference transects. (A) Delta+, average taxonomic distinctiveness (avTD); (B) Lambda+, variation of avTD.

The only species common between all transects and all depths is the polychaete *Aricidea (Strelzovia) claudiae* Laubier, 1967. In general, characteristic species of the reference transects which were absent or rare in the reserve, mostly included pelophilic forms. For example, the taxa *Heteromastus filiformis* (Claparède, 1864) and *Nemertea* gen. sp. were found abundantly throughout the southern part of the coast, but were absent in the shallow-water complex at the Utrish Nature Reserve transect. Species characteristic for both the shallow and the medium-depth communities in both reference and reserve's transects mostly included bivalves. Besides the dominant *Chamelea gallina*, they included *Lucinella divaricata* (Linnaeus, 1758), *Anadara kagoshimensis*, *Fabulina fabula* (Gmelin, 1791), and *Spisula subtruncata* (da Costa, 1778). In addition, the polychaete *Nephtys cirrosa longicornis* Jakubova, 1930, phoronid *Phoronis psammophila* Cori, 1889 and amphipod *Ampelisca diadema* were characteristic for these horizons. However, the abundant species *Melinna palmata* Grube, 1870, that was common in the southern part in the shallow- and medium-water communities, was absent at the Utrish Nature Reserve transect. The polychaete *Eunereis longissima* (Johnston, 1840) and bivalve *Abra alba* (W. Wood, 1802) were typical in the complexes of medium and large depths at both reference and reserve's transects. *Oriopsis armandi* (Claparède, 1864) and *Pitar rudis* were abundant in these complexes along the southern part of the coast, but were absent in the deep-water complex in the Utrish Nature Reserve. The absence of some abundant species in the Utrish Nature Reserve's macrozoobenthos could be explained by a low stations' number sampled here to date.

A comparative analysis of the structure of macrozoobenthos communities showed that, despite the difference in depth of the communities in the Utrish Nature Reserve and the southern part of the coast, the structure of macrozoobenthos within each complex turned out to be similar. A comparison of the macrozoobenthos structure in both areas by the density/biomass using the ANOSIM method has shown that grouping of stations by region, both between transects in general and between certain communities, was unreliable. The Taxonomic Distinctiveness Test has shown no significant differences between the study areas either (Fig. 5). Although the number of species per station was significantly larger in the reserve compared to the other transects, the average taxonomic diversity (avTD) and its variation in the reserve were within the 95% confidence interval for the region. Again, the SIMPER method did not allow the identification of species with reliably high contribution to the differences between Utrish and the rest of transects. The average dissimilarity values did not exceed 4–5, and their ratio to standard deviation did not exceed 1.5 for the first 1–3 species. For most species this ratio was or less than 1. Thus, the species diversity of the Utrish Nature Reserve communities is typical for the narrow northeastern shelf of the Black Sea.

The following feature should be noted for all transects: higher values of «straight» diversity indices (S, d) correspond to relatively smaller values of evenness and indexes that rely on it (J', H'). For example, Utrish is characterised by a smaller number of species and species richness values in the «venus sand» community compared to other transects, but higher values in the medium- and deep-water complexes. On the contrary, Pielou's evenness and Shannon index are higher in the «venus sand» community of the Utrish transect, while their values in the other two Utrish transect's complexes are relatively low compared to the southern transects. Another point to be noted is the low value of the taxonomic diversity (Delta+) in the deep-water complex, which indicates a large number of taxonomically related species or a low number of higher taxa present.

Thus, only two of the three contemporary communities are fully represented in the reserve marine area, but most of the characteristic macrozoobenthos species corresponded with species present on the southern part of the coast. An extension of the reserve marine boundary over the 70 m isobath in order to include the *Modiolula phaseolina* biocoenosis would significantly increase the presentability of the protected sea zone.

Temporal dynamics of the structure of the soft sediments' communities

Three communities have been recorded for the reserve's marine zone: (1) sand dominated by the bivalve *Chamelea gallina* at 20–25 m, (2) silted sand with shells dominated by the pelophilic bivalves *Pitar rudis* and *Gouldia minima* and the polychaete *Aricidea claudiae* at 30–40 m, and (3) silt (pelite) dominated by the bivalve *Parvicardium simile* at 50 m (Fig. 4A). Only one of these communities, the «venus sand» biocoenosis, proved to be stable over time: in the 20th century (Zernov, 1913; Kiseleva & Slavina, 1965; Alekseev & Sinegub, 1992), at the early 21st century (Chestin, 2009), as well as in 2016, the bivalve *Ch. gallina* was dominant here at depths of 20–25 m. The deeper faunal complexes changed over time. The community of the silt mussel (*Mytilus galloprovincialis*) occupied depths of 30–50 m in the 20th century; it was also noted here in 2001 (Chestin, 2009). In 2016, the mussel community was not observed at any of the investigated depths. *Mytilus galloprovincialis* itself was recorded as a single juvenile specimen at the depth of 40 m in the *P. rudis – G. minima* community. Both of these species were subdominant in the mussel community in the 20th century. It should be noted that the mussel zone was not observed at any of the southern transects in 2014–2017 either. The problem of the dynamics of the mussel zone in the 21st century has not been sufficiently studied, but there is a suggestion that its degradation in the northern Caucasus may be associated with the siltation of sediments due to the intensive bottom trawling and the impact of dumping (Zaika et al., 1990). Besides that, the distribution of this community could be patchy: for example, in the 20th century in the Tuapse-Shepsi region, the mussel community did not form a single belt, but was recorded only at part of the 30–50 m depth stations studied (Kiseleva & Slavina, 1972).

Another characteristic Black Sea community was not observed in the area of the reserve in 2016: a belt of pelite dominated by *Modiolula phaseolina*, recorded in this area in the 20th century. (Zernov, 1913; Kiseleva & Slavina, 1965; Alekseev & Sinegub, 1992). At a depth of 50 m, where the deep-water boundary of the reserve is located, the community of the bivalve *Parvicardium simile* was noted in 2016. *Modiolula phaseolina* was found only as a minor species. However, it is known that this community occupies greater depths (70 m and deeper) in the vicinities of the reserve, as shown by the South Stream studies (ESIA Russian Sector, 2014) and by the 1999–2001 surveys carried out directly in the area of the reserve (Chestin, 2009). Thus, the *M. phaseolina* community is more likely to be located deeper than 50 m in the reserve area, so it is desirable to extend the marine boundaries of the reserve to at least 70 m isobaths to increase the presentability of its bottom biocoenoses.

Benthic communities with domination of the invasive species *Rapana venosa* (Valenciennes, 1846) and *Anadara kagoshimensis*, which played an important role in the dynamics of macrozoobenthos in the early 21st century, were not observed in the marine area of the reserve neither in 2001 nor in 2016 (Chestin, 2009; Chikina, 2009). While *A. kagoshimensis* was recorded as a rare species here in 2016, *R. venosa* was not found in any sample at all. However, in 2001 *A. kagoshimensis* was among the dominant species at depths of 30–35 m near Southern Ozereyevka, which is only a little way to the south (Chestin, 2009). Therefore, it is possible, that these biocoenoses will be found in the southeastern sector of the marine part of the reserve, which currently remains unexplored.

General characteristics of macrophyte flora

The preliminary flora of the Utrish Nature Reserve includes 33 species (belonging to 12 orders, 17 families, 21 genera) (Kolyuchkina et al., 2017b). In terms of seaweed biogeography, the flora of the reserve contained mainly warm-temperate species (20 species or 71% of total). The cold-temperate group included only two species (7.14%). The temperate species made up a more diverse group consisting of six species (21%). One species was a cosmopolite.

Obviously this first recent survey performed in one season contained too low data to access the presentability of the whole Utrish Nature Reserve marine area when compared to approximately equal in size samples from other areas of the coast (Table 3). However, the species ratio mainly reflected the biogeographical composition of the region. Thus, contemporary data (Kolyuchkina, 2017b) for the Utrish area were consistent with what has been previously published (Lobkovskiy et al., 2001).

The new alien species *Bonnemaisonia hamifera* Hariot was found in the reserve's marine area. In all samples, only thalli of the tetrasporophytic phase of *B. hamifera* were found (Simakova & Smirnov, 2017). Its native range is the warm temperate area of the Pacific Ocean (Perestenko, 1994). Since the 19th century it became invasive in the north Atlantic and the Mediterranean (Boudouresque & Verlaque, 2002; Streftaris et al., 2005).

General characteristics of macrophyte vegetation

In general, the macrophyte zone consists of four belts: upper (0–2 m), upper mid (2–12 m), lower mid (12–18 m), and the lower belt (below 18 m) formed by the alien species *Bonnemaisonia hamifera* (Simakova et al., 2017).

The bottom of the upper macrophyte zone habitat (0–2 m) was composed of boulders and pebbles of various forms and sizes (from 10 cm to 50–70 cm). Communities found here were formed by annual algae from the association *Dictyota fasciola* f. *repens* + *Polysiphonia opaca* + *Ceramium ciliatum* + *Ulva compressa* (according to the classification of Kalugina-Gutnik, 1975). The floristic composition of this association was significantly reduced and represented by two species: *Padina* sp. and *Dictyota fasciola* (Roth) J.V. Lamouroux. The coverage of the vegetation varied significantly from individual thalli per m^2 to 30–50% of surface (Simakova et al., 2017).

Table 3. Macrophyte floristic composition of the Utrish Nature Reserve compared to other areas of the North Caucasian coast. The present survey in bold

Region	Number of samples	Total number of macrophyte species	Species number (% of survey total)			
			Rhodophyta	Ochrophyta	Chlorophyta	Seagrasses
Cape Utrish vicinity (Lobkovskiy et al., 2001)	20 quantitative +5 qualitative	48	29 (60.4%)	8 (16.7%)	11 (22.9%)	0
Utrish Nature Reserve (Kolyuchkina et al., 2017b)	**15 quantitative +10 qualitative**	**33**	**15 (45.5%)**	**11 (33.3%)**	**7 (21.2%)**	**0**
Inal Bay (Maximova, unpublished)	16 quantitative, 4 qualitative	25	14 (56%)	6 (24%)	5 (20%)	0
Cape Doob (Mitjaseva et al., 2003)	22 quantitative, 47 qualitative	60	35 (58.3%)	13 (21.7%)	12 (20%)	0
Golubaia Bay (Mitjaseva et al., 2003)		31	19 (61.3%)	7 (22.6%)	5 (16.1%)	0 (0%)
Gelendjik Bay (Mitjaseva et al., 2003)		14	6 (40%)	4 (26.7%)	4 (26.7%)	1 (3.8%)
Open coast of Tolstiy Cape (Simakova, 2009)	12 qualitative	21	13 (61.9%)	5 (23.8%)	3 (14.3%)	0
Maria-Magdalena Bank (Mitjaseva et al., 2003)	6 qualitative, 8 quantitative	41	19 (44.2%)	11 (25.6%)	11 (25.6%)	2 (7.8%)
Coastal area from Tuapse to Sochi (Lisovskaya & Nikitina, 2007)	38 stations	61	30 (49.2%)	6 (9.8%)	23 (37.7%)	2 (5.3%)
North Caucasian coast (region in general) (Kalugina-Gutnik, 1975)	About 2000 qualitative and quantitative	135	80 (59.3%)	31 (23%)	22 (16.3%)	2 (12.3%)
Russian + Georgian coasts (region in general) (Milchakova, 2007)	–	183	92 (50.2%)	51 (27.9%)	40 (21.9%)	No data

The depth range of 2–12 m was occupied by communities of the association *Cystoseira crinita* + *Cystoseira barbata* – *Cladostephus spongiosus* – *Ellisolandia elongata* (according to the classification of Kalugina-Gutnik, 1975). This syntaxon is very common along the North Caucasian coast and forms almost a continuous belt from Anapa to Cape Idocopas (ca. 100 km) (Afanasyev 2005; Lisovskaya & Nikitina, 2007; Milchakova, 2007). Usually *Cystoseira* spp. communities found along the North Caucasian coast are formed by four vegetation layers, including crustose algae which are not considered here. The first layer was 30–50 cm high and was dominated by *Cystoseira crinita* and *C. barbata*. The latter could be codominant or completely absent. The *Cystoseira*'s coverage was high and could exceed 100%. The second layer was formed mainly by *Cladostephus spongiosus*. Its height was less than 20 cm and the coverage was less than 50%. The third layer included usually several species, whose height was usually less than 5 cm, such as coralline algae and *Cladophoropsis membranaceae* (Simakova et al., 2017). An important element of the *Cystoseira* spp. associations' structure was the presence of epiphytes with a high species number and biomass (Kalugina-Gutnik, 1975; Simakova, 2011).

The coverage of *Cystoseira* spp. was high in the reserve during the sampling period (30–80%). The coverage maximum has been found at depths of 6–10 m at different sites. The structure of community layers was reduced. Plants of the second and the third layers were sparse. Only at a depth more than 6–7 m, the invasive *Bonnemaisonia hamifera* (a low plant of up to 2–3 cm high) formed spots with a high percentage of coverage. At depths of 10 m and more the proportion of plants of the second layer increased due to the deep-water Rhodophyta species *Phyllophora crispa*. The most abundant epiphytes were red algae: *Polysiphonia subulifera* and *Bonnemaisonia hamifera* (Simakova et al., 2017). The other five epiphyte species were rare.

The third deeper belt of bottom vegetation was formed mainly by three species: *Phyllophora crispa*, *Codium vermilara* and *Bonnemaisonia hamifera*. The first two species might form not only mixed beds but monodominant communities as well. It seems that these algae are being overgrown by *B. hamifera*. This may lead to significant changes in the distribution of native species.

Tetrasporophytes of *Bonnemaisonia hamifera* were found for the first time as mass aggregations of unattached thalli over an area with soft bottom at 17–40 m depths (Simakova et al., 2017; Simakova & Smirnov, 2017). Later it was found that this species was not only present in native communities as epilithic vegetation or epiphyte, but also occupied any vacant substrate especially in the zone deeper than 6–7 m. It was one of the dominant species (in terms of % coverage) in the lower zone. In addition to that, it fully covered hard bottom substrates at depths more than 18 m which became bare after the reduction and shift of native vegetation (Maximova & Luchina, 2002; Simakova & Maximova, 2009).

Presentability of contemporary macrophyte communities

Preliminary data on the floristic composition in the reserve's marine area indicate that it is inhabited by macrophyte species common for the North Caucasian coast. The species list comprises only 24% of regional flora. However, this number will probably increase with further research.

The majority of species found in the reserve's marine area were common species of the Black Sea macrophytobenthos; on the other hand, some species, which are widely distributed along the Caucasus coast, were not found here. For example, *Ellisolandia elongata* (J. Ellis & Solander) K.R. Hind & G.W. Saunders, *Ceramium ciliatum* (J. Ellis) Ducluzeau, *Gelidium crinale* (Hare ex Turner) Gaillon, *Polysiphonia elongata* (Hudson) Sprengel and some others were not found in the Utrish Natural Reserve.

Another very important group, which was not present in the reserve's marine area, is the seagrasses. Both species of *Zostera* are not very common in the North Caucasian region. *Zostera noltei* Hornem. meadows are found on sandy shallows in the inner part of the Gelendjikskaya Bay. *Zostera marina* L. forms meadows to the north of Anapa. Both species are also known from the south of Tuapse (Milchakova & Phillips, 2003). *Zostera* is a genus of ecosystem engineer species that plays a key role in many regions around the globe. The habitats that they require (sandy and muddy shallows) are absent in the studied area.

Since the marine area of the reserve is situated on an open coast, its waters are quite clean. During the surveys in 2016–2017 no evidence of anthropogenic suppression of dominant algae populations, in comparison to other regions, could be found. At the same time, a reduced structure of layers of the *Cystoseira* spp. community and a less epiphyte diversity, compared to the descriptions of a typical community of this kind, was found. Such reduction is typical for areas where a large amount of soft sediments cover hard bottom substrates. It usually occurs to the south of Tuapse (Kalugina-Gutnik, 1975). The same reduction of the community structure appears in areas where the hard bottom relief is not very diverse (such as along the open coast of the Cape Tolstiy) (Simakova, 2009).

The vicinity of the Cape Utrish is traditionally considered to be an area of the clearest water and least affected communities of macrophytobenthos. According to the published data, *Cystoseira barbata* occurred here in the 20th century up to a depth of 32 m (Kalugina-Gutnik, 1975). Such depth distribution was considered to be an absolute record for the Soviet sector of the Black Sea. To date, normal thalli of *Cystoseira crinita* and *C. barbata* are found in the reserve's marine area down to 12 m and, apparently, deeper. This exceeds the recent depth range of these species along the coast to the south of the Abrau Peninsula which has a similar to Ultrish depth distribution of hard bottom. For example, only dwarf thalli of *C. crinita* are found at 10 m depth near the Golubaya Bay (Simakova, 2011). The other species, *C. barbata*, occurs there slightly deeper (12 m) but also in a form of dwarf thalli. The same pattern was observed by other authors (Blinova et al., 1991; Afanasyev, 2008). This proves that the Utrish Nature Reserve includes more favourable habitats for macrophytes compared to other areas. In contrast, no native macrophytes were found at depths greater than 18 m (Simakova & Smirnov unpublished), which corresponds to earlier data (Lobkovskiy et al., 2001). That is smaller depth compared to the other areas of the Caucasian coast such as mentioned above (23 m) (Simakova, 2011). This indicates the result of the Black Sea ecosystem's anthropogenic transformation, which has a significant effect on macrophytes even in such a clear area.

Conclusions

It is apparent that such a small marine area cannot contain all the diversity of the Black Sea biotopes and associated benthic species. However, currently the biocoenoses of the reserve can be labeled as typical for the northeastern coast of the Black Sea. The area under study includes habitats that are common along the whole coast (an active cliff, a narrow pebble beach, a boulder bench and soft sediments). Of the most typical ones, only biotopes of accumulative banks, shells, clays and near-estuarine bottom landscapes have not been recorded. Unlike most areas of the North Caucasian coast, the relief in the reserve is significantly complicated by landslide structures of different ages. High species diversity of benthos on soft and rocky bottom makes it possible to consider the ecosystem of the reserve as a source of macrozoobenthos species for the northeastern coast of the Black Sea.

The macrozoobenthic species diversity of the reserve was equal to or higher than the other investigated sites of the North Caucasian coast. The macrozoobenthic communities present within the Protected Area on soft and rocky bottoms had a similar structure to those of the southern part of the North Caucasian coast. Presently, three types of macrozoobenthos biocoenoses with dominant bivalve mollusks were found on soft sediments in the reserve: (1) sand with dominance of *Chamelea gallina*, (2) silted sand dominated by *Pitar rudis* and *Gouldia minima*, (3) silt dominated by *Parvicardium simil*e. The low siltation level of sediments at depths of 20-25 m and the small role of macrozoobenthic invasive species make the faunistic complex of these depths within the reserve area unique, preserving nearly unchanged from the middle of the 20th century. Some of the known biocoenoses were not found in the Protected Area: *Mytilus galloprovincialis* silt and *Modiolula phaseolina* silt. The former was not found due to the absence of appropriate biotopes, but the first one was not noted at any site along the North Caucasian coast in recent time; this could be a consequence of the whole Black Sea ecosystem's transformation in the late 20th – early 21st century. Thus, only two of the three contemporary communities are fully represented in the reserve marine area, but most of the characteristic macrozoobenthos species correspond with species present in the southern part of the coast. An extension of the reserve's marine boundary over the 70 m isobath, thus including the *M. phaseolina* biocoenosis, would significantly increase the presentability of the protected marine territory. Further studies are needed to confirm this observation.

The rocky biotope was dominated by macroalgae *Cystoseira* spp., which are the common species throughout the Black Sea coast of the Caucasus. The species number recorded to date was not very high. The species diversity of the flora in the reserve was close to that of the other areas of the coast (Table 3), taking into account the sampling effort. However, as further research improves the reserve's macrophyte species list, it will obviously reach values typical for the region or possibly exceed them. This is supported by the fact that in the area of the reserve, the lower boundary of the main macrophyte dominant species' (*Cystoseira* spp.) habitat descends significantly lower than in the southern regions of the coast. The vegetation of the reserve turns out to be representative of the North Caucasian Coast in terms of communities' diversity. At the same time, *Zostera* spp. were not represented here. These very important macrophytes are very sparse along the Caucasian coast.

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РЕПРЕЗЕНТАТИВНОСТЬ БЕНТОСНЫХ СООБЩЕСТВ ПРИРОДНОГО ЗАПОВЕДНИКА УТРИШ ДЛЯ СЕВЕРО-КАВКАЗСКОГО ШЕЛЬФА ЧЕРНОГО МОРЯ

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Была проведена оценка репрезентативности биотопов и бентосных сообществ северо-западного участка природного заповедника Утриш для северокавказского побережья Черного моря. Для осуществления поставленной цели были привлечены как собственные, так и литературные данные по состоянию бентоса. Изученный район природного заповедника Утриш включает местообитания, обычные для побережья в целом (активный клиф, узкий галечный пляж, валунно-глыбовые навалы, бенч и рыхлые осадки). Из трех широко известных черноморских поясных макрозообентосных биоценозов на северо-восточном побережье Черного моря было отмечено только два: мелководный «венусовый песок» и глубоководный «фазеолиновый ил». Третий биоценоз («мидиевый ил») не был отмечен ни на акватории заповедника, ни на обследованной части шельфа южнее Новороссийска. Из этих трех поясов только «венусовый песок» был отмечен на акватории природного заповедника Утриш. Отсутствие мидиевого пояса на исследованной акватории заповедника было типичным явлением для южной части северокавказского побережья в современный период, и, таким образом, не оказывало влияния на репрезентативность бентосных экосистем заповедника. Биоценоз двустворчатых моллюсков *Pitar rudis – Gouldia minima* был обычен на заиленных песках с ракушью как в заповеднике, так и на контрольных участках комплекса средних глубин, замещая мидиевый пояс, который был типичным в 20 в. Его граница проходила на 10 м глубже в заповеднике по сравнению с контрольными районами. Отсутствие пояса *Modiolula phaseolina* на акватории заповедника может объясняться недостаточной протяженностью охраняемой морской территории (только до 52 м по глубине); из-за этого глубоководный комплекс в заповеднике в настоящее время представлен только узкой зоной. Расширение границ заповедника до глубин 70 м позволит включить в охранную зону и этот биоценоз, что значительно повысит репрезентативность морской зоны заповедника для северокавказского побережья Черного моря. Биогеографический состав флоры заповедника, ее видовое разнообразие и структура в целом соответствуют таковым для региона. Зона макрофитов состоит из четырех поясов: верхний пояс (0–2 м, *Dictyota fasciola* f. *repens* + *Polysiphonia opaca* + *Ceramium ciliatum* + *Ulva compressa*), верхний горизонт среднего пояса (2–12 м, *Cystoseira crinita* + *Cystoseira barbata – Cladostephus spongiosus – Ellisolandia elongata*), нижний горизонт среднего пояса (12–18 м, *Phyllophora crispa*, *Codium vermilara* and *Bonnemaisonia hamifera*) и нижний пояс (глубже 18 м), образованный недавним вселенцем *B. hamifera.* Большинство видов, найденных в морской части заповедника, были обычными видами черноморского макрофитобентоса. Однако природный заповедник Утриш является более благоприятным местообитанием для макрофитов, чем другие районы северокавказского побережья, поскольку обычный для побережья макрофит *Cystoseira* spp. был отмечен в заповеднике на больших глубинах, чем на остальном шельфе.

Ключевые слова: биотопы, биоценозы, макрозообентос, макрофитобентос, морской заповедник