

Species composition and distribution of macrobenthos in the intertidal zone of Kunashir Island (South Kurile Islands), Russia

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Abstract Characteristics of vertical distribution, species composition and biogeographical structure of macrobenthos of the intertidal communities of Kunashir Island (South Kurile Islands) are described. In the rocky and bouldery intertidal zones, communities dominated by barnacle *Chthamalus dalli* and a gastropod species *Littorina sitkana* with the poor species composition of the macrobenthos are typical for the upper intertidal subzone. The middle intertidal subzone is occupied by fucoid assemblages. The dense beds of laminarian algae dominate in the lower intertidal subzone with the total macrobenthic biomass up to 100 kg wet wt m⁻². On wave-exposed sandy beaches formed by clean sand, populations of the macrobenthic organisms are very poor, and macrophytes and the other attached forms are absent. The communities dominated by eelgrass *Zostera japonica* and a gastropod species *Batillaria cumingii* are found only in the sandy intertidal zones of the southern coast of Kunashir Island, in Izmeny Bay. Reduction of species richness and increase of biomass of macrobenthos have been recorded from 1963 to 1991 in Izmeny Bay, and it is due to the fact that this area has been exposed to anthropogenic impact. At least, 563 species of macrobenthos are found in the intertidal zone of Kunashir Island. Pacific low-boreal and Pacific wide-boreal species are dominant. Warm-water species are more abundant in the intertidal zones of Izmeny Bay and on the Sea of Okhotsk coast as compared to those on the Pacific coast of Kunashir Island. It is probably associated with the flow patterns of the Soya Warm Current. Species composition and distribution of the intertidal macrobenthos of Kunashir Island are typical for the low-boreal intertidal zone with irregular diurnal and semi-diurnal tides. The intertidal zones of Kunashir Island and neighboring Shikotan Island have similar species composition and distribution patterns of the macrobenthic communities.

Keywords: South Kurile Islands, intertidal zone, macrobenthos, community, species composition, distribution, biogeographical composition, long-term changes.

Introduction

Kunashir Island is the southernmost island of the Greater Kurile Ridge. Its coastline is weakly indented, especially on the Sea of Okhotsk side, and the Pacific coast is exposed to wave action stronger than the western coast of Kunashir Island. Sandy beaches are dominant on the south and southeastern coasts, whereas the northern coast is rocky and occasionally has bouldery-pebbly shores.

The intertidal zone is the area between the high and low tide marks. The boundary position between the

two main habitats of life (air and water) is unique feature of the intertidal zone, also defined as the amphibiotic zone. Organisms that live in this zone experience daily and seasonal fluctuations of temperature and changes in salinity and moisture and they must be able to tolerate extreme environmental changes.

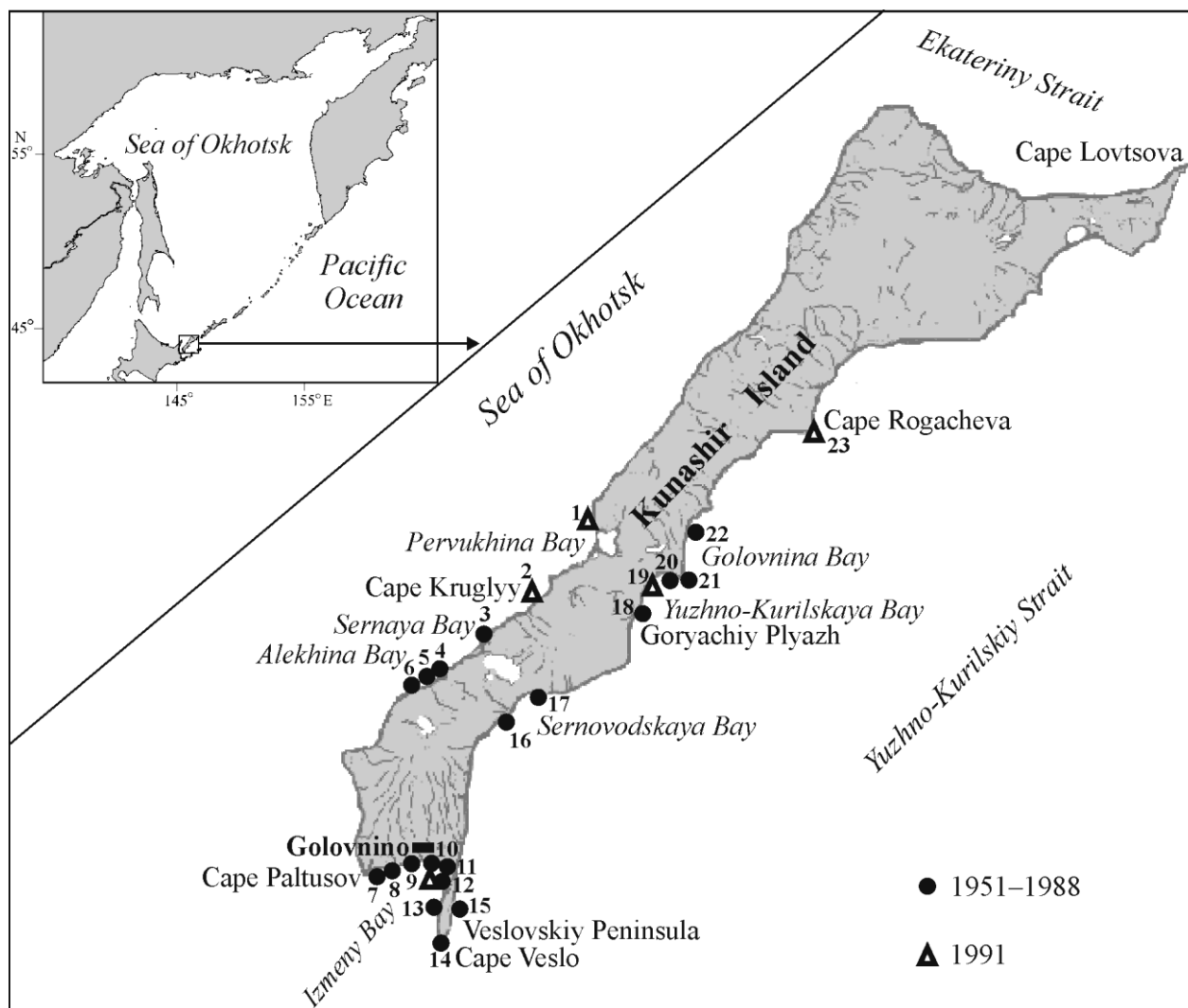


Figure 1. Schematic map of the sampling locations in the intertidal zones of Kunashir Island. 1 – Pervukhina Bay, 2 – Cape Kruglyy, 3 – Sernaya Bay; 4–6 – Alekhina Bay, 7 – Cape Paltusov, 8–13 – Izmeny Bay, 14 – Cape Veslo, 15 – Veslovskiy Peninsula, 16–17 – Sernovodskaya Bay, 18 – Goryachiy Plyazh (Hot Beach), 19–20 – Yuzhno-Kurilskaya Bay, 21–22 – Golovnnina Bay, 23 – Cape Rogacheva. Detailed information about the sampling locations contains in Table 1.

The intertidal zones of Kunashir Island were intensively investigated under the leadership of Oleg G. Kussakin by the expeditions of Leningrad State University (at present, Saint Petersburg State University), Zoological Institute and Botanical Institute (at present, V.L. Komarov Botanical Institute) of the Russian Academy of Sciences. In summer of 1951, in summer and winter of 1954, and in winter of 1955, flora and fauna of the intertidal zones of Sernovodskaya, Alekhina, Yuzhno-Kurilskaya, Golovnnina, and Izmeny bays were examined (Kussakin, 1956, 1957), but quantitative data were not obtained at that time. During summer months of 1963 and 1964, quantitative samplings were carried out in the same bays, as a rule, along the same transects of 1951, 1954, and 1955, and in addition to that, the intertidal investigations were conducted in

Sernaya Bay. On the basis of these results, quantitative data on distribution of the intertidal macrobenthos were obtained (Kussakin and Tarakanova, 1977). In autumn of 1987 and in spring of 1988, species composition and distribution patterns of macrobenthic communities were investigated in the intertidal zone of the Goryachiy Plyazh (Hot Beach) where shallow-water gasohydrothermal vents occur (Kostina, 1991) (Fig. 1; Table 1).

The latest coastal expedition on Kunashir Island was carried out in 1991 by personnel of the Laboratory of Chorology of the Institute of Marine Biology of the Far Eastern Branch of the Russian Academy of Sciences (at present, A.V. Zhirmunsky Institute of Marine Biology, National Scientific Center of Marine Biology, Far Eastern Branch, Russian Academy of Sciences). The intertidal zones of Pervukhina Bay, Cape Rogacheva and at Cape Kruglyy, not examined earlier, were investigated. In Yuzhno-Kuril'skaya Bay, the sampling was carried out in a few kilometers south of the locations of previous studies. In Izmeny Bay, survey was conducted at one of the locations studied in 1963.

In the present paper, the species composition and distribution of macrobenthos in the intertidal zones of Kunashir Island is given on the results of the latest expedition in 1991. The distribution patterns of macrobenthos all over the intertidal zones of Kunashir Island are described by the summarized information of 1951–1988 and 1991. A biogeographical analysis of the intertidal biota has also been undertaken. A quantitative comparison of macrobenthos is carried out between the 1963 and 1991 in one and the same site of Izmeny Bay. Features of the intertidal biota of Kunashir Island are briefly compared to that of the neighboring Shikotan Island.

Materials and Methods

Field survey

Sampling was carried out at low tides in the intertidal zones of Kunashir Island, in July–August 1991. Samples had to be collected according to the methods used in chorological investigation in the intertidal zones (Kussakin and Kostina, 1996; Ivanova et al., 2001). Belt transects laid perpendicularly to the coastline between 0 m depth and level of the highest tide were used to estimate the distribution and species composition of macrobenthos in the intertidal communities (Handbook of Biodiversity Methods, 2005). Belt transects were performed on the western coast of Kunashir Island, on a reef in the northern part of Pervukhina Bay (location 1) and on a reef 1 km southward of Cape Kruglyy (location 2); on the southern coast, on a beach, in 1.5 km eastward of Golovnino Village in Izmeny Bay (location 10); on the eastern coast, on a small nameless cape in central part of Yuzhno-Kuril'skaya Bay, 5 km southwesterly of Cape Zavodskoy (location 19) and in the tide pool on Cape Rogacheva (location 23) (Fig. 1; Table 1). The length of transect lines depended on the width and slope of the intertidal zones. The total length of transect was about 25 m on the sandy intertidal zone in Izmeny Bay, while on hard substrata, for instance, on reef in Pervukhina Bay, the transect line was not more 15 m lengths.

The shore along each transect was divided into three subzones, namely the upper, middle and lower subzones. Subdivision of the intertidal zones was conducted according to the principles of Vaillant (Vaillant, 1891). Because ice appears on the Kunashir Island coast in November, which can cause death of a portion of the intertidal biota, the estimations of sea levels and corresponding intertidal subzones were performed for tidal ranges from May to October. The boundaries of the upper, middle, and lower subzones are determined by the high water spring tides, high water neap tides, low water neap tides, and low water spring tides, respectively. Irregular diurnal and semi-diurnal tides are characteristic of Kunashir Island. The tides reach 1.8 m in Izmeny Bay, and in Yuzhno-Kuril'skaya Bay, the highest tides are about 1.65 m.

Each intertidal subzone is characterized by own communities. The distribution of species in the intertidal communities was provisionally estimated by eye. The types of communities were distinguished and named by

dominant (frequently belt-forming) species of macrobenthos (see Plates 1–11). For example, the *Littorina sitkana* community means an assemblage of macrobenthos dominated by a gastropod species *Littorina sitkana*; the *Chthamalus dalli* + *Littorina sitkana* community – dominated by two species with similar values of biomass, barnacle *Chthamalus dalli* and a gastropod species *Littorina sitkana*; the *Fucus evanescens* community – dominated by the brown alga *Fucus evanescens*, etc.

Quadrates of metal frames were randomly placed within each of the three intertidal subzones (upper, middle, and lower subzones) and within the boundaries of the distinguished communities along each transect. We chose two or three samples (quadrates) from each community. Quadrates of 100 and 250 cm² were put on soft sediments, and those of 100, 250, and 500 cm² were put on the rocky reefs. When organisms were small and exhibited nearly uniform distribution, we used smaller frames, as opposed to samplings in the communities of individuals with fairly large body size or species that were rarely distributed and not so common. On hard substrata, macrobenthos had to be collected by scraping in quadrates, until all organisms were removed from the surface of substratum. On soft sediments, the upper layer of sediment (approximately 10 cm thick) was being gotten out from quadrate. To remove sediments from the macrobenthic samples, we used a set of six 200 mm diameter aluminium soil sieves with mesh sizes 10 mm, 7 mm, 5 mm, 3 mm, 2 mm and 1 mm. Samples were sieved over 1 mm mesh size *in situ*.

Not all species were quantified. Qualitative samples of macrobenthos were taken outside the quadrates, but, as a rule, within the boundaries of the distinguished communities. Some species had to be collected outside the boundaries of communities, but included in the list of macrobenthos of the intertidal zone of Kunashir Island (see Appendix). Plants and animals had to be collected by hands in these samples. This method was used for determining presence/absence of species without definition of their density and biomass. Some species are rare, and all species of macrobenthos cannot get in quadrates. Besides, it wasn't always possible to quantify macrobenthos within some microhabitats, for instance, such as crevices, holes or under boulders. On the other hand, some species dwell in association with other species as epibionts, and it wasn't always possible to quantify them. Therefore we attempted to survey species composition of the intertidal macrobenthos as far as possible more fully, using the quantitative and qualitative samples (see Plate 14).

Each quantitative or qualitative sample was recorded separately. All the taxonomic groups of macrobenthos were registered. Specimens from the quantitative samples, after drying on a filter paper, weighed using pharmaceutical scales accurate to 10 mg; large seaweeds and seagrasses were weighed on a technical balance accurate to 1 g. The data obtained were extrapolated for 1 m². The biomasses presented in the paper, including shells of mollusks and the other skeletal structures of animals, are provided as wet weights. Some dominant species was identified in the field works. The collected material was fixed in 75% alcohol or 4% formalin and taken to the laboratory for identification. In 1991, 5 transects were performed, 68 quantitative and 6 qualitative samples of macrobenthos had to be collected in the intertidal zones of Kunashir Island, and also 147 specimens of algae and seagrasses had to be preserved on herbarium sheets.

Data analysis

The description of vertical distribution and species composition of the intertidal macrobenthos in Pervukhina Bay, on reef 1 km southward of Cape Kruglyy and on beach 1.5 km eastward of Golovnino Village in Izmeny Bay, in central part of Yuzhno-Kuril'skaya Bay, and on Cape Rogacheva was conducted by the quantitative and qualitative samples collected in 1991. Besides, a general conclusion about the distribution and species composition of the intertidal macrobenthos all over Kunashir Island were made on a basis of the materials of expeditions in 1951, 1954, 1955 (qualitative samples) (Kussakin, 1956, 1957), 1963, 1964 (quantitative samples) (Kussakin and Tarakanova, 1977), 1987, 1988 (Kostina, 1991), and 1991 (present data) (quantitative and qualitative samples).

A general list of species found on all locations studied of Kunashir Island was compiled by the results of qualitative and quantitative sampling of expeditions in 1951, 1954, 1955, 1963, 1964, 1987, 1988, and 1991 to represent composition of the intertidal biota of Kunashir Island as a whole and also to determine the

biogeographical composition of macrobenthos (see Appendix). Our records (expedition of 1991), early published literature data on expedition of 1951–1988 (Kussakin, 1956, 1957; Kussakin and Tarakanova, 1977; Kostina, 1991), and as well as reference to the macrophytic and macrofauna species of these expeditions (Zinova and Perestenko, 1974; Kussakin, 1975) not mentioned in previous publications were used to put together the list of the macrobenthic plants and animals of the intertidal zone of Kunashir Island. Besides, literature data on various groups of animals were also used to clarify the taxonomic position and the geographical area within which species can be found: Porifera (Khodakovskaya, 2003, 2005), Hydrozoa (Antsulevich, 1992; Sheiko, 2009), Actiniaria (Sanamyan and Sanamyan, 2009), Polychaeta (Buzhinskaja, 2013), Sipuncula (Morozov and Adrianov, 2002), Pantopoda, Leptostraca, and Mysida (Petrashev et al., 2004), Cirripedia (Sessilia) (Poltarukha et al., 2006), Amphipoda (Vassilenko, 2006; Budnikova and Bezrukov, 2008; Labay, 2013), Cumacea (Tzareva et al., 2013), Decapoda (Hayashi and Kim, 1999; Komai, 1999; Asakura and Watanabe, 2005; Kim et al., 2006; Marin, 2014), Isopoda (Golovan and Malyutina, 2010), Mollusca on the whole (Kantor and Sysoev, 2005), Gastropoda (Chernyshev and Chernova, 2005; Gulbin, 2009a, b, 2010a, b), Bivalvia (Lutaenko and Noseworthy, 2012), Bryozoa (Dick et al., 2005; Grischenko et al., 2007; Grischenko and Foster, 2012), Asteroidea (Shin, 1995; Byrne et al., 1997), Holothuroidea (Stepanov et al., 2012; Panina and Stepanov, 2013), Ascidiacea (Lejeune et al., 2011). Additionally, check-lists of species and some monographs on the fauna and flora of the Russian Far Eastern seas and adjacent waters were used to clarify the species' biogeography and taxonomy (Kussakin et al., 1997; Fauna and Ecosystems..., 2004; Illustrated Keys..., 2009, 2010, 2012; Check-List of Species..., 2013). Moreover, concerning the systematics, nomenclature, and detailed distribution of algae and seagrasses, we follow M. D. Guiry and G. M. Guiry (2016), and about classification and distribution of fishes, we follow R. Froese and D. Pauly (2016).

Biogeographical characteristics are given for each organisms of the species rank on a base of the patterns of the species distribution in geographic space. For the eastern and western coasts, the data of 1951–1964 and ones of 1987–1991 (only 1991 for western coast) are represented separately (see Appendix), since changes of the biogeographical composition of macrobenthos could take place for 30–40 years. Unfortunately, on the southern coast, only single transect was done in 1991, and 20 transects were performed from 1951 to 1964 (Table 1). Besides, 187 species were found from 1951 to 1964, and only 27 species were found in 1991 (polychaete *Alitta brandti*, a gastropod species *Cerithiopsis stejneri*, and fish *Opisthocentrus ocellatus* had not been detected during previous surveys). Therefore, we combined biogeographical data of 1951–1964 with those of 1991 for Izmeny Bay.

In the present paper, we use biogeographical terminology widely accepted in Russian biogeographical literature (Kussakin, 1975, 1990; Lutaenko, 1993; Kafanov and Kudryashov, 2000; and others). The temperate waters of the Northern Hemisphere are called boreal, and those of the Southern Hemisphere – notal.

1. Pacific species:

A. Low-boreal species are limited in their southward distribution by a line of Wonsan (North Korea) – Sado Island and Cape Inubo (western and eastern coasts of Honshu, respectively) – Point Conception (California) and in their northward distribution by Cape Patience (Cape Terpeniya, the east-central Sakhalin Island) – Ekateriny Strait (between Iturup and Kunashir islands) on the Asian coast and at Strait of Juan de Fuca (Puget Sound, Washington) on the American coast (amphi-Pacific species are distributed in low-boreal waters of both the Asian and American coasts).

B. High-boreal species are distributed mainly from a line of Cape Patience – Ekateriny Strait – Strait of Juan de Fuca to Bering Strait.

C. Widespread boreal species are distributed mainly from a line of Wonsan – Sado Island and Cape Inubo – Point Conception to Bering Strait, i.e., inhabit the Pacific low-boreal and high-boreal waters.

D. Subtropical-boreal species are distributed mainly from the northern part of Taiwan, Kyushu Island, Yellow Sea, and the southern part of the Korean Peninsula on the Asian coast and from the southern part of the

Baja California Peninsula on the American coast to Bering Strait. Subtropical-low-boreal species are limited in their northward distribution by low-boreal waters.

2. Species of the Northern Hemisphere:

A. Amphi-boreal species are distributed in both the Pacific and Atlantic temperate waters (on the eastern coast of the Atlantic Ocean, the boreal species are limited in their southward distribution mainly by the southern part of English Channel, but frequently including the Bay of Biscay and the western coast the Iberian Peninsula up to the Strait of Gibraltar, and in their northward distribution by Cape Kanin Nos (Barents Sea) and the western coast of Spitsbergen; on the western coast of the Atlantic Ocean, the boreal species spread from Cape Hatteras (North Carolina) to Davis Strait and Denmark Strait).

B. Boreal-arctic species inhabit the Pacific and/or Atlantic temperate waters and the Arctic seas.

C. Subtropical-boreal/low-boreal species are distributed in the subtropical and boreal/low-boreal waters both of the Pacific and Atlantic oceans (Atlantic subtropical species spread mainly from South Carolina, the northwestern Africa (mainly Morocco), and the Mediterranean Sea to the southern boundary of the Atlantic boreal waters, at the same time, there is not definite the northern boundary of the distribution of Atlantic low-boreal species on the American coast, and on the European coast, these species spread approximately from the southwestern part of the Iberian Peninsula to English Channel).

3. Worldwide distributed species:

A. Tropical-boreal/low-boreal and tropical-subtropical species are distributed from the tropic waters of World Ocean (Indo-Pacific, tropical eastern Pacific (from the southern tip of the Baja California Peninsula in the north to the northern Peru in the south), and tropical Atlantic (in the western Atlantic, these species distribute from Florida and Gulf of Mexico through Caribbean and along the South America's Atlantic coast to Cape Frio (Rio de Janeiro state), and in the eastern Atlantic, they extend along the African coast from Cape Blanco (Mauritania) to the Tigres Peninsula (Angola)) to the boreal/low-boreal/subtropical waters of the Pacific and/or Atlantic oceans.

B. Subtropical/tropical-boreal-Arctic species are distributed from the subtropical or tropical waters to the Arctic seas.

C. Anti-tropical species are distributed mainly in the temperate waters (partly in subtropical waters) of the Northern and Southern hemispheres and the polar regions, but show a geographical delimitation of the distribution pattern in tropical regions (also known as bipolar species).

D. Notal-tropical-boreal/low-boreal/subtropical species are distributed from the temperate waters of the Southern Hemisphere to boreal/low-boreal/subtropical waters of the Northern Hemisphere (in the northward, temperate waters of the Southern Hemisphere are limited mainly by the southern part of South America, the southernmost part of Australia, and New Zealand).

E. Species of almost world-wide distribution are called panoceanic (cosmopolitan) species for animals and multizonal species for plants.

A cluster analysis was carried out in order to group 23 sampling locations of Kunashir Island having similar the species composition of the intertidal macrobenthos. Hierarchical cluster analysis was performed using the StatSoft STATISTICA 6.0 (the clustering is based on Euclidean distance with using Ward's method). Qualitative data (lists of species) have been used (namely presence/absence of species in each of 23 locations) from 1951 to 1991 to construct a dendrogram. Study of the intertidal macrobenthos of Kunashir Island was carried out during 40 years, but each of 22 locations (1–9 and 11–23) has been investigated in a certain year or at least within 12–13 years (Table 1). Whereas in 1.5 km eastward of Golovnino Village (Izmeny Bay), the intertidal investigations were conducted in 1991 at one of the same location studied in 1951–1963 (location 10), therefore, in this location, the species compositions of macrobenthos of 1951–1963 and one of 1991 were used separately for cluster analysis (10a – 1951–1963 and 10b – 1991; see Fig. 3), since changes of the composition of the intertidal biota could occur for 30–40 years.

Results

Rocky intertidal zone

A reef southward of Cape Kruglyy (location 2) is an indented flat rocky platform with a slight slope. The coast is weakly protected and exposed to almost permanent wave action. The vertical stratification of communities is well marked.

The upper intertidal subzone: communities found in this subzone tend to exhibit a uniform species composition. There are community dominated by a gastropod species *Littorina sitkana* and community dominated by barnacle *Chthamalus dalli* (Table 2). Algae are not typical for these communities. The upper part of this subzone and partially supratidal zone are occupied by the *L. sitkana* belt. The *Littorina* biomass makes up to 99% of the total macrobenthic biomass, and this sea snail is the most numerous species (more than 90 thousand individuals m^{-2}). The following animals are also found in the community: species of gastropods *Falsicingula kurilensis* and *Lottia pelta*, an isopod species *Gnorimosphaeroma noblei*, and barnacle *Ch. dalli*. Immediately below the *L. sitkana* belt, the upper subzone is occupied by the *Ch. dalli* community with a low total biomass of macrobenthos (up to 240 g wet wt m^{-2}) including *Ch. dalli* itself and other species (species of gastropods *Nucella heyseana*, *L. sitkana*, *Lottia persona*, and others).

The belt-forming community dominated by the red alga *Gloiopeltis furcata* is found on the boundary between the upper and middle subzones. *F. kurilensis* and *L. sitkana* are the most abundant animals (Table 3).

The middle intertidal subzone: fucoids are dominant in this subzone. The *Silvetia babingtonii* community forms its own belt. Dominant species makes up about 95% of the total macrobenthic biomass (Table 4). *Littorina sitkana* dominates among animals in the community. In the *Fucus evanescens* + *Silvetia babingtonii* community, biomasses of the dominant and subdominant species make up to 90% of the total macrobenthic biomass. As well as in the *Gloiopeltis furcata* community, *L. sitkana* and *Falsicingula kurilensis* are dominant among animals. A gastropod species *Nassarius fraterculus* and the amphipod species *Apothyale bassargini*, *Ampithoe kussakini*, and *Spasskogammarus spasskii* frequently occur.

Besides, the community dominated by the brown alga *Analipus japonicus* can be found in the upper part of the middle intertidal subzone, in which species composition is very poor. Dominant species makes up to 95% of the total macrobenthic biomass (Table 4).

In the belt-forming community dominated by the calcareous red alga *Corallina pilulifera*, the other algae are not found (Table 6). Species of gastropods *F. kurilensis*, *N. fraterculus*, and *L. sitkana*, and also the amphipod species *A. kussakini* and *Parallorchestes ochotensis* are abundant. Dominant species makes up to 80% of the total macrobenthic biomass.

A community dominated by the red alga *Neorhodomela aculeata* is one of the most diverse communities in the middle subzone. Apart from *N. fraterculus*, *F. kurilensis*, *L. sitkana*, and *P. ochotensis*, the hermit crab *Pagurus middendorffii* frequently occurs. *Sargassum miyabei*, *Neorhodomela munita*, and *C. pilulifera* are almost equally represented among algae (Table 6).

A community dominated by the green alga *Chaetomorpha moniligera* can be frequently found in the middle subzone. The total biomass of macrobenthos is quite low (up to 560 g wet wt m^{-2}), and species of gastropods (*F. kurilensis*, *Nucella heyseana*, *Nassarius fraterculus*, and *L. sitkana*) are abundant in the community (Table 8).

In sites, on the boundary between the middle and lower subzones, where rocks are splited by spaces filled with sand, the community dominated by the surfgrass *Phyllospadix iwatensis* occurs with insignificant the total biomass of macrobenthos (up to 800 g wet wt m^{-2}) (Table 10). Polychaetes and some species of gastropods are more abundant groups of macrobenthos in the grass habitat. The diverse polychaetes (*Chone teres*, *Nereis vexillosa*, *Naineris jacutica*, *Glycinde armigera*, *Capitella capitata*, *Harmothoe imbricata*, and others) dwell in rhizomes and roots of *Phyllospadix*. Species of gastropods *N. fraterculus*, *N. heyseana*, *Lottia*

persona, *Mitrella burchardi*, *Cryptonatica hirasei*, and *Homalopoma sangarense* are conspicuous inhabitants of the *Phyllospadix* bed. Also small fish *Alectrias alectrolophus* frequently occurs in the tide puddles.

The lower intertidal subzone: the belt-forming communities dominated by the brown algae *Sargassum miyabei* and *Sargassum thunbergii* with rather rich species composition of macrobenthos are typical for this subzone (Table 11). The *S. miyabei* biomass makes up about 60% of the total macrobenthic biomass, whereas biomasses of accompanying species of the red algae – *Neorhodomela aculeata* and *Mastocarpus pacificus* – amount about 30% of the total biomass. Species of gastropods *Nassarius fraterculus*, *Falsicingula kurilensis*, *Littorina sitkana*, *Homalopoma sangarense*, and *Pusilina plicosa*, and the amphipod species *Ampithoe kussakini* and *Apohyale bassargini*, the isopod species *Idotea ochotensis* and *Holotelson tuberculatus* are frequently found in the community. In the *S. thunbergii* community, the dominant species makes up more than 95% of the total macrobenthic biomass. The species composition in the community is slightly different from that in the *S. miyabei* community. The amphipod species *A. bassargini*, *Ischyrocerus* sp., and *Caprella cristibrachium*, and a gastropod species *F. kurilensis* are the most numerous here.

Rocky-bouldery intertidal zone

A reef in Pervukhina Bay (location 1) is a flat rocky platform with scattered boulders under a high precipice. The coast is exposed to wave action. The vertical stratification of the communities is well marked.

The upper intertidal subzone: the settlements of *Chthamalus* and *Littorina* are rarefied, and they do not always form a continuous belt. The *Littorina sitkana* community occupies the sides of boulders. The biomass of *Littorina* is very low (45 g wet wt m⁻²). The *Chthamalus dalli* community is situated just below the *Littorina* belt and also characterized by low value of the macrobenthic biomass (up to 200 g wet wt m⁻²) (Table 2).

The middle intertidal subzone: the upper part of this subzone is occupied by the *Silvetia babingtonii* and *Fucus evanescens* communities with the rare patches of the green algae *Cladophora opaca*, *Chaetomorpha moniligera*, and *Ulva lactuca*. These communities are characterized by lower values of biomasses (up to 3390 g wet wt m⁻²) than those on the rocky reef southward of Cape Kruglyy, although *S. babingtonii* and *F. evanescens* also make up about 95% of the total biomass of macrobenthos (Table 4). Species of gastropods *Falsicingula kurilensis* and *Littorina sitkana*, a bivalve mollusk *Turtonia minuta* and an amphipod species *Ampithoe kussakini* are the most numerous in the fucoid communities.

The red and green algae communities occur below the fucoids. Communities dominated by the red algae *Laurencia nipponica*, *Chondrus pinnulatus* and *Mastocarpus pacificus* are found on Kunashir Island only on the reef in the Pervukhina Bay. In the latter community, biomass of the calcareous red alga *Corallina pilulifera* is about a third of the *M. pacificus* biomass (Table 6).

The *Neorhodomela aculeata* community is widespread on Kunashir Island. Species composition of the community is fairly diverse, but sea anemone *Cnidopus japonicus*, the hermit crab *Pagurus middendorffii*, an isopod species *Idotea ochotensis*, and the amphipod species *Ampithoe* sp. and *Caprella* sp. mainly prevail among animals, and the red alga *Rhodomela sachalinensis* is abundant among macrophytes (Table 6).

Communities dominated by the green algae *Ulva lactuca* and *Cladophora opaca* + *Chaetomorpha* sp. are usually situated below the *N. aculeata* community. In the *Ulva* community, algae *Mazzaella japonica*, *Sargassum miyabei*, and germs of *Saccharina* sp. dominate, whereas in the *Cladophora* community, *U. lactuca* prevails. The most abundant invertebrates of the communities are species of gastropods *Lottia persona* and *F. kurilensis*, and an amphipod species *A. kussakini* (Table 8).

On the boundary between the middle and lower subzones, where reef is splited by spaces filled with sand, thickets of *Phyllospadix iwatensis* spread out (Table 10). Among macrophytes, only the red alga *C. pilulifera* occurs, and species composition of animals is very diverse in this belt-forming community. However, biomass of animal species does not exceed 4% of the total macrobenthic biomass. Numerous species of polychaetes (*Chone teres*, *Nereis vexillosa*, *Naineris jacutica*, *Nereis zonata*, and others) dwell in roots and rhizomes of *Phyllospadix*. Species of gastropods *Nucella heyseana*, *Epheria turrita*, *Haloconcha minor*, *Mitrella burchardi*,

MACROBENTHOS IN THE INTERTIDAL ZONE OF KUNASHIR ISLAND

and some others, species of bivalves *Protothaca euglypta*, *Mysella kurilensis litoralis*, and *Turtonia minuta*, the isopod species *I. ochotensis*, *Holotelson tuberculatus*, *Gnorimosphaeroma noblei*, and *Cleantiella isopus*, the amphipod species *Pontogeneia* sp., *Pontogeneia kondakovi*, and others, sea urchin *Strongylocentrotus intermedius*, sea anemone *C. japonicus*, the hermit crab *P. middendorffii*, chiton *Boreochiton granulatus*, and the many other groups of invertebrates also can be found in the *Phyllospadix* beds.

The lower intertidal subzone: in the upper part of this subzone, the *Sargassum miyabei* and *Scytosiphon lomentaria* belt-forming communities with almost equal the total macrobenthic biomass (about 4500 g wet wt m⁻²) occur (Table 11). The thalli of *Sargassum* provide habitats for a diverse fauna (species of gastropods *Falsicingula kurilensis*, *Pusilina plicosa*, and *Volutharpa ampullacea*, the helmet crab *Telmessus cheiragonus*, the amphipod species *Ampithoe kussakini*, *Ampithoe* sp., and *Apohyale bassargini*, and species of bivalves *Turtonia minuta* and *Protothaca euglypta*, and others). Among macrophytes, only the red alga *Neorhodomela aculeata* and the brown alga *Sargassum thunbergii* are found in the *Sargassum* community. While in the *S. lomentaria* community, there are many different species of algae (the green alga *Ulva lactuca*, the brown algae *S. miyabei*, *Costaria costata*, *Chordaria flagelliformis*, *Saundersella simplex*, and *Ralfsia fungiformis*, and the red algae *Tichocarpus crinitus*, *Laurencia nipponica*, *Lomentaria hakodatensis*, *Palmaria stenogona*, and *Polysiphonia morrowii*, and many others), although, on the whole, macrobenthos is poorer in species composition as compared to the *S. miyabei* community.

The community dominated by the brown macroalga *Saccharina* sp. forms a distinct belt just below the *Sargassum* and *Scytosiphon* belts on the side towards the open sea. Biomass of *Saccharina* makes up more than 99% of the total macrobenthic biomass. Only several species of animals are found, and a gastropod species *F. kurilensis*, an amphipod species *Ampithoe volki*, and polychaete *Typosyllis* sp. are frequently recorded in the community (Table 11).

Bouldery-sandy intertidal zone

A cape in Yuzhno-Kurilskaya Bay (location 19) is a site of scattered boulders and rocky blocks among the sand. The coast is weakly protected from wave action. The vertical distribution of the communities exhibits insignificant stratification, and patchy distribution of macrobenthos is typical for this intertidal zone. Macrobenthos is represented by a rich infauna of soft-sediment habitats, and population of hard substrata is slightly poorer than that in the rocky and rocky-bouldery intertidal zones.

The upper intertidal subzone: the barnacle community dominated by *Chthamalus dalli* + *Semibalanus cariosus* is found on the rocky blocks and boulders (Table 2). The community is characterized by fairly high biomass of macrobenthos (3425 g wet wt m⁻²). Species of gastropods *Littorina sitkana* and *Nucella heyseana*, polychaete *Typosyllis adamanteus*, insect larvae, and other invertebrates are found, but plants are absent in the barnacle community.

The boundary between the upper and the middle subzones is occupied by the *Gloiopeltis furcata* + *Chthamalus dalli* community. A numerous amphipod species *Corophium* sp. and a gastropod species *L. sitkana* are frequently observed here (Table 3).

The middle intertidal subzone: communities dominated by the brown algae *Silvetia babingtonii*, *Fucus evanescens*, and *Analipus japonicus* are found on the sides of the rocky blocks and boulders. The dominant species make up not less than 90% of the macrobenthic biomass. The communities have different species compositions, but comprise only a few species. In the *Silvetia* community, *Chthamalus dalli*, *Littorina sitkana*, and an amphipod species *Apohyale bassargini* prevail. In the *Fucus* community, *L. sitkana* and an isopod species *Gnorimosphaeroma noblei* predominate. In the *Analipus* community, a gastropod species *Nucella heyseana*, and small specimens of polychaetes and amphipods are abundant (Table 5).

The *Corallina pilulifera* community can be found on the broad horizontal surfaces of boulders and rocky blocks. Biomass of the dominant species makes up about 95% of the total macrobenthic biomass. Polychaete *Nereis pelagica*, a gastropod species *Falsicingula kurilensis*, an isopod species *Synidotea lata*, the helmet crab *Telmessus cheiragonus*, and others invertebrates are abundant in the community (Table 7).

Communities dominated by the red algae *Tichocarpus crinitus*, *Odonthalia corymbifera*, and *Palmaria marginicrassa* are found on Kunashir Island only in the Yuzhno-Kuril'skaya Bay. Young germs of *Saccharina* sp. are quite a few in these red algal communities. Sponge *Halichondria panicea* usually occurs on the boulders and the red algae and makes up about 35% of the total biomass in the *O. corymbifera* community. Fauna is fairly diverse in the *T. crinitus* community and the *O. corymbifera* community. Hydroids *Abietinaria filicula* and *Eudendrium vaginatum*, the amphipod species *Caprella* sp. and *Caprella cristibrachium*, the helmet crab *T. cheiragonus*, and other groups of invertebrates are abundant in thickets of algae. Only a few species of animals are found in the *P. marginicrassa* community, however (Table 7).

Among communities of the red algae, there is the *Mazzaella parksii* community with fairly high species richness. Species of gastropods *Lottia persona*, *F. kurilensis*, and *L. sitkana*, hydroid *Obelia longissima*, polychaete *N. pelagica*, an amphipod species *A. bassargini*, species of bivalves *Panomya* sp., *Musculus laevigatus*, and *Turtonia minuta* mainly prevail. Among algae, only *C. pilulifera* is observed (Table 7).

Communities dominated by the green algae can be found in spaces between patches of the red algae. In the *Blidingia minima* community, macrobenthos is poor (only the brown alga *Analipus japonicus* and barnacle *Ch. dalli* can be frequently found). In the *Chaetomorpha melagonium* community and the *Ulva lactuca* community, fauna also represents by a few species (Table 8).

Colonies of hydroid *Abietinaria filicula* are anchored to the surfaces of boulders and rocky blocks shaded from sunlight. Only young germs of *Saccharina* sp. occur in the *Abietinaria filicula* community among macrophytes (Table 9). Among animals, a gastropod species *Lottia pelta*, ascidians, bryozoans *Cryptosula zavjalovensis* and *Celleporella hyalina*, sea anemone *Cnidopus japonicus*, and polychaete *N. pelagica* are dominated. Besides *A. filicula*, hydroids *Abietinaria thuiarioides*, *Halecium lucium*, *Eudendrium vaginatum*, *Sertularia robusta*, *Campanularia volubilis*, and others can be found in this community. Numerous sedentary polychaetes Sabellidae are found attached to the undersides of boulders in the tide puddles. In this community, polychaete *Naineris jacutica* and sea anemone *Oulactis orientalis* are dominated, and plants are absent.

On the boundary between the middle and lower subzones, *Phyllospadix iwatensis* forms the dense beds on the sand among the rocky blocks and boulders (Table 10). Most animals inhabit rhizomes and roots of *Phyllospadix*. Sea anemone *O. orientalis*, polychaetes *N. jacutica*, *Chone teres*, *Eudistylia suavis*, *Nereis vexillosa*, and *Pseudopotamilla ocellata*, species of gastropods *N. heyseana* and *L. sitkana*, and the helmet crab *T. cheiragonus* prevail quantitatively.

The lower intertidal subzone: the *Saccharina* sp. belt stretches in this subzone. The total biomass of the *Saccharina* community is more than 100 kg wet wt m⁻², and the dominant species makes up more than 99% of the community biomass (Table 11). Polychaetes (*Nereis pelagica*, *Chone* sp., and others), sea spiders, hydroids *Eudendrium vaginatum* and *Campanularia volubilis* are found into holdfasts of *Saccharina*, whereas amphipods (*Parallorchestes ochotensis*, *Apohyale bassargini*, and others) inhabit thalli of the alga.

Sandy intertidal zone

A beach in Izmeny Bay (location 10) is protected from a strong wave action. Species diversity is poorer as compared to that in the many other areas studied. At the Golovino Village, the intertidal zone is exposed to domestic sewage and wastewater from seafood processing.

The upper intertidal subzone: macrobenthos is not found here.

The middle intertidal subzone: it is occupied by the belt-forming community dominated by a gastropod species *Batillaria cumingii*. This community includes only several animal species, and the dominant species makes up about 90% of the macrobenthic biomass (Table 12).

The lower intertidal subzone: areas from the lowest part of the middle to the upper part of the lower intertidal subzones are occupied by the belt-forming community dominated by the eelgrass *Zostera japonica*. Macrobenthos is fairly rich. Infaunal bivalve mollusk *Ruditapes philippinarum*, polychaetes *Nereis vexillosa* and *Abarenicola pacifica*, and also epifaunal sea snails *Batillaria cumingii* and *Nassarius fraterculus* are the most abundant in the *Zostera* beds (Table 12). Eelgrass beds also provide shelter for shallow-water fish

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Opisthocentrus ocellatus.

The *Zostera marina* belt is widespread in the lower part of the lower subzone. *R. philippinarum* is dominated by biomass among animals (Table 12). Polychaetes (*Alitta brandti*, *Naineris jacutica*, *Glycinde armigera*, *Chone* sp., *Nereis pelagica*, and others), which are found burrowing into sand or dwelling in roots of eelgrass, prevail in the species composition of the *Z. marina* community. On leaves of *Zostera*, species of gastropods *Lirularia iridescens*, *Cerithiopsis stejnegeri*, and *Pusilina plicosa* dwell, and *B. cumingii* and *Nassarius multigranosus* live on the sand flat.

Tide pool

Cape Rogacheva (location 23): the middle subzone: on a flat reef, there is a tide pool about 20 m diameter and about 30 cm depth, separated from the open sea by a rocky terrace and protected from a strong wave action. The vertical stratification of communities is observed only on the walls of the tide pool, whereas the communities may exhibit a patchy distribution on a bottom of the tide pool.

At the level of boundary of transition of the walls of the tide pool into the top part of reef, the belt-forming community dominated by *Littorina sitkana* and the *Chthamalus dalli* + *Littorina sitkana* community occur (Table 13). Species composition of animals composes of a few species, and algae are not found in these communities. The red alga *Gloiopeltis furcata* community is situated along the edge of the tide pool, below belts of *Littorina* and *Chthamalus*.

A belt of fucoids with more diverse species composition than in communities of top of the tide pool is situated below the *G. furcata* community, on the walls of the pool and scattered boulders along the pool's walls. In the *Silvetia babingtonii* community with the rare patches of *Fucus evanescens*, biomass of algae is many times higher than the animal biomass, and the dominant species makes up more than 97% of the total biomass of macrobenthos (Table 14). Just below the *S. babingtonii* community, the *Fucus evanescens* community occurs. Macrobenthic species of the communities are diverse (species of gastropods *L. sitkana*, *Nucella freycinetii*, *Lottia persona*, *Mitrella burchardi*, and others, an amphipod species *Apohyale bassargini*, barnacle *Ch. dalli*, a bivalve mollusk *Mytilus trossulus kussakini*, the hermit crab *Pagurus middendorffii*, the isopod species *Gnorimosphaeroma noblei* and *Idotea ochotensis*, and other invertebrates). *L. sitkana* dominates among animals. A community dominated by the brown alga *Analipus japonicus* occurs below the fucoid belt.

Macrobenthos with mix of various species is typical for the bottom of the tide pool. Seagrasses, the red and green algae are dominant. A total projective cover of bottom by *Corallina* and *Phyllospadix* estimated visually is up to 90%. The calcareous red alga *Corallina pilulifera* community forms a dense carpet on the bottom of the pool. *Corallina* makes up about 95% of the total macrobenthic biomass (Table 15). In addition to quantitatively recorded species, the red algae *Halosaccion hydrophorum* and *Corallina officinalis*, the brown alga *Leathesia marina*, the green alga *Ulva lactuca*, and others are also found in the *Corallina* community. The animal biomass is almost twenty times less than the plant biomass. Mollusks *Falsicingula kurilensis* and *Littorina sitkana* are the most numerous dwellers. The *Phyllospadix iwatensis* community is typical for sites of the sand accumulation on the rocky substratum. The dominant species makes up about 95% of the total macrobenthic biomass (Table 15). Animals are diverse, but many species have a low biomass in this community. Both infaunal animals (polychaetes *Naineris jacutica*, *Nereis pelagica*, *Lumbrineris japonica*, and others, sipunculid worm *Phascolosoma (Physcosoma) agassizii*, species of nemertean *Tubulanus punctatus*, and a bivalve mollusk *Protothaca euglypta*) and epifaunal forms (the helmet crab *Telmessus cheiragonus*, the hermit crabs *Pagurus middendorffii*, *Pagurus hirsutiusculus*, and *Pagurus brachiomastus*, the wrinkled crab *Dermaturus mandtii* and the king crab *Paralithodes brevipes*, species of gastropods *Mitrella burchardi*, *Buccinum mirandum mirandum*, and others, sea anemone *Cnidopus japonicus*, sponge *Halichondria panicea*, chiton *Boreochiton granulatus*, Pantopoda, and many other invertebrates) can be found in this community. The red algae communities *Neodilsea yendoana*, *Pterosiphonia bipinnata*, *Neorhodomela aculeata* + *Neorhodomela oregona*, and *Mazzaella parksii* exhibit patchy distributions. In the communities, flora is composed of only several species, whereas fauna is very diverse (Table 16). In the *N. yendoana* community,

an isopod species *Idotea ochotensis*, an amphipod species *Apohyale bassargini*, and the hermit crab *Pagurus middendorffii* are frequently found. In the *P. bipinnata* community, barnacle *Chthamalus dalli*, polychaete *N. pelagica*, an isopod species *Cliamenella fraudatrix*, the amphipod species *A. bassargini* and *Pontogeneia* sp. are the most numerous species. Dominance of *Pontogeneia* sp. and mollusks *Littorina sitkana* and *Nucella heyseana* is typical for the *N. aculeata* + *N. oregona* community, whereas *A. bassargini* and mollusks *Hiatella arctica*, *L. sitkana*, and *Falsicingula kurilensis* prevail in the *M. parksii* community. *Chaetomorpha linum* and *Chaetomorpha melagonium* are dominant species in the communities of the green algae. Though the total biomasses are different in the communities, species compositions of macrobenthos are almost identical. Abundant animal species include *L. sitkana*, *A. bassargini*, and *F. kurilensis* (Table 16). On the seaside of the tide pool, at the edge of the terrace, *Alaria ochotensis* forms the dense beds. Macrobenthos of this belt-forming community is rather diverse in species composition (Table 11). Barnacles *Semibalanus cariosus* and *Chthamalus dalli*, species of gastropods *Nucella freycinetii*, *Lottia pelta*, and *Littorina sitkana*, species of bivalves *Mytilus trossulus kussakini* and *Hiatella arctica*, an amphipod species *Parallorchestes ochotensis*, and polychaete *Nereis pelagica* are the most abundant animals in the community. Many the red algae species (*Pterosiphonia bipinnata*, *Mazzaella parksii*, *M. japonica*, *Constantinea subulifera*, *Neoptilota asplenioides*, *Mastocarpus pacificus*, *Masudaphycus irregularis*, *Odonthalia annae*, and others) vegetate on the seaside of the rock reef.

Discussion

Biogeographical composition of macrobenthos

In the intertidal zones of Kunashir Island, 164 plant and 399 animal species are found. Red algae dominate among plants, and polychaetes, species of gastropods, and the amphipod species prevail among animals. Biogeographical composition of macrobenthos is typical for low-boreal subregion of the Pacific boreal region. Low-boreal and widespread boreal species are mainly dominant (on the eastern coast – 18 and 46% (1951–1964), 15 and 48% (1987–1991), respectively; on the western coast – 22 and 42% (1951–1964), 22 and 48% (1991), respectively; on the southern coast – 24 and 32% (1951–1991), respectively). After the mid-20th century, the proportions of cold-water species (boreal-Arctic and high-boreal species) of the total number of species found on the eastern and western coasts of Kunashir Island declined as compared to those of 1991 by 3–4%, that can be attributed to the consequences of global warming. At the same time, percentage of warm-water species (low-boreal species and species distributed from tropical or subtropical regions to low-boreal waters) decreased by 5% on the eastern coast. It should be noted increase of amount of geographically widespread species (species are able to tolerate a wide range of temperature conditions) by 4–8% on both the eastern and western coasts of Kunashir Island (Fig. 2).

Biogeographical structure of macrobenthos on various coasts of Kunashir Island is somewhat different. Warm-water species are more abundant in the intertidal zones of Izmeny Bay and the Sea of Okhotsk coast as compared to those of the Pacific coast of Kunashir Island (low-boreal and tropical/subtropical-low-boreal species make up in sum 28 (1951–1964) and 23% (1987–1991) of the total number of species found on the eastern coast, 33 (1951–1964) and 32% (1991) – on the western coast, and 42% (1951–1991) – on the southern coast of Kunashir Island). This fact is related to the circulation of waters of the Soya Warm Current (SWC). Flows of SWC distribute off the Sea of Japan through La Pérouse/Soya Strait in the south part of the Sea of Okhotsk, flowing southeastward along the Hokkaido coast and South Kurile Islands with a maximum influx during summer and a minimum influx during winter (Takizawa, 1982; Ohshima et al., 2001; Matsuyama et al., 2006), giving warm-water features to the intertidal biota of Kunashir Island, especially its southern and western coasts (Bobkov, 2004). One minor branch of SWC flows near Cape Shiretoko through Kunashirskiy/Nemuro Strait and Izmeny Strait/Notsuke Channel out to the Pacific Ocean, but does not pass in

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Yuzhno-Kuril'skiy/Southern Kuril Strait. The other minor branch, passing through Ekateriny Strait/Kunashiri Channel, fills only the most northern part of Yuzhno-Kuril'skiy Strait and also enters the Pacific Ocean. Perhaps this could explain why SWC may have no significant environmental impact on the biogeographical composition of the intertidal macrobenthos on the Pacific coast of Kunashir Island.

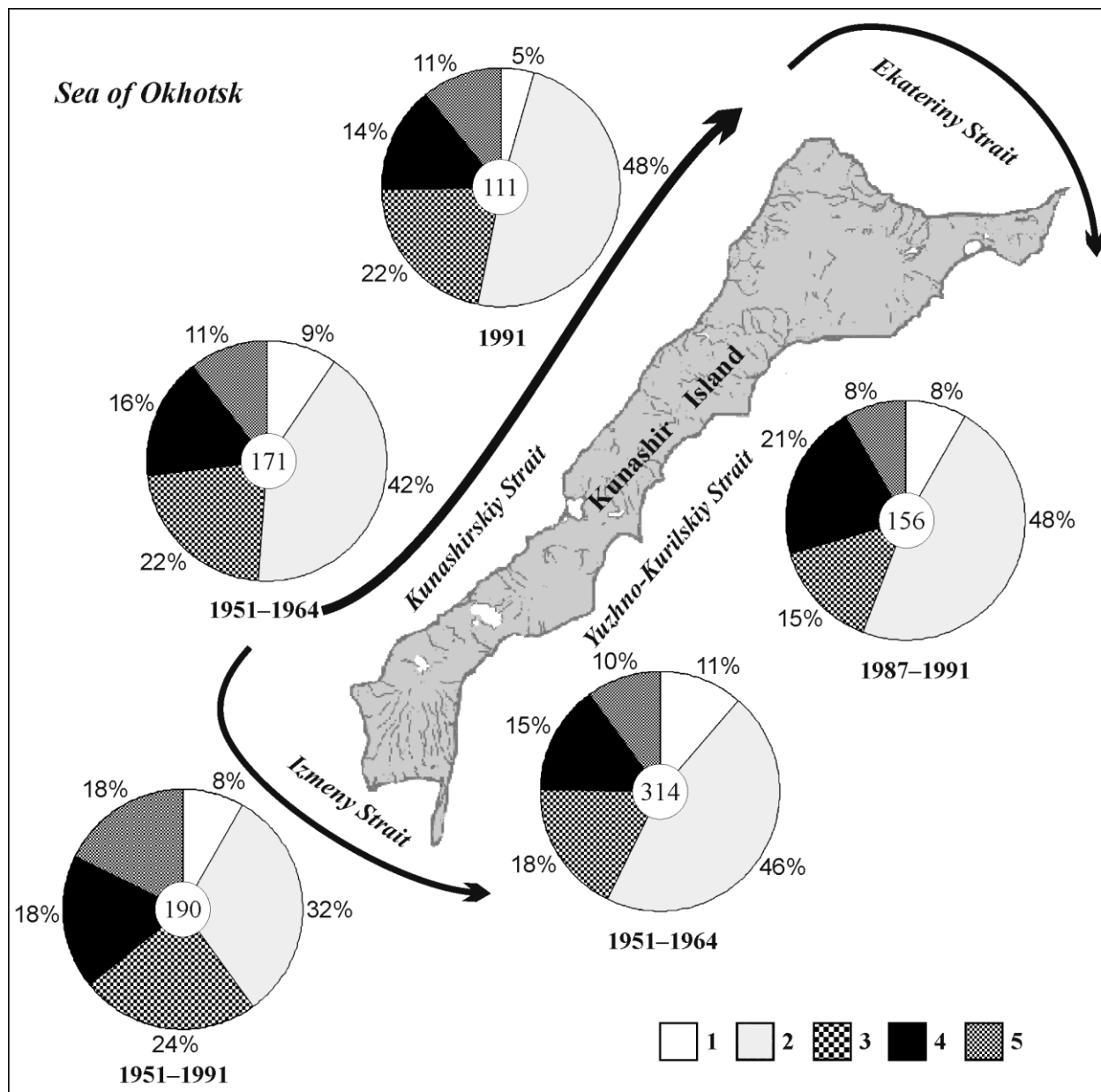


Figure 2. Biogeographical structures of macrobenthos in the intertidal zones of Kunashir Island. 1 – relatively cold-water high-boreal and boreal-Arctic species, 2 – widespread boreal species and species common in both subtropical and boreal waters, 3 – low-boreal species, 4 – widespread species, 5 – subtropical-low-boreal, tropical-low-boreal, and tropical-subtropical species. The branches of the Soya Warm Current are shown by arrows; the total number species are shown in the center of the circles.

The summer sea surface temperature (SST) is important factor determining distribution of marine organisms on the shelf of the Kurile Islands, including the intertidal zone. During winter, latitudinal gradients of the SST are smoothed, and the February isotherms of $-1...1^{\circ}\text{C}$ of SST pass throughout the entire Kurile Ridge, from the south to north (Atlas of Sakhalin Region, 1967), so, in winter, the temperature conditions of the South Kurile Islands are approximately equal with those of the North Kurile Islands. In July–October, the SWC becomes fully developed and approaches the South Kurile Islands, whereas during the other months, the SWC is weak. Besides, in winter, Yuzhno-Kuril'skiy Strait is filled with cold waters of the Sea of Okhotsk and Oyashio Current (Takizawa, 1982; Bobkov, 2004). Thus, changes in the proportion of cold- and warm-water species take place in accordance with variations of the long-term mean SST in the intertidal zones of the Kurile Islands during a warm season (Kussakin, 1975, 1976). The maximal number of warm-water species had been found in Izmeny Bay (42% in total, see Fig. 2), that conforms to peculiarities of hydrological conditions of the area (SST reaches 27°C in August), while not more than 33 and 28% warm-water species inhabit the western and eastern coasts of Kunashir Island, respectively. The number of cold-water species (boreal-Arctic and high-boreal species) is not very different on the coasts and makes up to 8, 9, and 11% on the southern, western and eastern coasts of Kunashir Island, respectively.

Occurrence of a large number of warm-water sea stars (*Aphelasterias japonica*, *Lethasterias fusca*, *Distolasterias elegans*, *Lysastrosoma anthosticta*, and others) is a peculiar feature of the western coast of Kunashir Island (see Appendix). The other warm-water species of animals, such as the isopod species *Dynoides dentisinus* and *Tylos granuliferus*, species of bivalves *Decorifer matusimanus* and *Teredo navalis*, and sea cucumber *Apostichopus japonicus* are also found only here. Among warm-water algae, tropical-low-boreal the belt-forming species *Sargassum thunbergii* occurs only in the intertidal zones of the western coast of Kunashir Island. The maximal number of species of subtropical- and tropical-low-boreal complexes is found on the southern coast, in the Izmeny Bay intertidal zone. The brown algae of Sargassaceae, *Sargassum pallidum* and *Stephanocystis hakodatensis*, the hippolytid shrimps *Eualus leptognathus* and *Spirontocaris ochotensis mororani*, the isopod species *Paranthura japonica* and *Cymodoce japonica*, mollusks *Notoacmea concinna*, *N. schrenckii*, *Littorina brevicula*, *Macoma incongrua*, and *Nuttallia obscurata*, and sea star *Asterina pectinifera* are found only in Izmeny Bay. Some of species are the dominant species in communities, for instance, subtropical-low-boreal *Batillaria cumingii*, on the southern coast Kunashir Island.

Among Decapoda, Isopoda, Echinodermata, and Mollusca, the number of warm-water species (subtropical-, tropical-low-boreal, and low-boreal species) is about 50% (see Appendix), because these more or less motile invertebrates probably can overwinter migrating from the intertidal zone to deeper water. Warm-water species are absent altogether among Bryozoa, and there are very few of these species among Porifera, Hydrozoa, and also macrophytes, i.e., sessile organisms. Kunashir Island probably is the northern border of distribution of many warm-water intertidal species of macrobenthos in the Far Eastern Seas (Kussakin, 1956).

Distribution of macrobenthos

On Kunashir Island, the vertical distribution pattern of macrobenthos is typical for that of a low-boreal intertidal zone with a maximum tidal range about 1.5–1.8 m. As a rule, poor, almost devoid of vegetation, communities dominated by *Chthamalus dalli* and *Littorina sitkana*, sometimes having a belt-like distribution pattern, are typical for the upper subzone of the rocky and bouldery intertidal zones. The *Gloiopeltis furcata* community can be found on the boundary of the upper and middle subzones.

Fucoid assemblages develop in the middle subzone. The upper part of this subzone is occupied by the *Silvetia babingtonii* community, often forming a belt, and below it, patches of the *Fucus evanescens* community are found. The *F. evanescens* community does not form its own belt, in contrast to the *S. babingtonii* community. The macrobenthic biomass in the communities can reach more than $25 \text{ kg wet wt m}^{-2}$. The other algal communities can be found in the lower part of the middle intertidal subzone. The *Corallina*

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pilulifera community often occurs in the puddles of residual tidal water and on the bottom of the tide pools. The diverse communities dominated by the red algae (*Neorhodomela aculeata*, *Mazzaella parksii*, *Laurencia nipponica*, *Chondrus pinnulatus*, *Mastocarpus pacificus*, *Tichocarpus crinitus*, *Odonthalia corymbifera*, *Palmaria marginicrassa*, and others) and the green algae (*Chaetomorpha moniligera*, *Ch. melagonium*, *Ulva lactuca*, *Cladophora opaca*, *Blidingia minima*, and others) form mosaics of patches among of fucoids and *Corallina*. The *Analipus japonicus* community is also typical for the middle intertidal subzone. The *Phyllospadix iwatensis* community, with a diverse animal population due to a large number of infaunal forms, occurs in sites where rocky bottom is splited by spaces filled with sand or inhabits soft-sediment substrata between boulders. The *C. pilulifera* and *Ph. iwatensis* thickets are also extended to the lower intertidal subzone.

In 1951, on the rocky sites of the eastern coast of Kunashir Island, the belt-forming community dominated by the red alga *Neosiphonia japonica* was distinguished in the lower part of the upper intertidal subzone and in the middle intertidal subzone, and the belt-forming community dominated by the brown alga *Chordaria chordaeformis* was observed in the middle intertidal subzone and in the upper part of the lower intertidal zone. At the same time, only patches of the *Ch. chordaeformis* community or some small solitary bushes of the alga were seen on the rocky surfaces of the western coast of Kunashir Island (Kussakin, 1956, 1977).

Large laminarian algae, especially *Alaria ochotensis* and *Saccharina* sp., form the dense beds in both the lower intertidal subzones and subtidal fringe, mainly on the eastern coast of Kunashir Island. In these communities, the total macrobenthic biomass can reach 100 kg wet wt m⁻². At the same time, communities dominated by the brown algae *Sargassum miyabei*, *S. thunbergii*, and *Scytosiphon lomentaria* with rather high species richness prevail in the intertidal zones of the western coast of Kunashir Island. In 1963–1964, in the lower intertidal subzone, the belt-forming community dominated by *Neorhodomela aculeata* + *Phyllospadix iwatensis* was observed on rocks split by spaces filled with sand, on coast of Sea of Okhotsk, and the *Arthrothamnus bifidus* + *Odonthalia floccosa* belt was found in the bouldery intertidal zone, on the Pacific coast of Kunashir Island (Kussakin and Tarakanova, 1977). In some areas, where the rocky and bouldery intertidal zones undergo the abrasive effects of winter ice, and perennial species cannot survive (including brown macroalgae of Laminariales), in summer, an annual green alga *Acrosiphonia duriuscula* develops (Kussakin et al., 1974; Kussakin and Tarakanova, 1977). In the lower subzone of the bouldery intertidal zone, the communities are often distributed in a form of patches, and, on the whole, the vertical stratification of the communities is less marked, than in the rocky subzone, although, the dominant species of the lower intertidal communities are basically similar on both rocks and boulders.

The sandy intertidal zone differs from the rocky and bouldery intertidal sites by the macrobenthic composition and distribution. On sandy beaches exposed to wave action and composed of clean, perfectly sorted sand, communities are usually poor, macrophytes and the other attached forms are absent. The upper part of such beaches and supratidal zone are inhabited by the amphipods, mainly by Talitridae, a mysid species *Archaeomysis grebnitzkii*, other motile invertebrates, and the larval forms of the various insects. In the lower part of the beaches, fauna is also not rich (there are mainly infaunal forms: species of bivalves *Spisula sachalinensis*, *Protothaca euglypta*, polychaete *Abarenicola pacifica*, nemerteans, and others), but its biomass reaches 1 kg m⁻², mainly due to development of mollusk *S. sachalinensis*. Fauna of silted-sandy beaches of the western and eastern coasts of Kunashir Island is like that of the sandy intertidal zone (Kussakin, 1956; Kussakin and Tarakanova, 1977). In the silted-sandy and sandy intertidal zones of Izmeny Bay, there are the communities dominated by *Zostera japonica* and *Batillaria cumingii*, which are not found in the other locations of Kunashir Island.

In the tide pools, a belt distribution of communities is observed only on the walls of the pools, whereas a patchy distribution of communities is typical for the bottom of the these pools. The tide pools are characterized by a high level of biodiversity of macrobenthos due to development of a complex of organisms, which is typical in both the lower intertidal subzone and subtidal zone (diverse red algae, brown algae of Laminariales and Sargassaceae, surfgrass *Phyllospadix iwatensis*, sponges *Halichondria panicea* and

Sycettusa nemurensis, hydroids *Abietinaria inconstans*, *A. filicula*, *Eudendrium vaginatum*, *Sertularella spinosa*, and *Sertularia similis*, sea slug *Coryphella athadona*, bryozoans *Tricellaria ternata* and *Celleporella hyalina*, sea stars *Asterina pectinifera*, *Aphelasterias japonica*, *Leptasterias (Eoleptasterias) kussakini*, and *L. (E.) similispinis*, sea urchin *Strongylocentrotus intermedius*, and others invertebrates, diverse ascidians and fishes).

In areas of gasohydrothermal vents, there are some changes in the qualitative and quantitative composition of the intertidal macrobenthos as compared to other areas of Kunashir Island. The intertidal macrobenthos of the Goryachiy Plyazh is under the influence of the thermal springs of Mendeleeva Volcano. The springs are observed among the rocks, boulders, and sand as the seeps of a hot water (up to 80°C) containing hydrogen sulfide. The macrobenthos is absent in the sites directly influenced by high temperature (above 40°C) and impoverished in the vicinity of the gasohydrothermal vents and seeping volcanic waters. Two tide pools up to 1.5 m depth with seeps of volcanic fluid and a sulfuric acid stream are on the Goryachiy Plyazh. In one of the pools (sea water temperature is 5°C in March and 25°C in October), there are only a few species of macrobenthos: algae *Chaetomorpha melagonium* covering with thick layer of diatoms, and *Fucus evanescens*, barnacles *Semibalanus cariosus* and *Chthamalus dalli*, sea anemone *Diadumene lineata*, and the isopod species *Synidotea lata* and *Tecticeps glaber*. But a population density of *D. lineata* reaches above 2000 individuals m⁻². In the others areas of Kunashir Island, *D. lineata* is not found. In the tide pool with the sea water temperature from 25°C to 60°C in different seasons, macrobenthos is absent, and only the algal-bacterial mats covered the walls of the pool are near hydrothermal vents (see Plates 12, 13). In the stream-bed, only the solitary algae *F. evanescens* and *Ulva prolifera* dwell. At the same time, there are no marked changes of the intertidal communities in the sites of volcanic springs characterized by the sea water temperature below 10–15°C and, in general, the species composition and distribution of the intertidal biota are ordinary for the rocky intertidal zones of Kunashir Island (Kostina, 1991).

Long-term changes of macrobenthos in Izmeny Bay

In 1991, survey of the intertidal zone was carried out in Izmeny Bay in 1.5 km eastward of Golovnino Village in one of the same transect as in 1963. In 1963, most of the middle intertidal subzone was occupied by the belt-forming community dominated by a bivalve mollusk *Ruditapes philippinarum* with biomass of the dominant species 114 g wet wt m⁻², and species of gastropods *Batillaria cumingii* and *Neptunea arthritica*, and a bivalve mollusk *Macoma incongrua* were the subdominant species (about 60–85 g wet wt m⁻²). In 1991, *B. cumingii* became the dominant species of the community (445.6 g wet wt m⁻²), and biomass of *R. philippinarum* reduced seven times as compared to 1963 (15.6 g wet wt m⁻²). Besides, a reduction of species richness took place in this community (in 1963 – 11 species, in 1991 – 5). In 1991, biomass of macrobenthos increased to a third of that observed in the 1963 in this community (329.0 g wet wt m⁻² and 503.6 g wet wt m⁻² in 1963 and 1991, respectively). Polychaetes *Abarenicola pacifica* and *Hediste japonica* were found in this community only in 1991.

In 1963, 26 macrobenthic species were found in the *Zostera japonica* belt-forming community, whereas in 1991 there were only 20 species. Besides, the brown alga *Chordaria* sp., the amphipod species *Allorchestes malleolus*, *Ampithoe* sp., and *Lepidepcreum* sp., an isopod species *Gnorimosphaeroma noblei*, gastropod species *Falsicingula kurilensis*, and a bivalve mollusk *Turtonia minuta* were found only in 1991. Biomass of macrobenthos increased in this community in 1991 as compared to 1963 (1280.5 g wet wt m⁻² and 1942.1 g wet wt m⁻² in 1963 and 1991, respectively).

In both 1963 and 1991, 15 plant and animal species were found in the *Zostera marina* belt-forming community. However, there were only six mutual species: eelgrass *Z. marina*, species of gastropods *Batillaria cumingii* and *Nassarius multigranosus*, a bivalve mollusk *Macoma incongrua*, and polychaetes *Nereis vexillosa* and *Abarenicola pacifica*. Some species of polychaetes (*Alitta brandti*, *Naineris jacutica*, *Glycinde armigera*, *Chone* sp., and *Nereis pelagica*) and two species of gastropods (*Cerithiopsis stejnegeri* and *Pusilina plicosa*) were found only in 1991. Biomass of macrobenthos increased a little bit in this community (2384.0 g

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wet wt m⁻² and 2422.8.1 g wet wt m⁻² in 1963 and 1991, respectively). Besides change of the species composition of the *Z. japonica* and *Z. marina* communities, change of the subdominant species took place (*M. incongrua* – in 1963 and *Ruditapes philippinarum* – in 1991).

The intertidal zone is exposed to wastewater from seafood processing and domestic sewage near Golovnino Village. Over 30 years, the quantitative and qualitative changes of the intertidal biota took place in this area. After 1963, the species richness of macrobenthos reduced, and changes in the species composition of communities occurred, whereas the total macrobenthic biomass increased in the communities. It fully conforms to the observed earlier tendency on the other South Kurile Islands, when eutrophication of biotopes takes place and increase of the total macrobenthic biomass is observed, and at the same time, species richness steadily declines under the effect of weak and moderate organic pollutions (Kussakin and Tsurpalo, 1999).

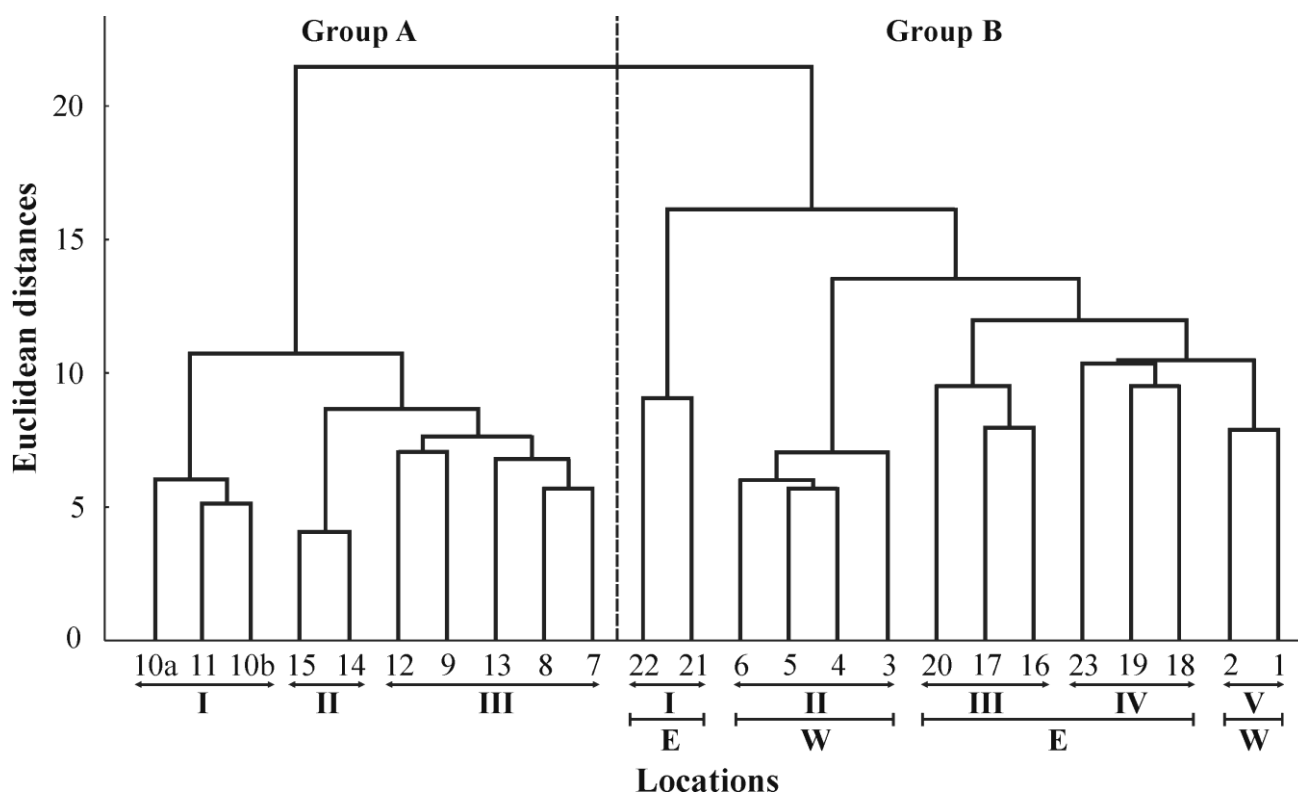


Figure 3. Dendrogram of similarity in the macrobenthic species composition between studied intertidal locations of Kunashir Island. Group A – southern coast: subgroup I includes beach eastward of Golovnino Village (10a – 1951–1963, 10b – 1991) and the northern part of Veslovskoe Lake (11); subgroup II includes Cape Veslo (14) and eastern coast of Veslovskiy Peninsula (15); subgroup III includes Cape Paltusov (7), beach eastward of Cape Paltusov (8), beach westward of Golovnino Village (9), Veslovskoe Lake (12), and western coast of Veslovskiy Peninsula (13). Group B – western (W) and eastern (E) coasts: subgroup I includes Golovnina Bay (21 – Cape Yuzhno-Kurilskiy and 22 – Cape Sukacheva); subgroup II includes Sernaya Bay (3) and Alekhina Bay (4 – boulders, 5 – rocks, and 6 – rocky blocks and boulders); subgroup III includes Sernovodskaya Bay (16 – Cape Chetverikova and 17 – Cape Vodopadnyy) and northeastern part of Yuzhno-Kurilskaya Bay (20); subgroup IV includes Goryachiy Plyazh (18), central part of Yuzhno-Kurilskaya Bay (19), and Cape Rogacheva (23); subgroup V includes Pervukhina Bay (1) and reef southward of Cape Kruglyy (2).

Comparative remarks

The sampling locations of the Kunashir Island intertidal zones are combined in two major groups by similarity of the macrobenthic species composition. The first major group (group A) comprises all locations of the silted-sandy and sandy intertidal zones in Izmeny Bay on the southern coast of Kunashir Island. Locations of the western and eastern coasts characterized mainly by the intertidal zones of hard substrata are combined in the second major group (group B) (Fig. 3).

Group A is further divided into three distinct subgroups. Subgroup I includes locations of the most inner part of Izmeny Bay (1.5 km eastward of Golovnino Village and the northernmost part of Veslovskoe Lake (lagoon) on Veslovskiy Peninsula). These sites are characterized by a weak wave action, silted sand covered gravel, admixture of H₂S in the sand, seawater freshening, and very wide belt dominated by eelgrasses *Zostera japonica* and *Z. marina* with a rather rich composition of animals and plants in the lower part of middle intertidal subzone and lower intertidal subzone. On beach, 1.5 km eastward of Golovnino Village, the macrobenthic species compositions of 1951–1963 and that of 1991 are combined together, although the species richness of macrobenthos reduced in 1991 as compared to 1963.

In locations westward of Golovnino Village up to the Cape Paltusov and on the western coast of Veslovskiy Peninsula, including most part of Veslovskoe Lake, i.e., towards the westernmost and southernmost coasts of Izmeny Bay (subgroup III), the seagrass communities gradually disappear in the intertidal zone and spread in the upper subtidal zone probably due to increasing wave action, decreasing silting of sands, and various other factors affecting the intertidal biota. However, settlements of *Zostera* can be found in lagoon of Cape Paltusov and Veslovskoe Lake (Kussakin, 1956; Kussakin and Tarakanova, 1977). In locations of subgroups I and III, macrobenthos is not found in most of the upper intertidal subzone, only associations dominated by the gastropod species *Batillaria cumingii* and *Littorina sitkana*, and barnacle *Chthamalus dalli* sometimes occur. Westward of Golovnino Village and on the southwestern coast of Veslovskiy Peninsula, where the *Zostera* belt spreads in the upper subtidal zone, community dominated by the green alga *Ulva linza* can be found in the middle intertidal subzone and the upper part of the lower intertidal subzone.

Locations of subgroup II (Cape Veslo and eastern coast of Veslovskiy Peninsula) are wave-exposed sandy beaches composed of clean sand, sometimes with admixture of gravel. The macrobenthic species composition is poor and uniform here. These locations are wholly devoid of any intertidal macrophytes and inhabited by mainly motile small crustaceans (the mysid, isopod, and amphipod species) and polychaetes, dwelling, as a rule, in the supratidal zone (Kussakin, 1956; Kussakin and Tarakanova, 1977).

Group B includes the eastern and western coasts of Kunashir Island often exposed to wave action (especially eastern coast). Communities dominated by *Chthamalus dalli* and *Littorina sitkana* are typical for the upper intertidal subzone, and communities dominated by fucoid algae (*Silvetia babingtonii* and *Fucus evanescens*) and the brown alga *Analipus japonicus* prevail in the middle intertidal subzone on the eastern and western coasts. Five subgroups characterized by certain species compositions of macrobenthos can be distinguished within group B. Locations of subgroup I are entrance rocky capes of Golovnina Bay on the eastern coast of Kunashir Island. However, entrance capes of Sernovodskaya Bay (Cape Vodopadnyy and Cape Chetverikova), also located on the eastern coast of Kunashir Island, are combined with the northeastern part of Yuzhno-Kurilskaya Bay (subgroup III), because at Cape Vodopadnyy and in the northeastern part of Yuzhno-Kurilskaya Bay, sampling was carried out in the bouldery intertidal zones with underlying sand. In locations of subgroups I and III, the belt-forming communities dominated by the red alga *Corallina pilulifera* and seagrass *Phyllospadix iwatensis* are widespread throughout the lower intertidal subzones, and laminarian algae are poorly developed. Moreover, sedentary and sessile forms (many species of mollusks (*Littorina sitkana*, *L. squalida*, *Falsicingula kurilensis*, *Nassarius fraterculus*, *Buccinum mirandum mirandum*, and others), tube-building polychaete worms (*Circeis spirillum*, *Eudistylia suavis*, and others), sea anemones (*Oulactis orientalis* and *Charisea saxicola*), and others) predominate on the rocky reefs in Golovnina Bay (Cape Yuzhno-Kurilskiy and Cape Sukacheva) and on Cape Chetverikova (Sernovodskaya Bay). At Cape

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Vodopadnyy of Sernovodskaya Bay and in the northeastern part of Yuzhno-Kuril'skaya Bay, there are both animals inhabiting boulders (chiton *Mopalia schrencki*, polychaetes *Lepidonotus squamatus* and *Harmothoe imbricata*, shield limpet *Lottia pelta*, crude whelk *Buccinum percrassum*, sea snail *Mitrella burchardi*, a bivalve mollusk *Protothaca euglypta*, sponge *Halichondria panicea*, and diverse sea anemones) and infaunal invertebrates, as a rule, polychaetes (many species of *Nereis*, *Cirratulus cirratus*, *Capitella capitata*, *Eulalia viridis*, *Autolytus caterinkae*, and *Proceratea prismatica*) (Kussakin and Tarakanova, 1977).

Subgroup IV comprises various locations of the Pacific coast of Kunashir Island (disposed close to each other, rocky intertidal zone of Goryachiy Plyazh and blocky-bouldery intertidal zone of central part of Yuzhno-Kuril'skaya Bay, and also tide pool on rocky reef of Cape Rogacheva) probably due to the fact that they are inhabited by organisms characteristic mainly for hard substrata. Besides, unlike subgroups I and III, laminarian algae, mainly *Alaria ochotensis* and *Saccharina* sp., form extensive belts in the lower intertidal subzones of locations of subgroup IV.

Subgroup II comprises all the sampling locations of Alekhina and Sernaya bays disposed close to each other on the western coast of Kunashir Island and characterized mainly by hard substrata in the upper part of the intertidal zone and spread of sands in the lower part of the intertidal zone. Besides, this area is under the influence of solfataric-hydrothermal springs of the Golov'nina Volcano (Alekhinskaya groups of thermal springs), some of which issue on the Sea of Okhotsk coast of Kunashir Island (Zharkov, 2014). Subgroup V includes rocky reef of Pervukhina Bay and reef southward of Cape Kruglyy on the western coast of Kunashir Island. In the lower intertidal subzones, the belt dominated by large laminarian algae is almost absent on the western coast of Kunashir Island, with the exception of some locations (for example, in Pervukhina Bay). The lower intertidal subzone of Alekhina and Sernaya bays are occupied by the red alga *Neorhodomela aculeata* community (Kussakin and Tarakanova, 1977), and the communities dominated by the brown algae *Sargassum miyabei*, *S. thunbergii*, and *Scytosiphon lomentaria* are widespread in Pervukhina Bay and on the reef southward of Cape Kruglyy.

The intertidal biota of Kunashir Island has many common features with that of the neighboring Shikotan Island by composition and patterns of distribution of the macrobenthic communities. The maximal similarity can be observed between the eastern coast of Kunashir Island and the northwestern coast of Shikotan Island, however, some distinctions can be made between patterns of macrobenthic communities of these islands. So, the belt-forming community dominated by the brown algae *Chordaria chordaeformis* do not occurs on Shikotan Island. The brown alga *Saundersella simplex*, that is epiphyte on *Ch. chordaeformis*, *Scytosiphon lomentaria*, and *Analipus japonicus*, common on the Sea of Okhotsk coast of Kunashir Island, was not found on Shikotan Island, but also it was observed neither on the Pacific coast of Kunashir Island nor in Izmeny Bay. The brown seaweed *Fucus evanescens* often forms dense belts on the coasts of Shikotan Island with a weak wave exposure, whereas in similar biotopes of Kunashir Island, *Fucus* shows patchy distribution pattern. Contrariwise, the *Silvetia babingtonii* belt-forming community is more distributed on Kunashir Island than on Shikotan Island. The soft crab *Hapalogaster grebnitzkii* is frequently found in the rocky intertidal zone of Shikotan Island and is not found on Kunashir Island, while porcelain crab *Pachycheles stevensii*, rock crab *Cancer gibbosulus*, and an isopod species *Cleantiella isopus* are found on hard substrata of Kunashir Island and are not found on Shikotan Island (Kussakin, 1956, 1977).

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Table 1. Sampling locations in the intertidal zones of Kunashir Island.

N	Location	Latitude, N°	Longitude, E°	Substratum	Month (or season), year	Number of transects
1	Northern part of Pervukhina Bay	44.074647	145.745755	Rocky reef with scattered boulders	July 1991	1
2	1 km southward of Cape Kruglyy	43.996992	145.650139	Rocky reef	July 1991	1
3	Northern part of Sernaya Bay	43.955560	145.591243	Rocky reef; sand in the lower part of the intertidal zone	Summer 1964 (Kussakin, Tarakanova, 1977)	1
4	Northern part of Alekhina Bay	43.921864	145.533807	Boulders; sand in the lower part of the intertidal zone	June–August 1951, December 1954, Summer 1964 (Kussakin, 1957; Kussakin, Tarakanova, 1977)	1
5	Northern part of Alekhina Bay	43.919628	145.528356	Rocky reef; boulders in the upper part and sand in the lower part of the intertidal zone	June–August 1951, Summer 1964 (Kussakin, 1957; Kussakin, Tarakanova, 1977)	1
6	Nameless cape in the southern part of Alekhina Bay	43.912284	145.509677	Rocky blocks and boulders	June–August 1951 (Kussakin, 1957)	1
7	Cape Paltusov	43.723973	145.443117	Sandy-silted beaches	June–August 1951 (Kussakin, 1956, 1957)	3
8	3.5 km eastward of Cape Paltusov, Izmeny Bay	43.729067	145.474101	Gravelly beach with admixture of sand and shell; silted sand in the lower part of the intertidal zone	June–August 1951 (Kussakin, 1957)	2
9	0.5 km westward of Golovnino Village in Izmeny Bay	43.735021	145.510750	Sandy beach; silted sand in the lower part of the intertidal zone	June–August 1951, Summer 1963 (Kussakin, 1956, 1957; Kussakin, Tarakanova, 1977)	1
10	1.5 km eastward of Golovnino Village in Izmeny Bay	43.732680	145.542164	Sandy beach with admixture of shell, gravel and silt	June–August 1951, December 1954, Summer 1963 (Kussakin, 1956, 1957; Kussakin, Tarakanova, 1977), July 1991	2 (1951–1963) and 1 (1991)
11	Northern part of Veslovskoe Lake (lagoon) on Veslovskiy Peninsula, Izmeny Bay	43.730994	145.550695	Sand with admixture shell in the upper part, silted sand in the middle part, and silted sand with admixture of shell and gravel in the lower part of the intertidal zone	June–August 1951, December 1954, Summer 1963 (Kussakin, 1956, 1957; Kussakin, Tarakanova, 1977)	4
12	Head of Veslovskoe Lake (lagoon) on Veslovskiy Peninsula, Izmeny Bay	43.701971	145.549391	Silt, occasional silted sand	June–August 1951, Summer 1963 (Kussakin, 1956, 1957; Kussakin, Tarakanova, 1977)	1

N	Location	Latitude, N°	Longitude, E°	Substratum	Month (or season), year	Number of transects
13	Western coast of Veslovskiy Peninsula, Izmeny Bay	43.683971	145.536205	Sandy beach with admixture of gravel and shell	June–August 1951, Summer 1963 (Kussakin, 1956, 1957; Kussakin, Tarakanova, 1977)	3
14	Cape Ves'lo	43.653363	145.544831	Sandy beach; sand with admixture of gravel in the lower part of the intertidal zone	June–August 1951 (Kussakin, 1956, 1957)	2
15	Eastern coast of Veslovskiy Peninsula, Yuzhno-Kuril'skiy Strait	43.709665	145.559433	Sandy beach; gravel in the lower part of the intertidal zone	June–August 1951 (Kussakin, 1956, 1957)	2
16	Sernovodskaya Bay, Cape Chetverikova	43.884122	145.623848	Rocky reef	June–August 1951, Summer 1964 (Kussakin, 1957; Kussakin, Tarakanova, 1977)	1
17	Sernovodskaya Bay, Cape Vodopadnyy	43.907625	145.669853	Sandy beach with the rare boulders	June–August 1951, Summer 1964 (Kussakin, 1956, 1957; Kussakin, Tarakanova, 1977)	1
18	Goryachiy Plyazh (Hot Beach)	43.992298	145.798745	Rocky reef with scattered boulders	October 1987, March 1988 (Kostina, 1991)	1
19	Nameless cape in central part of Yuzhno-Kuril'skaya Bay, 5 km southwesterly of Cape Zavodskoy	44.015185	145.813708	Rocky blocks and boulders on sandy beach	July 1991	1
20	Northeastern part of Yuzhno-Kuril'skaya Bay	44.028451	145.854392	Scattered boulders on the silted sand with admixture of shell	June–August 1951, January 1955, Summer 1963 (Kussakin, 1956, 1957; Kussakin, Tarakanova, 1977)	3
21	Golovnina Bay, Cape Yuzhno-Kuril'skiy	44.021152	145.877268	Rocky reef	June–August 1951, July, December 1954, January 1955, Summer 1963 (Kussakin, 1957; Kussakin, Tarakanova, 1977)	3
22	Golovnina Bay, Cape Sukacheva	44.070554	145.874329	Rocky reef	June–August 1951, Summer 1963 (Kussakin, 1957; Kussakin, Tarakanova, 1977)	2
23	Cape Rogacheva	44.183787	146.045066	Rocky reef	August 1991	1

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Table 2. Density (N, individuals m⁻²) and biomass (B, g wet wt m⁻²) of macrobenthos in the upper intertidal subzone on the rocky, rocky-bouldery, and blocky-bouldery substrata.

Taxa	Pervukhina Bay (location 1)						Cape Kruglyy (location 2)						Yuzhno-Kurilskaya Bay (location 19)					
	<i>Littorina sitkana</i> belt		<i>Chthamalus dalli</i> settlings		<i>Littorina sitkana</i> belt		<i>Chthamalus dalli</i> settlings		<i>Littorina sitkana</i> belt		<i>Chthamalus dalli</i> settlings		<i>Chthamalus dalli</i> + <i>Semibalanus carosus</i> settlings					
	N	B	N	B	N	B	N	B	N	B	N	B	N	B				
ANIMALS																		
<i>Littorina sitkana</i>	6700	45.0	5200	30.8	91700	5260.0	5800	27.0	5750	76.5								
<i>Chthamalus dalli</i>	-	-	5700	170.0	900	10.0	5400	125.0	16300	2242.5								
<i>Semibalanus carosus</i>	-	-	-	-	-	-	-	-	300	895.0								
<i>Nucella heyseana</i>	-	-	-	-	-	-	100	70.0	50	0.4								
<i>Falsicingula kurilensis</i>	+	+	-	-	2100	15.0	-	-	-	-								
<i>Lottia persona</i>	-	-	-	-	-	-	300	15.0	-	-								
<i>Lottia pelta</i>	-	-	-	-	100	7.0	-	-	-	-								
<i>Gnorimosphaeroma noblei</i>	-	-	-	-	800	7.0	-	-	-	-								
Serpulidae	-	-	-	-	-	-	-	5.2	-	-								
Insecta (larvae)	-	-	-	-	-	-	-	-	600	5.0								
Polychaeta	-	-	-	-	-	-	-	-	150	4.0								
<i>Typosyllis adamanteus</i>	-	-	-	-	-	-	-	-	50	1.5								
<i>Clitmenella fraudatrix</i>	-	-	-	-	-	-	200	0.2	-	-								
Amphipoda	-	-	-	-	-	-	-	-	50	0.1								
Total biomass	-	45.0	-	200.8	-	5299.0	-	242.4	-	3425.0								

*See Tables 2–16: Och – Ochrophyta, Rh – Rhodophyta, Ch – Chlorophyta, Tra – Tracheophyta, Hy – Hydrozoa, Ac – Actiniaria, Ne – Nemertea, Po – Polychaeta, Si – Sipuncula, Pa – Pantopoda, Ci – Cirripedia, Am – Amphipoda, Cu – Cumacea, De – Decapoda, Is – Isopoda, Le – Leptostraca, In – Insecta, Pol – Polychaetophora, Ga – Gastropoda, Bl – Bivalvia, Bry – Bryozoa, As – Ascidiacea. The sign “+” designates species found within the limits of a considered community, but their abundance is not registered; the sign “-” means that species is not found.

Table 3. Density (N, individuals m⁻²) and biomass (B, g wet wt m⁻²) of macrobenthos on the boundary between the upper and middle intertidal subzones, on the rocky and blocky-bouldery substrata. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Cape Kruglyy (location 2)			Yuzhno-Kurilskaya Bay (location 19)		
		N	B		N	B	
PLANTS							
<i>Gloiopeltis furcata</i>	Rh		805.0			1184.0	
<i>Analiplus japonicus</i>	Och		–			140.0	
Total biomass of plants			805.0			1324.0	
ANIMALS							
<i>Chthamalus dalli</i>	Ci	–	–	14880		928.0	
<i>Falsicingula kurilensis</i>	Ga	44700	195.0	40		0.2	
<i>Littorina sitkana</i>	Ga	8200	110.0	840		2.0	
<i>Loitia persona</i>	Ga	200	15.0	–		–	
<i>Nucella heyseana</i>	Ga	100	7.0	–		–	
<i>Apolyale bassargini</i>	Am	900	3.0	–		–	
<i>Nassarius fraterculus</i>	Ga	100	2.0	–		–	
<i>Corophium</i> sp.	Am	–	–	2120		2.0	
<i>Ampithoe kussakini</i>	Am	100	1.8	–		–	
<i>Turtonia minuta</i>	Bi	–	–	40		0.3	
<i>Pontogeneia</i> sp.	Am	200	0.2	–		–	
Total biomass of animals			334.0			932.5	
Total biomass			1139.0			2256.5	

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Table 4. Density (N, individuals m⁻²) and biomass (B, g wet wt m⁻²) of macrobenthos in the middle intertidal subzone on the rocky and rocky-bouldery substrata in the brown algae communities. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Pervukhina Bay (location 1)						Cape Kruglyy (location 2)							
		Silvetia babingtonii belt		Fucus evanescens patches		Silvetia babingtonii belt		Fucus evanescens + Silvetia babingtonii patches		Anatipus japonicus patches					
		N	B	N	B	N	B	N	B	N	B				
PLANTS															
<i>Fucus evanescens</i>	Och		71.6		3232.0						10440.0				
<i>Silvetia babingtonii</i>	Och		1508.0		-		5512.8				5680.0				
<i>Anatipus japonicus</i>	Och		-		-		-				-				820.0
<i>Cladophora opaca</i>	Ch		21.6		76.8		-				-				-
<i>Chaetomorpha moniligera</i>	Ch		-		36.8		-				-				-
<i>Corallina pilulifera</i>	Rh		-		+		-				8.8				-
<i>Ulva lactuca</i>	Ch		4.0		5.2		-				-				-
Total biomass of plants			1605.2		3350.8		5512.8				16128.8				820.0
ANIMALS															
<i>Littorina sitkana</i>	Ga	440	3.2	520	6.0	1840	280.0	41120	1388.8	1000	24.0				
<i>Falsicingula kurilensis</i>	Ga	1680	5.2	6920	22.0	160	0.4	119240	428.8	3100	10.0				
<i>Nassarius fraterculus</i>	Ga	-	-	-	-	120	12.0	1320	66.0	-	-				
<i>Nucella heyseana</i>	Ga	+	+	+	+	40	8.8	40	32.0	-	-				
Serpulidae	Po	-	-	-	-	80	28.0	-	-	-	-				
<i>Lottia pelta</i>	Ga	-	-	-	-	80	6.0	-	-	-	-				
<i>Lottia persona</i>	Ga	+	+	40	4.8	-	-	-	-	-	-				
<i>Chthamalus dalli</i>	Ci	-	-	-	-	120	2.8	-	-	-	-				
<i>Apothale bassargini</i>	Am	+	+	40	0.2	-	-	680	2.8	-	-				
<i>Ampithoe kussakini</i>	Am	-	-	360	1.4	-	-	200	1.6	-	-				
<i>Turtonia minuta</i>	Bi	360	1.2	320	0.8	-	-	-	-	-	-				
<i>Spasskogammarus spasskii</i>	Am	-	-	-	-	-	-	240	0.7	-	-				
<i>Cliamenella fraudatrix</i>	Is	-	-	-	-	-	-	-	-	200	0.6				
<i>Lottia ochracea</i>	Ga	40	0.4	-	-	-	-	-	-	-	-				
<i>Parallorchestes ochotensis</i>	Am	-	-	+	+	-	-	40	0.3	-	-				
<i>Allorchestes malleolus</i>	Am	-	-	-	-	-	-	40	0.2	-	-				
Total biomass of animals			10.0		35.2		338.0		1921.2		34.6				
Total biomass			1615.2		3386.0		5850.8		18050.0		854.6				

Table 5. Density (N, individuals m⁻²) and biomass (B, g wet wt m⁻²) of macrobenthos in the middle intertidal subzone on the blocky-bouldery substratum in the brown algae communities. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Yuzhno-Kurilskaya Bay (location 19)												
		<i>Silvetia babingtonii</i> belt			<i>Fucus evanescens</i> patches			<i>Anatipus japonicus</i> patches						
		N	B	N	N	B	N	N	B	N	B			
PLANTS														
<i>Silvetia babingtonii</i>	Och		25080.0											
<i>Fucus evanescens</i>	Och				16264.0									
<i>Anatipus japonicus</i>	Och												1400.0	1400.0
Total biomass of plants			25080.0		16264.0								1400.0	1400.0
ANIMALS														
<i>Chthamalus dalli</i>	Ci	4640	224.0											
<i>Nucella heyseana</i>	Ga	+	+										100	158.0
<i>Littorina sitkana</i>	Ga	280	18.0	160		2.4								
<i>Apolyale bassargini</i>	Am	440	18.0										100	0.5
<i>Nereis pelagica</i>	Po												300	12.4
Amphipoda	Am			120		4.8								
<i>Typosyllis adamanteus</i>	Po												300	4.8
Polychaeta	Po	80	3.2											
<i>Corophium</i> sp.	Am												1600	2.0
<i>Gnorimosphaeroma noblei</i>	Is			160		0.4								
<i>Ansola angustata</i>	Ga	40	0.2											
<i>Haloconcha minor</i>	Ga			80		0.2								
Total biomass of animals			263.4		7.8									177.7
Total biomass			25343.4		16271.8									1577.7

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Table 6. Density (N, individuals m⁻²) and biomass (B, g wet wt m⁻²) of macrobenthos in the middle intertidal subzone on the rocky and rocky-bouldery substrata in the red algae communities. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Pervukhina Bay (location 1)						Cape Kruglyy (location 2)						
		Neorhodomela aculeata patches		Laurencia nipponica patches		Chondrus pinnulatus patches		Mastocarpus pacificus patches		Corallina pilulifera belt		Neorhodomela aculeata patches		
		N	B	N	B	N	B	N	B	N	B	N	B	
PLANTS														
<i>Laurencia nipponica</i>	Rh	-	-	3024	-	-	-	-	-	-	-	-	-	-
<i>Chondrus pinnulatus</i>	Rh	-	-	-	2888	-	-	-	-	-	-	-	-	-
<i>Neorhodomela aculeata</i>	Rh	2748	-	-	-	-	-	-	-	-	-	-	986	-
<i>Corallina pilulifera</i>	Rh	14	-	-	-	-	114	-	1530	-	-	-	128	-
<i>Mastocarpus pacificus</i>	Rh	-	-	-	-	-	309	-	-	-	-	-	-	-
<i>Rhodomela sachalinensis</i>	Rh	780	-	-	-	-	-	-	-	-	-	-	-	-
<i>Sargassum miyabei</i>	Och	144	-	94.4	15.2	-	-	-	-	-	-	-	211	-
<i>Neorhodomela munita</i>	Rh	-	-	-	-	-	-	-	-	-	-	-	149.5	-
<i>Ulva lactuca</i>	Ch	-	-	122.4	-	-	-	-	-	-	-	-	-	-
<i>Neorhodomela oregona</i>	Rh	-	-	100.4	-	-	6.4	-	-	-	-	-	-	-
<i>Sphacelaria rigidula</i>	Och	-	-	76	-	-	-	-	-	-	-	-	-	-
<i>Lithophyllum tumidulum</i>	Rh	-	-	56	-	-	-	-	-	-	-	-	+	-
<i>Punctaria plantaginea</i>	Och	-	-	56	-	-	-	-	-	-	-	-	-	-
<i>Phyllospadix iwataensis</i>	Tra	-	-	-	16	-	-	-	-	-	-	-	-	-
<i>Cladophora opaca</i>	Ch	-	-	-	-	-	3.2	-	-	-	-	-	-	-
Total biomass of plants		3686		3529.2	2919.2		433.2		1530		1474.5			
ANIMALS														
<i>Falsicingula kurilensis</i>	Ga	80	0.3	360	1.2	-	2040	6	39700	150	3740	19.9		
<i>Nassarius fraterculus</i>	Ga	-	-	-	-	-	-	-	2400	97	820	75		
<i>Littorina sitkana</i>	Ga	480	2.9	-	-	-	-	-	5400	95	240	12		
<i>Cnidopus japonicus</i>	Ac	80	36	-	-	-	-	-	-	-	-	-		
<i>Pagurus middendorffii</i>	De	80	24.4	-	-	-	-	-	-	-	140	16		
<i>Ampithoe kussakini</i>	Am	80	0.5	-	-	-	40	0.1	2200	13.3	120	0.9		
<i>Nucella heyseana</i>	Ga	-	-	-	-	-	-	-	-	-	40	13		
<i>Parallorchestes ochotensis</i>	Am	80	0.3	-	-	-	120	0.4	1500	5.3	1820	8.5		
<i>Idotea ochotensis</i>	Is	760	8	40	0.4	-	-	-	-	-	-	-		

Taxa	Taxonomic group	Pervukhina Bay (location 1)						Cape Kruglyy (location 2)							
		<i>Neorhodomela aculeata</i> patches		<i>Laurencia nipponica</i> patches		<i>Chondrus pinnulatus</i> patches		<i>Mastocarpus pacificus</i> patches		<i>Corallina pilulifera</i> belt		<i>Neorhodomela aculeata</i> patches			
		N	B	N	B	N	B	N	B	N	B	N	B		
Polychaeta	Po	-	-	-	-	-	-	-	-	-	-	300	8	-	-
Amphipoda	Am	-	-	-	-	400	4.8	-	-	-	-	-	-	-	-
<i>Ampithoe</i> sp.	Am	1080	4	120	0.1	-	-	80	0.4	-	-	-	-	140	1.2
<i>Caprella</i> sp.	Am	1120	1.7	40	0.3	640	3.2	-	-	-	-	-	-	70	0.3
Actiniaria	Ac	-	-	-	-	40	2.8	-	-	-	-	-	-	-	-
<i>Lottia pelta</i>	Ga	-	-	-	-	-	-	-	-	-	-	-	-	20	2.4
<i>Pontogeneia</i> sp.	Am	400	0.8	680	1.6	-	-	-	-	-	-	-	-	60	0.2
<i>Orchomene</i> sp.	Am	-	-	-	-	-	-	-	-	-	-	200	1.3	-	-
<i>Schizoplax brandtii</i>	Pol	-	-	-	-	-	-	-	-	-	-	100	1	20	1.2
<i>Telmessus cheiragonus</i>	De	-	-	40	0.4	-	-	-	-	-	-	-	-	20	1
<i>Ampithoe lacertosa</i>	Am	120	0.9	-	-	-	-	-	-	-	-	-	-	100	0.8
<i>Turtonia minuta</i>	Bi	120	0.4	160	0.8	-	-	160	0.8	-	-	-	-	40	0.1
<i>Corophium</i> sp.	Am	-	-	-	-	-	-	-	-	-	-	100	0.8	-	-
<i>Caprella irregularis</i>	Am	120	0.6	-	-	-	-	-	-	-	-	-	-	-	-
<i>Caprella cristibrachium</i>	Am	-	-	240	0.5	-	-	-	-	-	-	-	-	140	0.4
<i>Chiamenella fraudatrix</i>	Is	-	-	-	-	-	-	-	-	-	-	100	0.5	20	0.2
<i>Caprella bispinosa</i>	Am	-	-	-	-	-	-	-	-	-	-	-	-	50	0.2
<i>Nereis zonata</i>	Po	-	-	-	-	-	-	-	-	-	-	-	-	60	0.2
<i>Holotelson tuberculatus</i>	Is	-	-	-	-	-	-	-	-	-	-	-	-	20	0.2
<i>Ischyrocerus cristatus</i>	Am	-	-	-	-	-	-	-	-	-	-	-	-	120	0.2
<i>Pleusymtes</i> sp.	Am	-	-	-	-	-	-	-	-	-	-	-	-	100	0.2
<i>Arylus ekmani</i>	Am	-	-	120	0.2	-	-	-	-	-	-	-	-	-	-
Pantopoda	Pa	-	-	-	-	-	-	-	-	-	-	-	-	20	0.2
<i>Gnorimosphaeroma noblei</i>	Is	40	0.2	-	-	-	-	-	-	-	-	-	-	-	-
<i>Ischyrocerus</i> sp.	Am	-	-	-	-	-	-	-	-	-	-	-	-	20	0.1
<i>Metopa</i> sp.	Am	40	0.1	-	-	-	-	-	-	-	-	-	-	-	-
Total biomass of animals			81.1		5.5		10.8		7.7				372.2		154.2
Total biomass			3767.1		3535.7		2930		441.9				1902.2		1628.7

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Table 7. Density (N, individuals m⁻²) and biomass (B, g wet wt m⁻²) of macrobenthos in the middle intertidal subzone on the blocky-bouldery substratum in the red algae communities. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Yuzhno-Kurilskaya Bay (location 19)											
		Corallina pilulifera patches		Tichocarpus crinitus patches		Odonthalia corymbifera patches		Palmaria marginicrassa patches		Mazzaella parksii patches			
		N	B	N	B	N	B	N	B	N	B		
PLANTS													
<i>Tichocarpus crinitus</i>	Rh	-	-	7444.0	-	-	-	-	-	-	-	-	-
<i>Mazzaella parksii</i>	Rh	-	-	182.0	-	-	-	-	-	-	-	4848.0	-
<i>Odonthalia corymbifera</i>	Rh	-	-	-	3200.0	-	-	-	-	-	85.0	-	-
<i>Corallina pilulifera</i>	Rh	1560.0	-	-	-	-	-	-	-	-	-	594.0	-
<i>Palmaria marginicrassa</i>	Rh	-	-	-	-	-	-	-	-	915.0	-	-	-
<i>Saccharina</i> sp.	Och	-	-	2840.0	236.0	-	-	-	-	42.0	-	-	-
<i>Chondrus pinnulatus</i>	Rh	-	-	-	-	-	-	-	-	47.0	-	-	-
<i>Odonthalia ochotensis</i>	Rh	-	-	18.8	-	-	-	-	-	-	-	-	-
Total biomass of plants		1560.0	-	10484.8	3436.0	-	-	-	-	1090.0	-	-	5442.0
ANIMALS													
<i>Halichondria panicea</i>	Sp	-	-	-	2260.0	-	-	-	-	-	-	-	-
Bryozoa	Bry	-	-	-	752.0	-	-	-	-	-	-	-	-
<i>Lottia persona</i>	Ga	-	-	-	-	-	-	-	-	-	-	800	120.1
<i>Obelia longissima</i>	Hy	-	-	-	-	-	-	-	-	-	-	-	62.0
<i>Abietinaria filicula</i>	Hy	-	-	60.0	+	-	-	-	-	-	-	-	+
<i>Nucella heyseana</i>	Ga	100	12.0	40	57.6	-	-	-	-	-	-	40	0.8
<i>Nereis pelagica</i>	Po	1000	30.0	-	-	-	-	-	-	-	-	1000	20.0
<i>Eudendrium vaginatum</i>	Hy	-	-	20.0	1.2	-	-	-	-	-	-	-	0.4
<i>Falsicingula kurilensis</i>	Ga	3600	11.0	40	0.1	-	-	-	-	-	-	8400	20.0
<i>Caprella</i> sp.	Am	-	-	2280	9.2	80	0.2	-	-	-	-	-	-
<i>Synidotea lata</i>	Is	100	8.3	-	-	-	-	-	-	-	-	-	-
<i>Telmessus cheiragonus</i>	De	300	7.0	40	0.8	240	8.0	-	-	-	-	-	-
<i>Apohyale bassargini</i>	Am	-	-	40	0.4	+	+	-	-	-	-	160	7.6
<i>Turtonia minuta</i>	Bi	100	0.5	-	-	40	0.8	-	-	-	-	640	6.4
<i>Littorina sikana</i>	Ga	-	-	-	-	-	-	-	-	-	-	440	5.3
<i>Musculus laevigatus</i>	Bi	-	-	-	-	-	-	-	-	-	-	200	4.0
<i>Panomya</i> sp.	Bi	-	-	-	-	-	-	-	-	-	-	760	3.9

Taxa	Yuzhno-Kurilskaya Bay (location 19)																	
	Taxonomic group		Corallina pilulifera patches			Tichocarpus crinitus patches			Odonthalia corymbifera patches			Palmaria marginicrassa patches			Mazzaella parksii patches			
	N	B	N	B	N	B	N	B	N	B	N	B	N	B	N	B		
<i>Idotea ochotensis</i>	-	-	-	-	240	2.8	-	-	-	-	-	-	-	-	-	-		
<i>Typosyllis adamanteus</i>	100	2.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Ciamanella fraudatrix</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	400	2.4	-		
<i>Modiolus kurilensis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	120	2.1	-		
<i>Lyonsia</i> sp.	200	2.1	-	-	-	-	-	-	-	-	-	-	-	-	-	2.0		
<i>Sertularia robusta</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Naineris jacutica</i>	-	-	-	-	40	2.0	-	-	-	-	-	-	-	-	-	-		
Sabellidae	100	1.0	40	2.0	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Allorchestes malleolus</i>	-	-	-	-	40	2.0	-	-	-	-	-	-	-	-	-	-		
Pantopoda	200	0.5	40	0.3	280	0.8	100	1.0	-	-	-	-	-	-	-	-		
<i>Coryphella athadona</i>	-	-	-	-	-	-	100	1.0	-	-	-	-	-	-	-	-		
<i>Orchomenella</i> sp.	100	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Hiatella arctica</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	40	0.8	-		
<i>Paralorchestes ochotensis</i>	-	-	200	0.8	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Nereis</i> sp.	100	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Caprella cristibrachium</i>	-	-	520	0.2	280	0.6	-	-	-	-	-	-	-	-	-	-		
<i>Haloconcha minor</i>	-	-	-	-	-	-	100	0.5	-	-	-	-	-	-	-	-		
<i>Ampithoe</i> sp.	-	-	40	0.4	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Abietinaria thuiarioides</i>	-	-	-	+	-	0.4	-	-	-	-	-	-	-	-	-	-		
<i>Jassa marmorata</i>	-	-	40	0.3	40	0.1	-	-	-	-	-	-	-	-	-	-		
<i>Pontogeneia</i> sp.	-	-	40	0.2	40	0.1	-	-	-	-	-	-	-	-	-	-		
Isopoda	-	-	40	0.1	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Mytilus trossulus kussakini</i>	100	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
T total biomass of animals	-	76.4	-	152.4	-	3031.0	-	2.5	-	-	-	-	-	-	-	257.8		
Total biomass	-	1636.4	-	10637.2	-	6467.0	-	1092.0	-	-	-	-	-	-	-	5699.8		

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Table 8. Density (N, individuals m⁻²) and biomass (B, g wet wt m⁻²) of macrobenthos in the middle intertidal subzone on the rocky, rocky-bouldery, and blocky-bouldery substrata in the green algae communities. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Pervukhina Bay (location 1)			Cape Kruglyy (location 2)			Yuzhno-Kurilskaya Bay (location 19)										
		<i>Ulva lactuca</i> patches			<i>Chaetomorpha moniligera</i> patches			<i>Chaetomorpha melagonium</i> patches			<i>Blidingia minima</i> patches			<i>Ulva lactuca</i> patches				
		N	B	N	N	B	N	N	B	N	N	B	N	N	B	N	N	B
PLANTS																		
<i>Chaetomorpha melagonium</i>	Ch	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Ulva lactuca</i>	Ch	—	632.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Chaetomorpha moniligera</i>	Ch	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Cladophora opaca</i>	Ch	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Blidingia minima</i>	Ch	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Chaetomorpha</i> sp.	Ch	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Devaleraea</i> sp.	Rh	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Mazzaella japonica</i>	Rh	—	100.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Anatipus japonicus</i>	Och	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Saccharina</i> sp.	Och	—	116.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Sargassum miyabei</i>	Och	—	80.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Cladophora speciosa</i>	Ch	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Corallina pilulifera</i>	Rh	—	14.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total biomass of plants		—	942.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ANIMALS																		
<i>Chthamalus dalli</i>	Ci	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Lottia persona</i>	Ga	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Falsicingula kurilensis</i>	Ga	520	2.8	600	32.0	6700	30.0	—	—	—	—	—	—	—	—	—	—	—
<i>Nucella heyseana</i>	Ga	—	—	2900	5.0	300	24.0	—	—	—	—	—	—	—	—	—	—	—
<i>Telmessus cheiragonus</i>	De	40	2.0	—	—	100	7.0	—	—	—	—	—	—	—	—	—	—	—
<i>Nassarius fraterculus</i>	Ga	—	—	—	—	400	18.0	—	—	—	—	—	—	—	—	—	—	—
<i>Littorina sitkana</i>	Ga	—	—	—	—	300	10.0	—	—	—	—	—	—	—	—	—	—	—
<i>Ampithoe kussakini</i>	Am	80	0.4	1100	6.0	200	3.0	—	—	—	—	—	—	—	—	—	—	—
<i>Ampithoe tarasovi</i>	Am	80	2.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Corophium</i> sp.	Am	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Lottia pelta</i>	Ga	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Spionidae	Po	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Tarantonia minuta</i>	Bi	80	0.4	300	1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Ciamenella fraudatrix</i>	Is	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Amphipoda	Am	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Panopoda	Pa	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Idotea ochotensis</i>	Is	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Ampithoe</i> sp.	Am	80	0.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total biomass of animals		—	8.3	—	44.0	—	92.0	—	—	—	—	—	—	—	—	—	—	—
Total biomass		—	950.7	—	859.0	—	559.0	—	—	—	—	—	—	—	—	—	—	—

Table 9. Density (N, individuals m⁻²) and biomass (B, g wet wt m⁻²) of macrobenthos on the boundary between the middle and lower intertidal subzones, on the blocky-boundary substratum. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Yuzhno-Kuril'skaya Bay (location 19)					
		Sabellidae settlings		<i>Abietinaria filicula</i> settlings		B	
		N	B	N	B	N	B
PLANTS							
<i>Saccharina</i> sp.	Och		-				350.0
Total biomass of plants			-				350.0
ANIMALS							
Sabellidae							
<i>Naineris jacutica</i>	Po	9350	20700.0	-			-
<i>Abietinaria filicula</i>	Po	8900	1395.0	-			-
<i>Lottia pelta</i>	Ga	-	-	200			1169.0
Asciacea	As	-	-				363.0
<i>Oulacis orientalis</i>	Ac	100	153.0	-			163.0
<i>Cryptosula zavjalovensis</i>	Bry		-				-
<i>Celleporella hyalina</i>	Bry		-				149.0
<i>Cnidopus japonicus</i>	Ac	-	-	200			145.0
<i>Nereis pelagica</i>	Po	200	17.8	500			88.5
<i>Nereis zonata</i>	Po	400	16.2	-			8.8
<i>Eteone longa</i>	Po	100	3.2	100			-
<i>Syllis hyalina</i>	Po	100	1.4	100			1.0
<i>Apolyale bassargini</i>	Am	-	-	200			0.4
<i>Vilasinia pillula</i>	Bi	-	-	100			1.2
<i>Abietinaria thuiarioides</i>	Hy	-	-	100			1.0
<i>Halecium lucium</i>	Hy	-	-			300	0.7
Pantopoda	Pa	-	-				0.6
<i>Eudendrium vaginatum</i>	Hy		-				0.5
Total biomass of animals			22286.6				2091.9
Total biomass			22286.6				2441.9

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Table 10. Density (N, individuals m⁻²) and biomass (B, g wet wt m⁻²) of macrobenthos on the boundary between the middle and lower intertidal subzones, on the sandy substratum. Abbreviations of taxonomic groups as in Table 2.

Taxa	Pervukhina Bay (location 1)						Cape Kruglyy (location 2)			Yuzhno-Kurilskaya Bay (location 19)		
	<i>Phyllospadix iwatensis</i> belt			<i>Phyllospadix iwatensis</i> patches			<i>Phyllospadix iwatensis</i> belt			<i>Phyllospadix iwatensis</i> belt		
	N	B		N	B		N	B		N	B	
PLANTS												
<i>Phyllospadix iwatensis</i>		10928.0					620.0				5528.0	
<i>Corallina pilulifera</i>		+					6.0				-	
Total biomass of plants		10928.0					626.0				5528.0	
ANIMALS												
<i>Oulactis orientalis</i>	-	-		+			+			80	604.0	
<i>Naineris jacutica</i>	80	24.0		480			21.4			5080	404.0	
<i>Chone teres</i>	11840	390.0		2560			90.0			6240	364.0	
<i>Nucella heyseana</i>	40	0.8		+			+			80	130.0	
<i>Telmessus cheiragonus</i>	+	+		-			-			40	80.0	
<i>Eudistylia suavis</i>	-	-		-			-			40	48.0	
<i>Nereis vexillosa</i>	40	31.4		80			25.5			120	35.0	
<i>Pseudopotamilla ocellata</i>	-	-		-			-			40	34.8	
<i>Littorina sitkana</i>	-	-		-			-			120	16.0	
Cirratulidae	+	+		240			11.2			-	-	
<i>Idotea ochotensis</i>	40	0.4		+			+			80	10.0	
<i>Nassarius fraterculus</i>	-	-		40			8.0			-	-	
<i>Protohaca euglypta</i>	40	8.0		-			-			-	-	
<i>Glycinde armigera</i>	40	6.4		80			5.6			-	-	
<i>Nereis zonata</i>	80	5.0		80			1.4			-	-	
<i>Eudendrium vaginatum</i>		-					-				4.4	
<i>Eteone longa</i>	-	-		-			-			120	4.0	
Polynoidae	+	+		-			-			40	3.6	
Maldanidae	-	-		200			2.4			-	-	
<i>Capitella capitata</i>	40	0.4		120			2.0			-	-	
<i>Ampiphoë kussakini</i>	+	+		+			+			40	2.0	
<i>Typosyllis adamaniteus</i>	-	-		40			1.2			-	-	
<i>Lumbrineris japonica</i>	-	-		40			1.0			-	-	

Taxa	Taxonomic group	Pervukhina Bay (location 1)		Cape Kruglyy (location 2)		Yuzhno-Kurilskaya Bay (location 19)	
		<i>Phyllospadix iwataensis</i> belt		<i>Phyllospadix iwataensis</i> patches		<i>Phyllospadix iwataensis</i> belt	
		N	B	N	B	N	B
<i>Typosyllis</i> sp.	Po	-	-	-	-	80	1.0
<i>Mysella kurilensis litoralis</i>	Bi	120	1.0	-	-	-	-
<i>Epheria turrita</i>	Ga	40	0.8	-	-	-	-
<i>Pontogeneia</i> sp.	Am	160	0.8	-	-	-	-
<i>Falsicingula kurilensis</i>	Ga	80	0.4	-	-	40	0.4
<i>Halococoncha minor</i>	Ga	40	0.4	-	-	-	-
<i>Turtonia minuta</i>	Bi	80	0.4	-	-	-	-
<i>Pontogeneia kondakovi</i>	Am	80	0.3	-	-	-	-
<i>Anonyx</i> sp.	Am	40	0.3	-	-	-	-
<i>Gnorimosphaeroma noblei</i>	Is	80	0.1	-	-	40	0.3
<i>Paralloorchestes ochotensis</i>	Am	40	0.2	+	+	-	-
<i>Holotelson tuberculatus</i>	Is	40	0.2	+	+	-	-
<i>Syllis hyalina</i>	Po	-	-	-	-	40	0.2
<i>Cleantrella isopus</i>	Is	40	0.0	-	-	-	-
Total biomass of animals			471.3		169.7		1741.7
Total biomass			11399.3		795.7		7269.7

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Table 11. Density (N, individuals m⁻²) and biomass (B, g wet wt m⁻²) of macrobenthos in the lower intertidal subzone on the rocky, rocky-bouldery, and blocky-bouldery substrata. Abbreviations of taxonomic groups as in Table 2.

Taxa	Pervukhina Bay (location 1)						Cape Kruglyy (location 2)						Yuzhno-Kurilskaya Bay (location 19)						Cape Rogacheva (location 23)					
	Sargassum miyabei belt		Scytosiphon lomentaria belt		Saccharina sp. belt		Sargassum miyabei belt		Sargassum thunbergii belt		Saccharina sp. belt		Sargassum thunbergii belt		Saccharina sp. belt		Saccharina sp. belt		Alaria ochotensis belt					
	N	B	N	B	N	B	N	B	N	B	N	B	N	B	N	B	N	B	N	B	N	B		
PLANTS																								
<i>Saccharina</i> sp.	-	-	-	-	10280.0	-	-	-	-	-	-	-	-	-	106880.0	-	-	-	-	-	+	8850.0		
<i>Alaria ochotensis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Sargassum thunbergii</i>	-	36.0	-	-	-	-	-	-	6008.0	-	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Scytosiphon lomentaria</i>	-	-	4440.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Sargassum miyabei</i>	4280.0	-	88.0	-	-	-	1992.0	-	-	-	644.0	-	-	-	-	-	-	-	-	-	-	-		
<i>Neorhodomela aculeata</i>	200.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Pterosiphonia bipinnata</i>	-	-	-	-	-	-	-	-	-	-	273.2	-	-	-	-	-	-	-	-	-	-	596.0		
<i>Mastocarpus pacificus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Mazzaella parksii</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Corallina pilulifera</i>	-	-	1.6	-	-	-	28.0	-	-	-	-	-	-	-	-	-	-	-	-	-	164.0	46.0		
<i>Ulva lactuca</i>	-	-	24.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Analipus japonicus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13.0		
<i>Costaria costata</i>	-	-	8.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Tichocarpus crinitus</i>	-	-	6.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Chordaria flagelliformis</i>	-	-	4.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Laurencia nipponica</i>	-	-	4.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Porphyra</i> sp.	-	-	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Total biomass of plants	4516.0	-	4579.2	-	10280.0	-	2937.2	-	6081.6	-	106880.0	-	9669.0	-	-	-	-	-	-	-	-	-		
ANIMALS																								
<i>Semibalanus cariosus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	500	827.0		
<i>Chthamalus dalli</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1740	420.0		
<i>Nucella freycinetii</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	80	67.8		
<i>Falsistigula kurilensis</i>	6760	22.0	40	0.4	600	3.2	22600	57.9	16200	63.2	600	30.0	40	2.0	600	30.0	40	2.0	600	30.0	2380	43.0		
<i>Nassarius fraterculus</i>	-	-	-	-	-	-	640	58.0	40	4.8	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Eudendrium vaginatum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Lottia pelta</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	56.0	-	-	-	200	50.0		
<i>Mytilus trossulus kussakini</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60	49.0		
<i>Littorina sitkana</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2380	43.0		
<i>Homalopoma sangarense</i>	+	+	+	+	-	-	80	30.0	-	-	80	30.0	-	-	-	-	-	-	-	-	-	-		
<i>Paraliorchestes ochotensis</i>	40	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	140	1.8	-	-	560	28.0		
<i>Nucella heyseana</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<i>Apohyale bassargini</i>	200	0.6	-	-	40	0.2	200	0.8	24160	19.4	200	0.8	24160	19.4	200	0.8	24160	19.4	200	0.8	80	0.2		
<i>Nereis pelagica</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	280	6.5	-	-	720	15.0		
<i>Idotea ochotensis</i>	-	-	-	-	-	-	40	14.0	-	-	40	14.0	-	-	-	-	-	-	-	-	-	-		

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Table 12. Density (N, individuals m⁻²) and biomass (B, g wet wt m⁻²) of macrobenthos in the middle and lower intertidal subzones on the sandy-silted-gravelly substratum. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Izmeny Bay (location 10)					
		<i>Batillaria cumingii</i>		<i>Zostera japonica</i>		<i>Zostera marina</i>	
		N	B	N	B	N	B
PLANTS							
<i>Zostera japonica</i>	Tra	-	-	-	1427.7	-	-
<i>Zostera marina</i>	Tra	-	-	-	-	1265.6	-
<i>Chordaria</i> sp.	Och	-	-	-	60.0	-	-
Total biomass of plants					1487.7		1265.6
ANIMALS							
<i>Batillaria cumingii</i>	Ga	1600	445.6	140	67.6	200	77.6
<i>Ruditapes philippinarum</i>	Bi	80	15.6	30	342.3	80	1027.6
<i>Nassarius fraterculus</i>	Ga	120	22.8	80	11.3	-	-
<i>Abarenicola pacifica</i>	Po	80	15.6	100	12.8	40	0.2
<i>Nereis vexillosa</i>	Po	-	-	140	14.1	120	12.8
<i>Nassarius multigranulosus</i>	Ga	-	-	-	-	120	9.6
<i>Macoma incongrua</i>	Bi	-	-	30	2.5	40	7.6
<i>Alitta brandii</i>	Po	-	-	-	-	40	6.0
<i>Naineris jacutica</i>	Po	-	-	-	-	80	4.6
<i>Glycinde armigera</i>	Po	-	-	-	-	40	4.2
<i>Hediste japonica</i>	Po	40	4.0	-	-	-	-
<i>Chone</i> sp.	Po	-	-	-	-	840	3.6
<i>Nereis pelagica</i>	Po	-	-	-	-	120	2.8
<i>Gnорinosphaeroma noblei</i>	Is	-	-	240	1.3	-	-
Polychaeta	Po	-	-	30	0.9	-	-
<i>Leptodecreum</i> sp.	Am	-	-	150	0.7	-	-
<i>Turtonia minuta</i>	Bi	-	-	160	0.4	-	-
<i>Cerithiopsis stejnegeri</i>	Ga	-	-	-	-	80	0.4
<i>Pusilina plicosa</i>	Ga	-	-	-	-	200	0.2
<i>Nereis</i> sp.	Po	-	-	150	0.1	-	-
<i>Ampithoe</i> sp.	Am	-	-	10	0.1	-	-
<i>Gastropoda</i> juv.	Ga	-	-	30	0.1	-	-
<i>Dogielinotus moskvitini</i>	Am	-	-	10	0.1	-	-
<i>Falscingula kurilensis</i>	Ga	-	-	30	0.1	-	-
<i>Limularia iridescens</i>	Ga	-	-	-	-	840	0.0
<i>Allorchestes malleolus</i>	Am	-	-	10	0.0	-	-
Leptostraca	Le	-	-	10	0.0	-	-
Cumacea	Cu	-	-	10	0.0	-	-
Total biomass of animals			503.6		454.4		1157.2
Total biomass			503.6		1942.1		2422.8

Table 13. Density (N, individuals m^{-2}) and biomass (B, g wet wt m^{-2}) of macrobenthos on the boundary of transition of the walls of the tide pool into the top part of reef. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Cape Rogacheva (location 23)					
		<i>Littorina sitkana</i> belt		<i>Chthamalus dalli</i> + <i>Littorina sitkana</i> patches		<i>Gloiopeltis furcata</i> patches	
		N	B	N	B	N	B
PLANTS							
<i>Gloiopeltis furcata</i>	Rh		-		-		500.0
Total biomass of plants							500.0
ANIMALS							
<i>Littorina sitkana</i>	Ga	5800	290.0	6100	50.0	8200	155.0
<i>Chthamalus dalli</i>	Ci	-	-	5000	70.0	600	5.0
<i>Apolyale bassargini</i>	Am	-	-	-	-	1600	5.0
<i>Clitamenella fraudatrix</i>	Is	-	-	-	-	600	2.0
Total biomass of animals			290.0		120.0		167.0
Total biomass			290.0		120.0		667.0

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Table 14. Density (N, individuals m⁻²) and biomass (B, g wet wt m⁻²) of macrobenthos on the walls of the tide pool. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Cape Rogacheva (location 23)					
		<i>Silvetia babingtonii</i> belt		<i>Fucus evanescens</i> patches		<i>Anatipus japonicus</i> patches	
		N	B	N	B	N	B
PLANTS							
<i>Silvetia babingtonii</i>	Och		18440.0		-		+
<i>Fucus evanescens</i>	Och		10.0		8208.0		20.0
<i>Anatipus japonicus</i>	Och		-		-		970.0
<i>Corallina pilulifera</i>	Rh		-		-		90.0
Total biomass of plants			18450.0		8208.0		1080.0
ANIMALS							
<i>Littorina sitkana</i>	Ga	18400	360.0	4720	128.0	200	5.0
<i>Nucella freycinetii</i>	Ga	-	-	80	36.0	-	-
<i>Lottia persona</i>	Ga	160	20.4	+	+	-	-
<i>Chthamalus dalli</i>	Ci	240	13.6	160	6.0	-	-
<i>Apolyale bassargini</i>	Am	920	12.0	1400	6.0	100	0.1
<i>Cliamenella fraudatrix</i>	Is	-	-	-	-	700	1.2
<i>Nereis</i> sp.	Po	-	-	-	-	200	1.0
<i>Pontogeneia</i> sp.	Am	-	-	-	-	100	0.7
<i>Abietinaria filicula</i>	Hy		0.2		-		-
<i>Gnorimosphaeroma noblei</i>	Is	40	0.0	+	+	-	-
Total biomass of animals			406.2		176.0		8.0
Total biomass			18856.2		8384.0		1088.0

Table 15. Density (N, individuals m⁻²) and biomass (B, g wet wt m⁻²) of macrobenthos on the bottom of the tide pool in the plant communities with projective cover up to 90%. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Cape Rogacheva (location 23)			
		<i>Corallina pilulifera</i>		<i>Phyllospadix iwataensis</i>	
		N	B	N	B
PLANTS					
<i>Phyllospadix iwataensis</i>	Tra	-	-	-	8320.0
<i>Corallina pilulifera</i>	Rh	-	1282.0	-	292.0
<i>Cladophora opaca</i>	Ch	-	10.0	-	-
<i>Neorhodomela munita</i>	Rh	-	1.0	-	-
<i>Chaetomorpha monilifera</i>	Ch	-	0.5	-	-
Total biomass of plants			1293.5		8612.0
ANIMALS					
<i>Protothaca euglypta</i>	Bi	-	-	760	48.0
<i>Falsicingula kurilensis</i>	Ga	9700	39.0	1000	2.0
<i>Naineris jacutica</i>	Po	-	-	1160	33.3
<i>Littorina sitkana</i>	Ga	6400	20.0	1640	20.0
<i>Nereis pelagica</i>	Po	-	-	560	18.9
<i>Phascosoma (Phykosoma) agassizii</i>	Si	-	-	40	16.0
<i>Polychaeta</i>	Po	200	5.0	-	-
<i>Hiatella arctica</i>	Bi	-	-	80	4.8
<i>Lumbrineris japonica</i>	Po	-	-	80	1.5
<i>Nucella heyseana</i>	Ga	100	1.0	+	+
<i>Cliamenella fraudatrix</i>	Is	400	1.0	-	-
<i>Pantopoda</i>	Pa	-	-	80	0.8
<i>Bryozoa</i>	Bry	-	-	-	0.8
<i>Sertularia similis</i>	Hy	-	-	-	0.4
<i>Eudendrium vaginatum</i>	Hy	-	-	-	0.4
<i>Mysella kurilensis litoralis</i>	Bi	-	-	40	0.4
<i>Abietinaria filicula</i>	Hy	-	-	-	0.2
<i>Syllis hyalina</i>	Po	-	-	40	0.2
Total biomass of animals			66.0		147.7
Total biomass			1359.5		8759.7

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Table 16. Density (N, individuals m⁻²) and biomass (B, g wet wt m⁻²) of macrobenthos on the bottom of the tide pool in the plant communities with projective cover up to 10%. Abbreviations of taxonomic groups as in Table 2.

Taxa	Taxonomic group	Cape Rogacheva (location 23)											
		Neodilsea yendoana patches		Pterosiphonia bipinnata patches		Neorhodomela aculeata + Neorhodomela oregona patches		Mazzaella parksii patches		Chaetomorpha linum patches		Chaetomorpha melagonium patches	
		N	B	N	B	N	B	N	B	N	B	N	B
PLANTS													
<i>Mazzaella parksii</i>	Rh	-	-	-	-	-	-	-	7950.0	-	-	-	-
<i>Pterosiphonia bipinnata</i>	Rh	-	-	6950.0	-	-	-	-	-	-	-	-	-
<i>Neodilsea yendoana</i>	Rh	3950.0	-	-	-	-	-	-	-	-	-	-	-
<i>Chaetomorpha linum</i>	Ch	-	-	-	-	12.5	-	-	-	2620.0	-	-	-
<i>Neorhodomela aculeata</i>	Rh	-	-	-	-	1832.5	-	-	-	-	-	177.0	-
<i>Neorhodomela oregona</i>	Rh	-	-	-	-	975.0	-	-	-	-	-	-	-
<i>Chaetomorpha melagonium</i>	Ch	-	-	-	-	-	-	-	-	+	-	320.0	-
<i>Corallina pilulifera</i>	Rh	200.0	-	-	-	81.3	-	1110.0	-	10.0	-	-	-
<i>Clathromorphum</i> sp.	Rh	-	-	-	-	-	-	17.0	-	-	-	-	-
<i>Phyllospadix iwatensis</i>	Tra	-	-	-	-	6.3	-	-	-	-	-	-	-
Total biomass of plants		4150.0	-	6950.0	-	2907.6	-	9077.0	-	2630.0	-	497.0	-
ANIMALS													
<i>Hiattella arctica</i>	Bi	-	-	-	-	25	0.5	1800	202.0	-	-	-	-
<i>Littorina sikana</i>	Ga	200	2.0	200	5.0	6575	113.5	7100	98.0	7300	1500	-	4.1
<i>Chthamalus dalli</i>	Cl	-	-	500	100.0	-	-	-	-	-	-	-	-
<i>Nereis pelagica</i>	Po	-	-	1700	50.0	-	-	-	-	-	-	-	-
<i>Apolyte bassargini</i>	Am	100	9.0	4000	16.6	225	0.6	200	29.0	500	100	100	17.4
<i>Idotea ochotensis</i>	Is	80	25.0	-	-	25	0.2	-	-	-	-	-	-
<i>Pontogeneia</i> sp.	Am	-	-	1400	3.0	6175	20.2	-	-	-	-	-	-
<i>Clamienella fraudatrix</i>	Is	100	0.5	9400	17.0	650	1.3	900	2.0	100	-	-	-
<i>Nucella heyseana</i>	Ga	-	-	-	-	50	15.0	-	-	-	-	-	-
<i>Falsicingula kurilensis</i>	Ga	-	-	300	0.6	375	1.8	3700	6.5	700	900	-	1.0
Asciacea	As	-	5.0	-	-	-	-	-	-	-	-	-	-
<i>Parallorchestes ochotensis</i>	Am	-	-	-	-	-	-	100	4.7	-	-	-	-
<i>Nereis</i> sp.	Po	-	-	-	-	-	-	300	4.0	-	-	-	-
<i>Nassarius fraterculus</i>	Ga	-	-	-	-	50	2.5	-	-	-	-	-	-
<i>Panomya</i> sp.	Bi	-	-	200	2.0	-	-	-	-	-	-	-	-
<i>Lottia persona</i>	Ga	-	-	-	-	50	1.0	100	1.0	-	-	-	-
<i>Abietinaria flicula</i>	Hy	-	1.0	-	-	-	-	-	+	-	-	-	-
<i>Allorchestes malleolus</i>	Am	100	1.0	-	-	-	-	-	-	-	-	-	-
<i>Gnorimosphaeroma noblei</i>	Is	-	-	-	-	-	-	-	-	100	0.6	-	-
<i>Mysella kurilensis litoralis</i>	Bi	-	-	-	-	-	-	100	0.5	-	-	-	-
Pantopoda	Pa	-	-	-	-	-	-	100	0.5	-	-	-	-
<i>Ischyrocerus</i> sp.	Am	100	0.4	-	-	25	0.0	-	-	-	-	-	-
<i>Sertularella spinosa</i>	Hy	-	-	-	-	-	-	-	0.2	-	-	-	-
Total biomass of animals		43.9	-	194.2	-	156.6	-	348.4	-	39.3	-	22.5	-
Total biomass		4193.9	-	7144.2	-	3064.2	-	9425.4	-	2668.3	-	519.5	-

Plate 1



Plate 1. The general view of the rocky-bouldery intertidal zone on reef in the Pervukhina Bay.

Plate 2



Plate 2. Communities of the upper intertidal subzone. A – the *Littorina sitkana* community; B – the *Chthamalus dalli* community; C – the *Gloiopeltis furcata* community.

Plate 3



Plate 3. The *Fucus evanescens* community in the middle intertidal subzone. The upper photo – water level is 0.3 m.

Plate 4



Plate 4. The brown algae communities in the middle intertidal subzone. A – the *Fucus evanescens* community and the *Silvetia babingtonii* patches; B – the *Analipus japonicus* community.



Plate 5. The green algae communities in the middle intertidal subzone. A – the *Ulva lactuca* community; B – the *Chaetomorpha moniligera* community.

Plate 6



Plate 6. The red algae communities in the middle intertidal subzone. A – the *Corallina pilulifera* community; B – the *Mazzaella parksii* community.

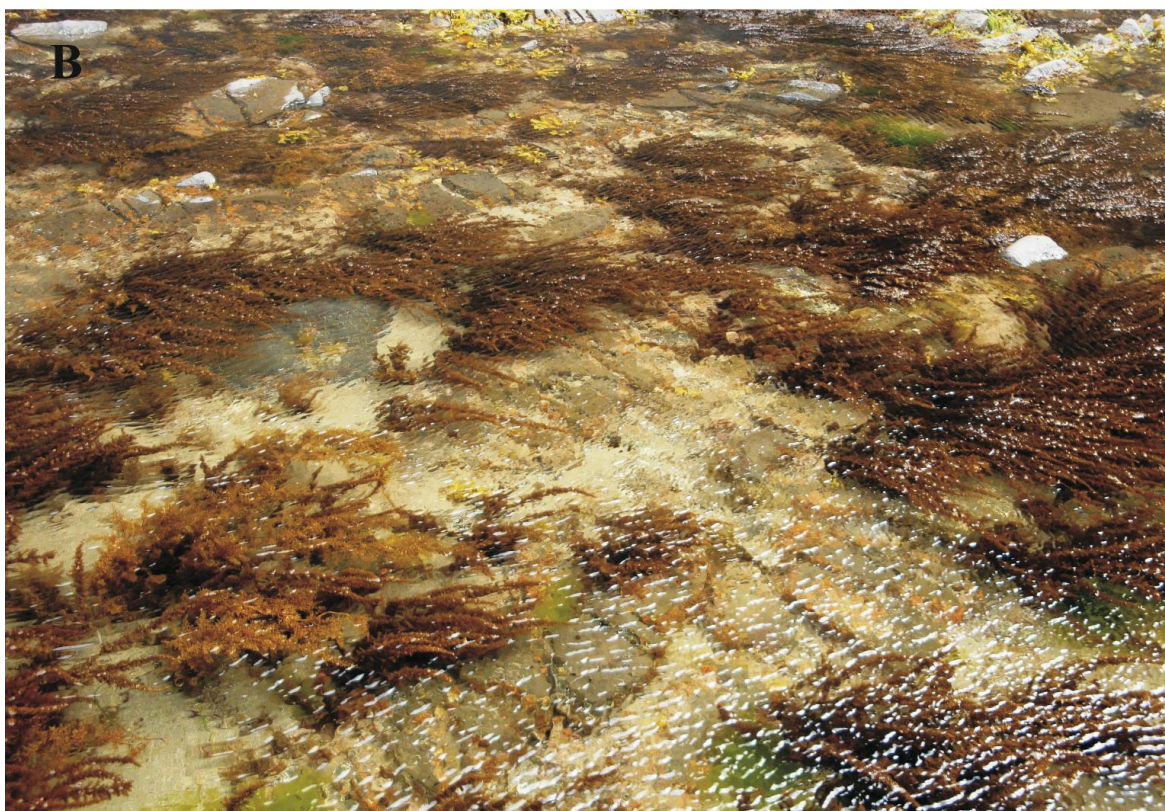


Plate 7. Communities in the lower part of the middle intertidal subzone and lower intertidal subzone (water level is 0.3–0.4 m). A – the *Phyllospadix iwatensis* community; B – the *Sargassum miyabei* community.

Plate 8



Plate 8. Laminarian communities in the lower intertidal subzone. The upper photo – water level is 0.4 m.

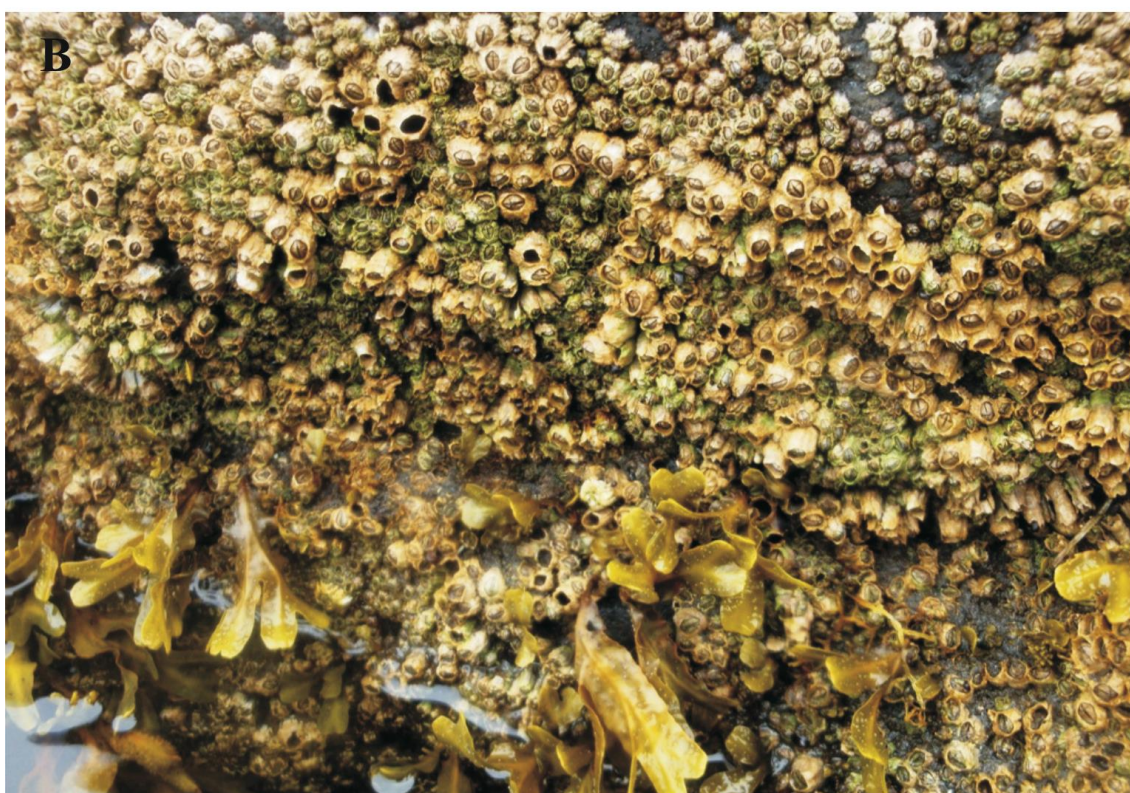


Plate 9.

Vertical distribution of macrobenthos on the boundary between the upper and middle intertidal subzones. A – belt of *Chthamalus dalli* with patches of *Gloiopeltis furcata*, and crustose bases of *Analipus japonicus* are below *Ch. dalli*; B – belts of *Chthamalus dalli* and *Fucus evanescens*.

Plate 10



Plate 10. Vertical distribution of macrobenthos in the middle intertidal subzone. A – patches of the brown alga *Analipus japonicus*, the red alga *Mazzaella parksii*, and barnacle *Chthamalus dalli*; B – belt of *Fucus evanescens*, and over – settlings of *Chthamalus dalli*.

Plate 11

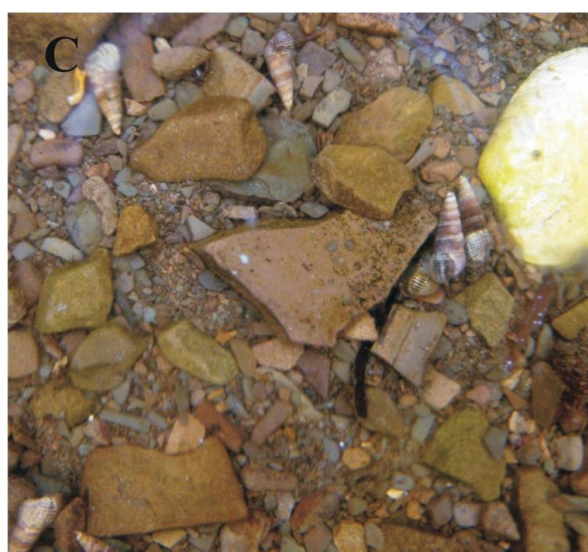
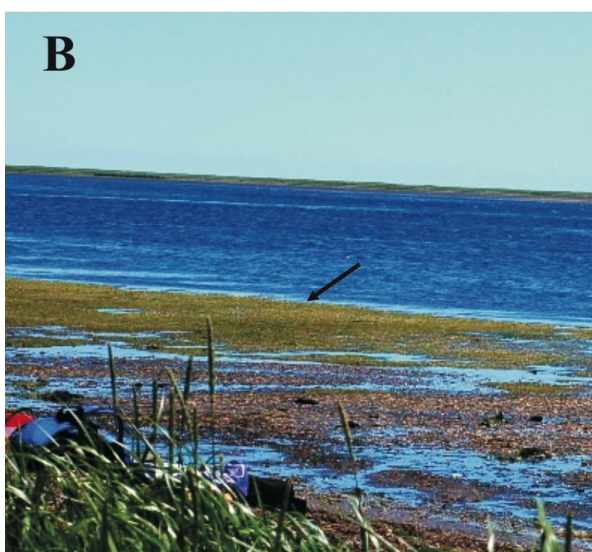


Plate 11. Intertidal zone in the Izmeny Bay. A – the *Zostera* field (show by arrow); B – the *Zostera marina* belt-forming community (show by arrow); C – the *Batillaria cumingii* community.

Plate 12



Plate 12. The general view of the intertidal zone of the Goryachiy Plyazh (A) and sea anemone *Diadumene lineata* (B).

Plate 13



Plate 13. The tide pools on the Goryachiy Plyazh. A – the tide pool with “cold” volcanic H₂S seeps; B – the tide pool with “hot” volcanic H₂S seeps (the algal-bacterial mats is indicated by arrow).



Plate 14. Samplings in the intertidal zone. A – the quantitative samplings in the upper intertidal subzone; B – the quantitative samplings in the middle intertidal subzone; C – the qualitative samplings in the lower intertidal subzone.

Appendix

The list of the macrobenthic plants and animals of the intertidal zone of Kunashir Island

The larvae of Insecta have not been identified. Some groups (Nemertea, Polychaeta, Amphipoda, Isopoda, Cumacea, Pantopoda, Leptostraca, Bryozoa, Ascidiacea, juveniles of gastropods and sea anemones) are partly identified.

The Latin names of species mentioned in previous publications (Kussakin, 1956, 1957, 1975; Zinova and Perestenko, 1974; Kussakin and Tarakanova, 1977; Kostina, 1991) are enclosed in square brackets if these names are true synonyms (=), and it is not determined whether the species of true synonyms or it is incorrectly applied name (“as”).

Abbreviations: E – eastern coast, W – western coast, and S – southern coast of Kunashir Island; BG – biogeographical group. In the column “biogeographical group”, the following abbreviations of species are given: ab. – amphi-boreal; ap. – amphi-Pacific; as. – near-Asiatic; at. – anti-tropical; b.-a. – boreal-Arctic; hb. – high-boreal; lb. – low-boreal; n.-tr.-b.(lb. or st.) – notal-tropical-boreal (low-boreal or subtropical); p.-Pacific; p.-o. – panoceanic; st.-b.(lb.) – subtropical-boreal (low-boreal); st.(tr.)-b.-a. – subtropical (tropical)-boreal-Arctic; tr.-st.(lb. or b.) – tropical-subtropical (low-boreal or boreal); wb. – widespread boreal; mz. – multizonal.

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
PLANTS							
Regnum CHROMISTA							
Phylum Ochrophyta							
Classis Phaeophyceae							
Ordo Desmarestiales							
Familia Desmarestiaceae							
<i>Desmarestia aculeata</i> (Linnaeus) J.V. Lamouroux	+						b.-a.
<i>Desmarestia viridis</i> (O.F. Müller) J.V. Lamouroux					+		?at.
Ordo Ectocarpales							
Familia Acinetosporaceae							
<i>Pylaiella littoralis</i> (Linnaeus) Kjellman, <i>nomen conservandum</i>	+						mz.
Familia Chordariaceae							
<i>Acrothrix pacifica</i> Okamura et Yamada	+				+		as. st.-lb.
<i>Chordaria chordaiformis</i> (Kjellman) H. Kawai et S.-H. Kim [= <i>Chordaria flagelliformis</i> f. <i>chordaiformis</i> Kjellman]	+		+				b.-a.
<i>Chordaria flagelliformis</i> (O.F. Müller) C. Agardh	+	+	+	+			at.
<i>Chordaria</i> spp.	+					+	
<i>Coilodesme californica</i> (Ruprecht) Kjellman	+						p. st.-b.
<i>Coilodesme cystoseirae</i> (Ruprecht) Setchell et N.L. Gardner	+		+		+		p. wb.
<i>Dictyosiphon chordaria</i> Areschoug				+			b.-a.
<i>Dictyosiphon foeniculaceus</i> (Hudson) Greville	+			+	+		b.-a.
<i>Eudesme virescens</i> (Carmichael ex Berkeley) J. Agardh	+				+		?mz.
<i>Leathesia marina</i> (Lyngbye) Decaisne [= <i>Leathesia difformis</i> Areschoug]	+	+	+	+	+		mz.
<i>Melanosiphon intestinalis</i> (De A. Saunders) M.J. Wynne		+					ab., st.-b.
<i>Punctaria chartacea</i> Setchell et N.L. Gardner	+						p. wb.
<i>Punctaria flaccida</i> Nagai						+	as. lb.
<i>Punctaria latifolia</i> Greville						+	mz.
<i>Punctaria occidentalis</i> Setchell et N.L. Gardner	+						p. wb.
<i>Punctaria plantaginea</i> (Roth) Greville [= <i>Punctaria rubescens</i> (Lyngbye) J. Agardh]	+	+	+	+	+		?at.
<i>Saundersella simplex</i> (Saunders) Kylin				+	+		b.-a.
<i>Sphaerotrichia divaricata</i> (C. Agardh) Kylin [= <i>Sphaerotrichia japonica</i> Kylin]	+					+	at.

MACROBENTHOS IN THE INTERTIDAL ZONE OF KUNASHIR ISLAND

Taxa	E		W		S		BG
	1951-1964	1987-1991	1951-1964	1991	1951-1964	1991	
<i>Streblonema fasciculatum</i> Thuret						+	?at.
Familia Scytosiphonaceae							
<i>Colpomenia sinuosa</i> (Mertens ex Roth) Derbes et Solier			+		+		n.-tr.-b.
<i>Petalonia fascia</i> (O.F. Müller) Kuntze		+					mz.
<i>Scytosiphon lomentaria</i> (Lyngbye) Link, <i>nomen conservandum</i>	+	+	+	+	+		mz.
Ordo Fucales							
Familia Fucaceae							
<i>Fucus evanescens</i> C. Agardh	+	+	+	+			b.-a.
<i>Silvetia babingtonii</i> (Harvey) E.A. Serrão, T.O. Cho, S.M. Boo et Brawley [= <i>Pelvetia wrightii</i> Okamura]	+	+	+	+			as. lb.
Familia Sargassaceae							
<i>Sargassum miyabei</i> Yendo [= <i>Sargassum kjellmanianum</i> Yendo]	+	+	+	+	+		tr.-lb.
<i>Sargassum pallidum</i> (Turner) C. Agardh [as <i>Sargassum confusum</i> C. Agardh]						+	tr.-lb.
<i>Sargassum thunbergii</i> (Mertens ex Roth) Kuntze			+	+			tr.-lb.
<i>Stephanocystis crassipes</i> (Mertens ex Turner) Draisma, Ballesteros, F. Rousseau et T. Thibaut [= <i>Cystophyllum crassipes</i> (Mertens ex Turner) J. Agardh; <i>Cystoseira crassipes</i> (Mertens ex Turner) C. Agardh]	+		+		+		as. wb.
<i>Stephanocystis geminata</i> (C. Agardh) Draisma, Ballesteros, F. Rousseau et T. Thibaut [= <i>Cystoseira geminata</i> C. Agardh]						+	p. wb.
<i>Stephanocystis hakodatensis</i> (Yendo) Draisma, Ballesteros, F. Rousseau et T. Thibaut [= <i>Cystoseira hakodatensis</i> (Yendo) Fensholt]						+	tr.-lb.
Ordo Laminariales							
Familia Agaraceae							
<i>Costaria costata</i> (C. Agardh) De A. Saunders	+			+			p. wb.
Familia Alariaceae							
<i>Alaria esculenta</i> (Linnaeus) Greville [= <i>Alaria macroptera</i> (Ruprecht) Yendo]	+						b.-a.
<i>Alaria marginata</i> Postels et Ruprecht [= <i>Alaria taeniata</i> Kjellman]	+						p. wb.
<i>Alaria ochotensis</i> Yendo		+					as. wb.
<i>Alaria praelonga</i> Kjellman	+						p. wb.
<i>Alaria</i> spp.	+		+				
Familia Chordaceae							
<i>Chorda asiatica</i> Sasaki et Kawai [as <i>Chorda filum</i> (Linnaeus) Stackhouse]	+					+	as. wb.
Familia Laminariaceae							
<i>Arthrothamnus bifidus</i> (S.G. Gmelin) J. Agardh	+						p. wb.
<i>Arthrothamnus kurilensis</i> Ruprecht	+						?as. wb.
<i>Laminaria digitata</i> (Hudson) Lamouroux	+						st.-b.-a.
<i>Saccharina gyrata</i> (Kjellman) C.E. Lane, C. Mayes, Druehl et G.W. Saunders [= <i>Kjellmaniella gyrata</i> (Kjellman) Miyabe]	+		+				as. wb.
<i>Saccharina japonica</i> (Areschoug) C.E. Lane, C. Mayes, Druehl et G.W. Saunders [= <i>Laminaria japonica</i> Areschoug]	+			+			ab.
<i>Saccharina</i> spp.		+		+			
Familia Pseudochordaceae							
<i>Pseudochorda nagaii</i> (Tokida) Inagaki	+					+	as. lb.
Ordo Ralfsiales							
Familia Ralfsiaceae							
<i>Analipus filiformis</i> (Ruprecht) Papenfuss [= <i>Analipus fusiformis</i> Kjellman]	+						p. wb.

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
<i>Analipus japonicus</i> (Harvey) Wynne [= <i>Heterochordaria abietina</i> (Ruprecht ex Farlow) Setchell et N.L. Gardner]	+	+	+	+			p. wb.
<i>Ralfsia fungiformis</i> (Gunnerus) Setchell et Gardner	+				+		tr.-b.-a.
Ordo Sphacelariales							
Familia Sphacelariaceae							
<i>Sphacelaria rigidula</i> Kützing [= <i>Sphacelaria furcigera</i> Kützing]	+				+		?mz.
Regnum PLANTAE							
Phylum Rhodophyta							
Classis Bangiophyceae							
Ordo Bangiales							
Familia Bangiaceae							
<i>Fuscifolium tasa</i> (Yendo) S.C. Lindstrom [= <i>Porphyra tasa</i> (Yendo) Ueda]	+						p. wb.
<i>Porphyra umbilicalis</i> Kützing	+						mz.
<i>Porphyra</i> spp.	+		+	+			
<i>Wildemania amplissima</i> Foslie [= <i>Porphyra amplissima</i> (Kjellman) Setchell et Hus]	+						b.-a.
<i>Wildemania variegata</i> De Toni [= <i>Porphyra variegata</i> (Kjellman) Kjellman]	+						?tr.-b.
Classis Compsogonophyceae							
Ordo Erythropeltidales							
Familia Erythrotrichiaceae							
<i>Erythrotrichia carnea</i> (Dyllwin) C. Agardh					+		mz.
<i>Erythrotrichia</i> sp.					+		
Classis Florideophyceae							
Ordo Acrochaetiales							
Familia Acrochaetiaceae							
<i>Acrochaetium kurilense</i> (Nagai) Papenfuss	+						as. wb.
<i>Acrochaetium moniliforme</i> (Rosenvinge) Børgesen [= <i>Kylinia moniliformis</i> (Rosenvinge) Kyli]	+						?n.-tr.-b.
<i>Acrochaetium reductum</i> (Rosenvinge) Hamel	+						?n.-tr.-b.
<i>Acrochaetium</i> sp.	+						
Ordo Ahnfeltiales							
Familia Ahnfeltiaceae							
<i>Ahnfeltia tobuchiensis</i> (Kanno et Matsubara) Makienko [as <i>Ahnfeltia plicata</i> (Hudson) Fries]						+	as. lb.
Ordo Ceramiales							
Familia Ceramiaceae							
<i>Antithamnion</i> sp.	+						
<i>Ceramium japonicum</i> Okamura [as <i>Ceramium rubrum</i> C. Agardh]	+		+	+	+		as. st.-lb.
<i>Ceramium kondoi</i> Yendo	+		+				p. wb.
Familia Delesseriaceae							
<i>Heteroglossum carnosum</i> (Mikami) Perestenko [as <i>Okamurina pacifica</i> (Yamada) A.D. Zinova]	+						as. wb.
<i>Tokidadendron bullatum</i> (N.L. Gardner) M.J. Wynne	+						p. wb.
Familia Rhodomelaceae							
<i>Chondria crassicaulis</i> Harvey	+	+	+				tr.-lb.
<i>Laurencia nipponica</i> Yamada				+	+		?as. st.-lb.
<i>Laurencia okamurae</i> Yamada	+		+		+		tr.-st.
<i>Laurencia</i> spp.	+		+				
<i>Neorhodomela aculeata</i> (Perestenko) Masuda [as <i>Rhodomela larix</i> (Turner) C. Agardh; <i>Neorhodomela larix</i> (Turner) Masuda]	+	+	+	+			p. wb.
<i>Neorhodomela munita</i> (Perestenko) Masuda			+	+			as. lb.
<i>Neorhodomela oregona</i> (Doty) Masuda			+	+			p. wb.
<i>Neosiphonia japonica</i> (Harvey) M.-S. Kim et I.K. Lee	+						?at.

MACROBENTHOS IN THE INTERTIDAL ZONE OF KUNASHIR ISLAND

Taxa	E		W		S		BG
	1951-1964	1987-1991	1951-1964	1991	1951-1964	1991	
[= <i>Polysiphonia japonica</i> Harvey]							
<i>Neosiphonia yendoi</i> (Segi) M.S. Kim et I.K. Lee				+			as. lb.
<i>Odonthalia annae</i> Perestenko	+	+					as. wb.
<i>Odonthalia corymbifera</i> (S.G. Gmelin) Greville	+	+					?as. st.-b.
<i>Odonthalia floccosa</i> (Esper) Falkenberg [= <i>Odonthalia aleutica</i> (C. Agardh) J. Agardh]	+						p. wb.
<i>Odonthalia kamtschatica</i> (Ruprecht) J. Agardh	+						p. wb.
<i>Odonthalia ochotensis</i> (Ruprecht) J. Agardh			+				as. wb.
<i>Polysiphonia morrowii</i> Harvey				+			at.
<i>Polysiphonia stricta</i> (Dillwyn) Greville [= <i>Polysiphonia urceolata</i> (Lightfoot ex Dillwyn) Greville]	+						mz.
<i>Pterosiphonia bipinnata</i> (Postels et Ruprecht) Falkenberg			+				p. wb.
<i>Rhodomela confervoides</i> (Hudson) P.C. Silva [= <i>Rhodomela subfusca</i> (Woodward) C. Agardh]	+		+				b.-a.
<i>Rhodomela sachalinensis</i> Masuda				+			as. lb.
Familia Wrangeliaceae							
<i>Neoptilota asplenioides</i> (Esper) Kylin ex Scagel, Garbary, Golden et Hawkes [= <i>Ptilota asplenioides</i> (Esper) C. Agardh]	+	+	+				at.
<i>Ptilota filicina</i> J. Agardh	+		+	+			p. wb.
<i>Ptilota</i> spp.	+		+				
Ordo Corallinales							
Familia Corallinaceae							
<i>Alatocladia modesta</i> (Yendo) H.W. Johansen			+				as. lb.
<i>Bossiella compressa</i> N.G. Kloczcova [as <i>Amphiroa cretacea</i> (Postels et Ruprecht) Endlicher]	+	+		+			as. wb.
<i>Corallina officinalis</i> Linnaeus [= <i>Pachyarthron cretaceum</i> (Postels et Ruprecht) Manza; <i>Bossiella cretacea</i> (Postels et Ruprecht) H.W. Johansen]	+	+	+		+		mz.
<i>Corallina pilulifera</i> Postels et Ruprecht	+	+	+	+	+		n.-tr.-b.
<i>Lithophyllum tumidulum</i> Foslie			+	+			as. st.-lb.
Ordo Gigartinales							
Familia Dumontiaceae							
<i>Constantinea rosa-marina</i> (S.G. Gmelin) Postels et Ruprecht	+						p. wb.
<i>Constantinea subulifera</i> Setchell	+	+					p. wb.
<i>Dilsea</i> sp.	+						
<i>Dumontia contorta</i> (S.G. Gmelin) Ruprecht [= <i>Dumontia incrassata</i> (O.F. Müller) J.V. Lamouroux]	+						?b.-a.
<i>Farlowia</i> sp.	+						
<i>Masudaphycus irregularis</i> (Yamada) S.C. Lindstrom [= <i>Farlowia irregularis</i> Yamada]	+	+					as. st.-lb.
<i>Neodilsea yendoana</i> Tokida	+	+	+				as. wb.
Familia Endocladaceae							
<i>Gloiopeltis furcata</i> (Postels et Ruprecht) J. Agardh	+	+		+	+		tr.-b.
Familia Gigartinaceae							
<i>Chondrus armatus</i> (Harvey) Okamura					+		?as. lb.
<i>Chondrus pinnulatus</i> (Harvey) Okamura	+	+	+	+	+		as. lb.
<i>Chondrus yendoi</i> Yamada et Mikami	+						as. lb.
<i>Chondrus</i> sp.	+						
<i>Iridaea</i> spp. [as <i>Iridaea subdichotomum</i>]	+		+				
<i>Mazzaella japonica</i> (Mikami) Hommersand [= <i>Rhodoglossum japonicum</i> Mikami]	+	+		+			as. lb.
<i>Mazzaella parksii</i> (Setchell et Gardner) Hughey, Silva et Hommersand [as <i>Iridaea cornucopiae</i> Postels et Ruprecht]	+	+	+				p. wb.
<i>Mazzaella</i> sp. [= <i>Iridophycus</i> sp.]	+						

Taxa	E		W		S	BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964 1991	
Familia Kallymeniaceae						
<i>Callophyllis rhynchocarpa</i> Ruprecht			+			p. wb.
<i>Callophyllis</i> sp.					+	
<i>Cirrulicarpus gmelinii</i> (Grunow) Tokida et Masaki	+					p. wb.
Familia Phylloporaceae						
<i>Mastocarpus pacificus</i> (Kjellman) Perestenko [= <i>Gigartina pacifica</i> Kjellman; <i>Gigartina ochotensis</i> (Ruprecht) Yendo]	+	+	+	+		p. wb.
<i>Schizymeria dubyi</i> (Chauvin ex Duby) J. Agardh [as <i>Schizymeria dubyi</i> var. <i>palmata</i> Yamada]	+					?n.-tr.-b.
Familia Tichocarpaceae						
<i>Tichocarpus crinitus</i> (S.G. Gmelin) Ruprecht	+	+	+	+		as. wb.
Ordo Gracilariales						
Familia Gracilariaceae						
<i>Gracilaria vermiculophylla</i> (Ohmi) Papenfuss [as <i>Gracilaria verrucosa</i> (Hudson) Papenfuss; <i>Gracilaria</i> <i>confervoides</i> (Linnaeus) Greville]	+		+		+	tr.-b.
Ordo Hapalidiales						
Familia Hapalidiaceae						
<i>Clathromorphum</i> sp.			+			
<i>Lithothamnion</i> spp.	+		+		+	
<i>Melobesia</i> spp.	+		+			
Ordo Hildenbrandiales						
Familia Hildenbrandiaceae						
<i>Hildenbrandia rubra</i> (Sommerfelt) Meneghini [as <i>Hildenbrandia prototypus</i> Nardo]	+					mz.
<i>Hildenbrandia</i> sp.	+					
Ordo Palmariales						
Familia Palmariaceae						
<i>Devaleraea</i> sp.			+			
<i>Halosaccion glandiforme</i> (S.G. Gmelin) Ruprecht	+		+			p. wb.
<i>Halosaccion hydrophorum</i> (Postels et Ruprecht) Kützing			+			p. wb.
<i>Palmaria marginicrassa</i> I.K. Lee			+			as. wb.
<i>Palmaria stenogona</i> Perestenko [as <i>Rhodymenia</i> <i>stenogona</i> Perestenko]	+		+	+		as. wb.
Ordo Rhodymeniales						
Familia Lomentariaceae						
<i>Lomentaria hakodatensis</i> Yendo			+	+		?n.-tr.-b.
Familia Rhodymeniaceae						
<i>Sparlingia pertusa</i> (Postels et Ruprecht) G.W. Saunders, I.M. Strachan et Kraft [= <i>Rhodymenia pertusa</i> (Postels et Ruprecht) J. Agardh]				+		b.-a.
Classis Stylonematophyceae						
Ordo Stylonematales						
Familia Stylonemataceae						
<i>Stylonema alsidii</i> (Zanardini) K.M. Drew [= <i>Goniotrichum</i> <i>elegans</i> (Chauvin) Zanardini]	+					n.-tr.-b.
Phylum Chlorophyta						
Classis Chlorophyceae						
Ordo Chlamydomonadales						
Familia Chlorochytriaceae						
<i>Chlorochytrium</i> sp.					+	
Classis Ulvophyceae						
Ordo Bryopsidales						
Familia Codiaceae						
<i>Codium ritteri</i> Setchell et N.L. Gardner [as <i>Codium</i> <i>dichotomum</i> S.F. Gray]	+					p. hb.
<i>Codium yezoense</i> (Tokida) K.L. Vinogradova	+		+			as. lb.

MACROBENTHOS IN THE INTERTIDAL ZONE OF KUNASHIR ISLAND

Taxa	E		W		S		BG
	1951-1964	1987-1991	1951-1964	1991	1951-1964	1991	
Ordo Cladophorales							
Familia Cladophoraceae							
<i>Chaetomorpha aerea</i> (Dyllwin) Kützing	+				+		n.-tr.-b.
<i>Chaetomorpha cannabina</i> (Areschoug) Kjellman	+		+		+		ab., st.-b.
<i>Chaetomorpha ligustica</i> (Kützing) Kützing			+				?mz.
<i>Chaetomorpha linum</i> (O.F. Müller) Kützing			+				n.-tr.-b.
<i>Chaetomorpha melagonium</i> (F. Weber et D. Mohr) Kützing	+	+					?mz.
<i>Chaetomorpha moniligera</i> Kjellman	+	+	+	+	+		as. lb.
<i>Chaetomorpha spiralis</i> Okamura [= <i>Chaetomorpha torta</i> (Farlow ex F.S. Collins) Yendo]	+				+		n.-tr.-st.
<i>Chaetomorpha</i> spp.	+	+	+	+	+		
<i>Cladophora opaca</i> Sakai			+	+			as. lb.
<i>Cladophora speciosa</i> Sakai			+				as. wb.
<i>Cladophora stimpsonii</i> Harvey	+	+					tr.-b.
<i>Cladophora</i> spp.	+		+		+		
Ordo Ulotrichales							
Familia Monostromataceae							
<i>Monostroma grevillei</i> (Thuret) Wittrock	+	+					?at.
Familia Ulotrichaceae							
<i>Acrosiphonia duriuscula</i> (Ruprecht) Yendo [= <i>Spongomorpha duriuscula</i> (Ruprecht) Collins; as <i>Acrosiphonia sonderi</i> (Kützing) Kornmann]	+		+				p. wb.
<i>Pseudothrix groenlandica</i> (J. Agardh) Hanic et S.C. Lindstrom			+				at.
<i>Ulothrix flacca</i> (Dillwyn) Thuret [= <i>Ulothrix pseudoflacca</i> Wille]			+				mz.
<i>Urospora penicilliformis</i> (Roth) Areschoug			+	+			?mz.
Ordo Ulvales							
Familia Kornmanniaceae							
<i>Blidingia minima</i> (Nägeli ex Kützing) Kylin [= <i>Enteromorpha minima</i> Nägeli ex Kützing]	+	+			+		mz.
<i>Kornmannia leptoderma</i> (Kjellman) Bliding [= <i>Monostroma zostericola</i> Tilden]	+						st.-b.-a.
Familia Ulvaceae							
<i>Ulva clathrata</i> (Roth) C. Agardh [= <i>Enteromorpha clathrata</i> (Roth) Greville]					+		mz.
<i>Ulva compressa</i> Linnaeus [= <i>Enteromorpha compressa</i> (Linnaeus) Nees]					+		mz.
<i>Ulva intestinalis</i> Linnaeus [= <i>Enteromorpha intestinalis</i> (Linnaeus) Nees]				+	+		mz.
<i>Ulva lactuca</i> Linnaeus [= <i>Ulva fenestrata</i> Postels et Ruprecht]	+	+	+	+	+		mz.
<i>Ulva linza</i> Linnaeus [= <i>Enteromorpha procera</i> K. Ahlner; <i>Enteromorpha linza</i> (Linnaeus) J. Agardh]		+	+		+		mz.
<i>Ulva prolifera</i> O.F. Müller [= <i>Enteromorpha prolifera</i> (O.F. Müller) J. Agardh]		+					mz.
<i>Ulva</i> spp. [= <i>Enteromorpha</i> sp.]			+		+		
Familia Ulvellaceae							
<i>Ulvella lens</i> P. Crouan et H. Crouan					+		mz.
Phylum Tracheophyta							
Classis Monocots							
Ordo Alismatales							
Familia Cymodaceaceae							
<i>Phyllospadix iwatensis</i> Makino [as <i>Phyllospadix scouleri</i> W.J. Hooker]	+	+	+	+			as. st.-lb.
Familia Zosteraceae							
<i>Zostera japonica</i> Ascherson et Graebner [as <i>Zostera nana</i>					+	+	tr.-b.

Taxa	E		W	S		BG
	1951–1964	1987–1991	1951–1964 1991	1951–1964	1991	
Roth]						
<i>Zostera marina</i> Linnaeus			+	+	+	ab., st.-b.
ANIMALS						
Regnum ANIMALIA						
Phylum Porifera						
Classis Calcarea						
Ordo Leucosolenida						
Familia Grantiidae						
<i>Grantia</i> sp.			+			
Familia Heteropiidae						
<i>Sycettusa nemurensis</i> (Hozawa, 1929) [= <i>Grantessa nemurensis</i> Hozawa, 1929]	+					as. wb.
Classis Demospongiae						
Ordo Halichondrida						
Familia Halichondriidae						
<i>Halichondria panicea</i> (Pallas, 1766)	+	+	+	+		st.-b.-a.
<i>Halichondria sitiens</i> (Schmidt, 1870)	+					b.-a.
Ordo Poecilosclerida						
Familia Esperlopsidae						
<i>Amphilectus lobata</i> (Bowerbank, 1866) [as <i>Mycale lobata</i> (Bowerbank, 1866)]	+					b.-a.
Familia Microcionidae						
<i>Clathria pennata</i> (Lambe, 1895) [= <i>Biemna pennata</i> Koltun, 1958]					+	ap.
<i>Ophlitaspongia pennata</i> (Lambe, 1894) [= <i>Tylodesma pennata</i> (Lambe, 1894)]			+			ap.
Familia Tedaniidae						
<i>Tedania fragilis</i> Lambe, 1894	+					p. wb.
Phylum Cnidaria						
Classis Hydrozoa						
Ordo Anthoathecata						
Familia Corynidae						
<i>Coryne pusilla</i> Gaertner, 1774	+					ab.
<i>Coryne</i> spp.	+	+				
Familia Eudendriidae						
<i>Eudendrium vaginatum</i> Allman, 1863 [= <i>Eudendrium annulatum</i> Norman, 1864]	+	+		+		ab.
Familia Tubulariidae						
<i>Ectopleura larynx</i> (Ellis et Solander, 1786) [= <i>Tubularia larynx</i> Ellis et Solander, 1786]	+	+				at.
<i>Tubularia</i> sp.	+					
Ordo Leptothecata						
Familia Campanulariidae						
<i>Campanularia volubilis</i> (Linnaeus, 1758)		+				st.-b.-a.
<i>Obelia longissima</i> (Pallas, 1766)		+				at.
<i>Orthopyxis integra</i> (McGillivray, 1842) [= <i>Campanularia integra</i> McGillivray, 1842]	+					b.-a.
<i>Orthopyxis platycarpa</i> Bale, 1914 [= <i>Campanularia platycarpa</i> (Bale, 1914)]	+		+			p. st.-b.
Familia Haleciidae						
<i>Halecium lucium</i> Antsulevich, 1980		+				as. lb.
Familia Plumulariidae						
<i>Plumularia filicaulis</i> Kirchenpauer, 1876		+				n.-tr.-lb.
Familia Sertulariidae						
<i>Abietinaria filicula</i> (Ellis et Solander, 1786)		+				ab.
<i>Abietinaria inconstans</i> (Clark, 1876) [= <i>Abietinaria costata</i> (Nutting, 1901)]	+					p. wb.
<i>Abietinaria spiralis</i> Naumov, 1960				+		as. lb.

MACROBENTHOS IN THE INTERTIDAL ZONE OF KUNASHIR ISLAND

Taxa	E		W		S		BG
	1951-1964	1987-1991	1951-1964	1991	1951-1964	1991	
<i>Abietinaria thuiarioides</i> (Clark, 1876)		+					b.-a.
<i>Sertularella mutsuensis</i> Stechow, 1931	+				+		as. wb.
<i>Sertularella spinosa</i> Kirchenpauer, 1884	+	+					as. wb.
<i>Sertularia robusta</i> (Clark, 1876)		+					ab.
<i>Sertularia similis</i> Clark, 1876		+					ab.
Classis Staurozoa							
Ordo Stauromedusae							
Familia Lucernariidae							
<i>Haliclystus borealis</i> Uchida, 1933	+		+				as. lb.
Classis Anthozoa							
Ordo Actiniaria							
Familia Actiniidae							
<i>Aulactinia</i> sp. [= <i>Bunodactis</i> sp.]	+						
<i>Cnidopus japonicus</i> (Verrill, 1871)	+	+	+	+			p. wb.
<i>Oulactis orientalis</i> (Averincev, 1967) [= <i>Anthopleura orientalis</i> Averincev, 1967; as <i>Anthopleura artemisia</i> (Pickering in Dana, 1846); <i>Anthopleura elegantissima</i> (Brandt, 1835); <i>Anthopleura xanthogrammica</i> (Brandt, 1835)]	+	+	+	+			as. wb.
<i>Urticina kurila</i> (Averincev, 1967) [= <i>Tealia coriacea kurila</i> Averincev, 1967]	+						as. lb.
Actiniidae gen. sp.				+			
Familia Condylanthidae							
<i>Charisea saxicola</i> Torrey, 1902	+	+		+			p. wb.
Familia Diadumenidae							
<i>Diadumene lineata</i> (Verrill, 1869) [= <i>Haliplanella luciae</i> (Verrill, 1898)]			+				p.-o.
Familia Metridiidae							
<i>Metridium senile</i> (Linnaeus, 1761)	+	+	+	+			p.-o.
Phylum Nemertea							
Classis Rhynchocoela							
Ordo Heteronemertea							
Familia Lineidae							
<i>Lineus torquatus</i> Coe, 1901	+						p. wb.
Ordo Tubulaniformes							
Familia Tubulanidae							
<i>Tubulanus punctatus</i> (Takakura, 1898)			+				as. st.-lb.
Phylum Annelida							
Classis Polychaeta							
Ordo Capitellida							
Familia Arenicolidae							
<i>Abarenicola claparedi oceanica</i> Healy et Wells, 1959 [as <i>Arenicola claparedi</i> Levinsen, 1884]	+				+		p. wb.
<i>Abarenicola pacifica</i> Healy et Wells, 1959					+	+	p. wb.
<i>Branchiomaldane vincenti</i> Langerhans, 1881	+						ab.
Familia Capitellidae							
<i>Capitella capitata</i> (Fabricius, 1780)	+	+	+	+	+		at.
<i>Heteromastus filiformis</i> (Claparède, 1864)	+						ab.
<i>Heteromastus filiformis laminariae</i> Zachs, 1923					+		as. lb.
<i>Mediomastus californiensis</i> Hartman, 1944	+		+		+		p. wb.
Familia Maldanidae							
<i>Nicomache</i> (<i>Nicomache</i>) <i>personata</i> Johnson, 1901	+				+		ab.
Maldanidae gen. sp.				+			
Ordo Cirratulida							
Familia Cirratulidae							
<i>Cirratulus branchiocolatus</i> Chlebovitsch, 1959					+		as. lb.
<i>Cirratulus cirratus</i> (O.F. Müller, 1776)	+		+		+		p.-o.
<i>Cirriformia tentaculata</i> (Montagu, 1808) [= <i>Audouinia</i>	+						ab., st.-b.

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
<i>tentaculata</i> (Montagu, 1808)]							
Cirratulidae gen. sp.				+			
Ordo Echiurida							
Familia Echiuridae							
<i>Echiurus echiurus echiurus</i> (Pallas, 1766)					+		at.
Ordo Eunicida							
Familia Dorvilleidae							
<i>Schistomeringos japonica</i> (Annenkova, 1937) [= <i>Staurocephalus japonica</i> Annenkova, 1937; <i>Dorvillea japonica</i> (Annenkova, 1937)]					+		ap.
Familia Lumbrineridae							
<i>Lumbrineris inflata</i> Moore, 1911 [= <i>Lumbrinereis cervicalis</i> Treadwell, 1922]	+				+		p. wb.
<i>Lumbrineris japonica</i> (Marenzeller, 1879) [= <i>Lumbrineris latreilli japonica</i> Marenzeller, 1879]	+	+	+	+	+		ab., st.-b.
Familia Oeononidae							
<i>Drilonereis filum</i> (Claparède, 1868)	+						ab., st.-b.
Familia Onuphidae							
<i>Nothria hyperborea</i> (Hansen, 1878) [= <i>Onuphis conchylega</i> (Sars, 1835)]					+		b.-a.
<i>Onuphis iridescens</i> (Johnson, 1901)	+						at.
Ordo Flabelligerida							
Familia Flabelligeridae							
<i>Pherusa plumosa</i> (O.F. Müller, 1776) [= <i>Stylarioides plumosa</i> (O.F. Müller, 1776)]	+		+				st.-b.-a.
Ordo Opheliida							
Familia Opheliidae							
<i>Armandia brevis</i> (Moore, 1906)					+		p. wb.
Familia Scalibregmatidae							
<i>Hyboscolex pacificus borealis</i> Imajima et Hartman, 1964 [as <i>Oncoscolex pacificus</i> (Moore, 1909)]	+		+				ap.
<i>Scalibregma</i> sp.			+				
Ordo Orbiniida							
Familia Orbiniidae							
<i>Naineris jacutica</i> Annenkova, 1931 [= <i>Naineris laevigata</i> (Grube, 1855)]	+	+	+	+	+	+	as. lb.
<i>Naineris quadricuspida</i> (Fabricius, 1780)	+		+		+		b.-a.
<i>Naineris</i> sp.	+						
<i>Orbiniella nuda</i> Hobson, 1974			+				p. wb.
<i>Protoariciella oligobranchia</i> Hobson, 1976			+				ap.
<i>Scoloplos armiger</i> (O.F. Müller, 1776)	+				+		p.-o.
Ordo Phyllococida							
Familia Glyceridae							
<i>Glycera macrobranchia</i> (Moore, 1911) [as <i>Glycera convoluta</i> Keferstejn, 1862]	+				+		ap.
Familia Goniadidae							
<i>Glycinde armigera</i> Moore, 1911	+			+	+	+	ab.
Familia Nephtyidae							
<i>Nephtys californiensis</i> Hartman, 1938	+				+		ap.
<i>Nephtys ciliata</i> (O.F. Müller, 1776)	+						b.-a.
<i>Nephtys longosetosa</i> Örsted, 1842–1843	+				+		b.-a.
Familia Nereididae							
<i>Alitta brandti</i> Malmgren, 1865 [as <i>Nereis virens</i> M. Sars, 1835]			+			+	ab.
<i>Hediste japonica</i> (Izuka, 1908) [= <i>Neanthes japonica</i> (Izuka, 1908); <i>Nereis japonica</i> Izuka, 1908]	+				+	+	as. st.-lb.
<i>Namanereis littoralis</i> (Müller in Grube, 1871) [as <i>Lycastopsis augeneri</i> Okuda, 1937]	+				+		as. st.-lb.

MACROBENTHOS IN THE INTERTIDAL ZONE OF KUNASHIR ISLAND

Taxa	E		W	S		BG
	1951-1964	1987-1991	1951-1964 1991	1951-1964	1991	
<i>Nereis pelagica</i> Linnaeus, 1758	+	+		+	+	b.-a.
<i>Nereis vexillosa</i> Grube, 1851	+	+	+	+	+	p. wb.
<i>Nereis zonata</i> Malmgren, 1867	+	+	+			st.-b.-a.
<i>Nereis zonata tigrina</i> Zachs, 1933	+					as. wb.
<i>Nereis</i> spp.		+	+		+	
<i>Platynereis bicanaliculata</i> (Baird, 1863) [= <i>Platynereis agassizi</i> (Ehlers, 1868)]				+		ap.
Familia Phyllodoceidae						
<i>Eteone flava</i> (Fabricius, 1780)	+		+			b.-a.
<i>Eteone longa</i> (Fabricius, 1780)	+	+	+	+		b.-a.
<i>Eulalia viridis</i> (Linnaeus, 1767)	+		+	+		ab., st.-b.
<i>Eumida sanguinea</i> (Ørsted, 1843) [= <i>Eulalia sanguinea</i> (Ørsted, 1843)]					+	ab., st.-b.
<i>Nereiphylla hera</i> Kato et Mawatari, 1999 [as <i>Phyllodoce castanea</i> (Marenzeller, 1879)]	+					as. lb.
<i>Phyllodoce maculata</i> (Linnaeus, 1767)	+		+	+		ab.
Familia Polynoidae						
<i>Halosydna brevisetosa</i> Kinberg, 1855 [as <i>Halosydna nebulosa</i> (Grube, 1866)]	+					ap.
<i>Harmothoe imbricata</i> (Linnaeus, 1767)	+	+	+	+	+	st.-b.-a.
<i>Lepidonotus squamatus</i> (Linnaeus, 1764)	+		+			ab.
Polynoidae gen. spp.		+	+			
Familia Syllidae						
<i>Autolytus beringianus</i> Annenkova, 1934	+					as. hb.
<i>Autolytus caterinkae</i> Uschakov, 1950	+					as. hb.
<i>Exogone gemmifera</i> Pagenstecher, 1862	+					st.-b.-a.
<i>Proceraea prismatica</i> (O.F. Müller, 1776) [= <i>Autolytus prismaticus</i> (O.F. Müller, 1776)]	+					b.-a.
<i>Syllis armillaris</i> (O.F. Müller, 1776) [= <i>Typosyllis armillaris</i> (O.F. Müller, 1776)]	+		+	+		p.-o.
<i>Syllis cornuta</i> Rathke, 1843 [= <i>Langerhansia cornuta</i> (Rathke, 1843)]			+			p.-o.
<i>Syllis fasciata</i> Malmgren, 1867 [= <i>Typosyllis fasciata</i> (Malmgren, 1867)]	+	+				b.-a.
<i>Syllis hyalina</i> Grube, 1863			+			ab., st.-lb.
<i>Syllis oerstedii</i> (Malmgren, 1867) [= <i>Typosyllis oerstedii</i> (Malmgren, 1867)]				+		b.-a.
<i>Syllis variegata</i> Grube, 1860 [= <i>Typosyllis variegata</i> (Grube, 1860)]	+		+	+		ab., st.-b.
<i>Typosyllis adamanteus</i> (Treadwell, 1914) [= <i>Typosyllis decorus</i> (Annenkova, 1934)]			+	+		as. st.-lb.
<i>Typosyllis</i> spp.	+	+	+	+		
Ordo Sabellida						
Familia Sabellidae						
<i>Chone teres</i> Bush, 1905	+	+	+			p. wb.
<i>Chone</i> spp.	+	+			+	
<i>Eudistylia suavis</i> (Grube, 1878) [= <i>Bispira polymorpha</i> Johnson, 1901]	+	+				ap.
<i>Paradialychone cincta</i> (Zachs, 1933) [= <i>Chone cincta</i> Zachs, 1933]	+					as. st.-lb.
<i>Paradialychone ecaudata</i> (Moore, 1923) [= <i>Chone ecaudata</i> (Moore, 1923)]			+			p. wb.
<i>Potamilla neglecta</i> (M. Sars, 1851)	+					at.
<i>Pseudopotamilla myriops</i> (Marenzeller, 1884) [= <i>Potamilla myriops</i> Marenzeller, 1884]	+	+				p. wb.
<i>Pseudopotamilla ocellata</i> Moore, 1905			+			p. wb.
Sabellidae gen. sp.			+			
Familia Serpulidae						

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
<i>Circeis spirillum</i> (Linnaeus, 1758) [= <i>Spirorbis spirillum</i> (Linnaeus, 1758); <i>Dexiospira spirilla</i> (Linnaeus, 1758)]	+		+		+		b.-a.
<i>Hydroides uncinata</i> (Philippi, 1844)	+						tr.-b.
<i>Laeospira granulata</i> (Linnaeus, 1767)			+				b.-a.
<i>Neodexiospira alveolata</i> (Zachs, 1933) [= <i>Dexiospira alveolata</i> (Zachs, 1933)]	+		+		+		as. lb.
<i>Paradexiospira vitrea</i> (Fabricius, 1780)			+				b.-a.
Serpulidae gen. spp.	+	+	+	+	+		
Ordo Spionida							
Familia Spionidae							
<i>Boccardia natrix</i> Söderström, 1920	+		+				at.
<i>Malacoceros</i> (<i>Rhynchospio</i>) <i>arenincolus asiaticus</i> Chlebovitsch, 1959 [= <i>Rhynchospio arenincola</i> Hartman, 1936]	+	+	+				as. wb.
<i>Microspio kussakini</i> Chlebovitsch, 1959					+		as. lb.
<i>Scolelepis squamata</i> (O.F. Müller, 1806) [= <i>Nerine cirratulus</i> (Delle Chiaje, 1831)]	+						ab., st.-lb.
<i>Scolelepis</i> spp. [= <i>Nerinides</i> sp.]	+	+					
<i>Spio filicornis</i> (O.F. Müller, 1776)	+	+					b.-a.
Spionidae gen. sp.			+				
Ordo Terebellida							
Familia Ampharetidae							
<i>Schistocomus sovjeticus</i> Annenkova, 1937	+						as. lb.
Familia Terebellidae							
<i>Eupolymnia robusta</i> (Annenkova, 1925) [as <i>Eupolymnia trigonostoma</i> (Schmarda, 1861); <i>Polymnia trigonostoma</i> (Schmarda, 1861)]	+				+		as. lb.
<i>Neoleprea californica</i> (Moore, 1904) [= <i>Terebella californica</i> (Moore, 1904)]	+						ap.
<i>Pista elongata</i> Moore, 1909	+				+		ap.
Phylum Sipuncula							
Classis Phascolosomatidea							
Ordo Phascolosomatiformes							
Familia Phascolosomatidae							
<i>Phascolosoma</i> (<i>Physcosoma</i>) <i>agassizii</i> Keferstein, 1866 [as <i>Phascolosoma japonicum</i> Grube, 1877]	+	+	+		+		tr.-b.
Phylum Arthropoda							
Classis Pycnogonida							
Ordo Pantopoda							
Familia Ammotheidae							
<i>Achelia alaskensis</i> (Cole, 1904)	+						p. wb.
<i>Achelia kurilensis</i> Losina-Losinsky, 1961	+		+				as. wb.
Familia Nymphonidae							
<i>Nymphon striatum</i> Losina-Losinsky, 1929	+						as. lb.
Classis Maxillopoda							
Ordo Sessilia							
Familia Archaeobalanidae							
<i>Semibalanus cariosus</i> (Pallas, 1788) [= <i>Balanus cariosus</i> (Pallas, 1788)]	+	+	+		+		p. wb.
Familia Chthamalidae							
<i>Chthamalus dalli</i> Pilsbry, 1916	+	+	+	+	+		p. wb.
Classis Malacostraca							
Ordo Amphipoda							
Familia Ampithoidae							
<i>Ampithoe kussakini</i> Gurjanova, 1955	+	+	+	+			p. wb.
<i>Ampithoe lacertosa</i> Bate, 1858 [= <i>Ampithoe japonica</i> Stebbing, 1888]					+	+	p. wb.

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Taxa	E		W		S		BG
	1951-1964	1987-1991	1951-1964	1991	1951-1964	1991	
<i>Ampithoe tarasovi</i> Bulycheva, 1952				+			as. lb.
<i>Ampithoe volki</i> Gurjanova, 1938				+			as. wb.
<i>Ampithoe</i> spp.		+	+	+	+	+	
Familia Anisogammaridae							
<i>Anisogammarus pugettensis</i> (Dana, 1853)	+		+		+		p. wb.
<i>Carineogammarus makarovi</i> (Bulycheva, 1952) [= <i>Anisogammarus makarovi</i> (Bulycheva, 1952)]	+		+		+		p. wb.
<i>Eogammarus kygi</i> (Derzhavin, 1923) [= <i>Anisogammarus kygi</i> (Derzhavin, 1923)]			+		+		as. wb.
<i>Eogammarus possjeticus</i> Tzvetkova, 1967 [= <i>Anisogammarus possjeticus</i> Tzvetkova, 1967]					+		as. lb.
<i>Locustogammarus locustoides</i> (Brandt, 1851) [= <i>Anisogammarus locustoides</i> (Brandt, 1851)]	+	+	+				p. wb.
<i>Spasskogammarus spasskii</i> (Bulycheva, 1952) [= <i>Anisogammarus spasskii</i> (Bulycheva, 1952)]	+	+	+	+			as. wb.
Familia Caprellidae							
<i>Caprella bispinosa</i> Mayer, 1890					+		as. st.-b.
<i>Caprella cristibrachium</i> Mayer, 1903	+	+	+	+			p. wb.
<i>Caprella danilevskii</i> Czerniavski, 1868	+		+				tr.-b.
<i>Caprella irregularis</i> Mayer, 1890					+		p. wb.
<i>Caprella laeviuscula</i> Mayer, 1903	+						p. wb.
<i>Caprella mutica</i> Schurin, 1935	+						as. lb.
<i>Caprella</i> spp.	+	+	+	+	+		
Familia Corophiidae							
<i>Corophium crassicorne</i> Bruzelius, 1859		+					ab.
<i>Corophium steinegeri</i> Gurjanova, 1951				+			as. wb.
<i>Corophium</i> spp.	+	+		+	+		
Familia Dexaminidae							
<i>Atylus ekmani</i> (Gurjanova, 1938)					+		as. wb.
<i>Guernea (Guernea) coalita</i> (Norman, 1868)						+	as. wb.
Familia Dogielinotidae							
<i>Dogielinotus moskvitini</i> (Derzhavin, 1930) [= <i>Allorchestes moskvitini</i> Derzhavin, 1930]	+		+		+	+	as. wb.
Familia Eusiridae							
<i>Pontogeneia andrijaschevi</i> Gurjanova, 1951						+	as. wb.
<i>Pontogeneia intermedia</i> Gurjanova, 1938		+					p. wb.
<i>Pontogeneia kondakovi</i> Gurjanova, 1951					+		as. wb.
<i>Pontogeneia makarovi</i> Gurjanova, 1951		+	+				as. wb.
<i>Pontogeneia</i> spp.		+	+	+			
Familia Hyalidae							
<i>Allorchestes malleolus</i> Stebbing, 1899	+	+	+	+	+		as. wb.
<i>Apohyale bassargini</i> (Derzhavin, 1937) [= <i>Hyale novaezealandiae</i> Bulycheva, 1957, non Thomson, 1879]	+	+	+				as. wb.
<i>Parallorchestes ochotensis</i> (Brandt, 1851)			+	+			p. wb.
<i>Parallorchestes zibellina</i> (Derzhavin, 1937) [= <i>Hyale zibellina</i> (Derzhavin, 1937)]	+		+				as. wb.
Familia Ischyroceridae							
<i>Ischyrocerus anguipes</i> Krøyer, 1838					+		b.-a.
<i>Ischyrocerus cristatus</i> Gurjanova, 1938		+	+				as. wb.

Taxa	E		W	S		BG
	1951–1964	1987–1991	1951–1964 1991	1951–1964	1991	
<i>Ischyrocerus</i> spp.		+	+			
<i>Jassa marmorata</i> Holmes, 1903		+				ab.
Familia Lysianassidae						
<i>Anonyx</i> sp.			+			
<i>Lepidepecreum</i> sp.					+	
<i>Orchomene</i> sp.			+			
<i>Orchomenella</i> spp.		+	+	+		
Lysianassidae gen. sp.					+	
Familia Melitidae						
<i>Melita dentata</i> (Krøyer, 1842)	+			+		b.-a.
<i>Melita</i> sp.					+	
Familia Photidae						
<i>Pareurystheus sexdentatus</i> (Stephensen, 1944) [= <i>Eurystheus sexdentata</i> Stephensen, 1944]					+	as. lb.
<i>Protomedeia</i> sp.					+	
Familia Pleustidae						
<i>Pleusymtes japonica</i> (Gurjanova, 1938)		+				as. lb.
<i>Pleusymtes</i> sp.					+	
Familia Stenothoidae						
<i>Metopa</i> sp.					+	
Stenothoidae gen. sp.					+	
Familia Talitridae						
<i>Paciforchestia pyatakovi</i> (Derzhavin, 1937) [= <i>Orchestia pyatakovi</i> Derzhavin, 1937]					+	as. lb.
<i>Platorchestia crassicornis</i> (Derzhavin, 1937) [= <i>Orchestia platensis</i> Bulycheva, 1957, non Krøyer, 1845; <i>Talorchestia crassicornis</i> Derzhavin, 1937]	+				+	as. lb.
<i>Platorchestia pachypus</i> (Derzhavin, 1937) [= <i>Talorchestia pachypus</i> Derzhavin, 1937]	+				+	as. st.-lb.
<i>Platorchestia zachsi</i> (Derzhavin, 1937) [= <i>Talorchestia zachsi</i> Derzhavin, 1937]	+		+	+	+	as. wb.
<i>Traskorchestia ochotensis</i> (Brandt, 1851) [= <i>Orchestia ochotensis</i> Brandt, 1851]	+				+	as. wb.
<i>Trinorchestia trinitatis</i> (Derzhavin, 1937) [= <i>Orchestoidea brito</i> Bulycheva, 1957, non Stebbing, 1891; <i>Orchestoidea trinitatis</i> Derzhavin, 1937]	+		+	+	+	ab.
Talitridae gen. sp.					+	
Ordo Cumacea						
Familia Diastylidae						
<i>Diastylis lazarevi</i> Lomakina, 1955		+				as. wb.
Ordo Decapoda						
Familia Cancridae						
<i>Cancer gibbosulus</i> (de Haan, 1835)		+				ap.
Familia Cheiragonidae						
<i>Erimacrus isenbeckii</i> (Brandt, 1848)			+			as. wb.
<i>Telmessus cheiragonus</i> (Tilesius, 1812)	+	+	+	+	+	p. wb.
Familia Crangonidae						
<i>Crangon propinquus</i> Stimpson, 1860 [= <i>Crangon septemspinosa</i> var. <i>propinqua</i> Stimpson, 1860]					+	as. wb.

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Taxa	E		W	S		BG
	1951-1964	1987-1991	1951-1964 1991	1951-1964	1991	
Familia Epiplatidae						
<i>Pugettia quadridens</i> (de Haan, 1839)	+		+	+		as. st.-lb.
Familia Hapalogastridae						
<i>Dermaturus mandtii</i> Brandt, 1850	+	+				p. wb.
Familia Hyppolytidae						
<i>Eualus leptognathus</i> (Stimpson, 1860) [= <i>Eualus japonica</i> (Yokoya, 1930)]					+	as. st.-lb.
<i>Spirontocaris ochotensis mororani</i> Rathbun, 1902					+	as. st.-lb.
Familia Lithodidae						
<i>Paralithodes brevipes</i> (A. Milne-Edwards et Lucas, 1841)	+	+				p. wb.
Familia Paguridae						
<i>Pagurus brachiomastus</i> (Thallwitz, 1891)	+	+	+	+	+	as. lb.
<i>Pagurus hirsutiusculus</i> (Dana, 1851)			+			p. wb.
<i>Pagurus middendorffii</i> Brandt, 1851	+	+	+	+	+	p. wb.
Familia Pandalidae						
<i>Pandalus latirostris</i> Rathbun, 1902	+		+		+	as. st.-b.
<i>Pandalus prensor</i> Stimpson, 1860 [= <i>Pandalus meridionalis</i> (Balss, 1914)]					+	as. st.-b.
Familia Pinnotheridae						
<i>Pinnaxodes mutuensis</i> Sakai, 1939 [as <i>Pinnaxodes major</i> Ortmann, 1894]	+					as. st.-lb.
Familia Porcellanidae						
<i>Pachycheles stevensii</i> Stimpson, 1858	+					as. st.-lb.
Familia Varunidae						
<i>Eriocheir japonica</i> (de Haan, 1835)	+		+		+	as. st.-lb.
<i>Hemigrapsus penicillatus</i> (de Haan, 1835) [= <i>Brachynotus penicillatus</i> (de Haan, 1835)]	+				+	as. st.-lb.
<i>Hemigrapsus sanguineus</i> (de Haan, 1835) [= <i>Brachynotus sanguineus</i> (de Haan, 1835)]	+				+	as. st.-lb.
Ordo Isopoda						
Familia Aegidae						
<i>Rocinela maculata</i> Schioedte et Meinert, 1879	+					as. lb.
Familia Cirolanidae						
<i>Excirrolana japonica</i> (Thielmann, 1910)	+				+	as. st.-lb.
Familia Detonidae						
<i>Detonella papillicornis</i> (Richardson, 1904) [as <i>Detonella sackchalina</i> Verhoeff, 1942]	+		+		+	p. wb.
Familia Idoteidae						
<i>Cleantiella isopus</i> (Miers, 1881) [= <i>Cleantis isopus</i> Miers, 1881]	+			+		as. st.-lb.
<i>Idotea gurjanovae</i> Kussakin, 1974	+			+		as. wb.
<i>Idotea ochotensis</i> Brandt, 1851	+	+	+	+	+	as. wb.
<i>Idotea orientalis</i> Gurjanova, 1933	+					as. wb.
<i>Synidotea lata</i> Gurjanova, 1933 [as <i>Synidotea bicuspidata</i> (Owen, 1839)]	+	+		+		as. wb.
Familia Janiridae						
<i>Ianiropsis derjugini</i> Gurjanova, 1933	+		+			p. wb.
<i>Ianiropsis kincaidi</i> Richardson, 1904	+		+			p. wb.
<i>Ianiropsis setifera</i> Gurjanova, 1950	+					as. wb.

Taxa	E		W		S		BG
	1951–1964	1987–1991	1951–1964	1991	1951–1964	1991	
Familia Ligiidae							
<i>Ligia cinerascens</i> Budde-Lund, 1885	+		+		+		as. st.-lb.
Familia Limnoriidae							
<i>Limnoria lignorum</i> (Rathke, 1799)	+		+				ab.
Familia Paranthuridae							
<i>Paranthura japonica</i> Richardson, 1909					+		as. st.-lb.
Familia Porcellionidae							
<i>Porcellio scaber</i> Latreille, 1804	+		+		+		p.-o.
Familia Sphaeromatidae							
<i>Cliamenella fraudatrix</i> (Kussakin, 1962) [= <i>Dynamenella glabra</i> non Richardson, 1899; <i>Dynamenella fraudatrix</i> Kussakin, 1962]	+	+	+	+	+		as. lb.
<i>Cymodoce japonica</i> Richardson, 1907 [as <i>Cymodoce acuta</i> Richardson, 1904]						+	tr.-lb.
<i>Dynoides dentisinus</i> Shen, 1929			+				as. st.-lb.
<i>Gnorimosphaeroma noblei</i> Menzies, 1954	+	+	+	+	+	+	p. wb.
<i>Gnorimosphaeroma ovatum</i> (Gurjanova, 1933) [as <i>Gnorimosphaeroma oregonense</i> (Dana, 1852)]	+		+		+		as. st.-lb.
<i>Holotelson tuberculatus</i> Richardson, 1909	+		+	+	+		as. st.-lb.
Familia Tecticipitidae							
<i>Tecticeps glaber</i> Gurjanova, 1933	+	+			+		as. lb.
Familia Tylidae							
<i>Tylos granuliferus</i> Budde-Lund, 1885 [= <i>Tylos granulatus</i> Miers, 1877]			+				as. st.-lb.
Ordo Leptostraca							
Familia Nebaliidae							
<i>Nebalia bipes</i> (Fabricius, 1780)					+		ab.
<i>Nebalia japonensis</i> (Claus, 1888)	+				+		as. lb.
Ordo Mysida							
Familia Mysidae							
<i>Archaeomysis grebnitzkii</i> Czerniavsky, 1882	+		+		+		p. wb.
Phylum Mollusca							
Classis Polyplacophora							
Ordo Chitonida							
Familia Acanthochitonidae							
<i>Cryptochiton stelleri</i> (Middendorff, 1847)	+						p. wb.
Familia Ischnochitonidae							
<i>Ischnochiton hakodadensis</i> Pilsbry, 1892	+			+			as. lb.
Familia Mopaliidae							
<i>Mopalia schrencki</i> Thiele, 1909	+			+			as. lb.
<i>Mopalia seta</i> Jakovleva, 1952	+	+		+			as. lb.
Familia Schizoplacidae							
<i>Schizoplax brandtii</i> (Middendorff, 1847)	+		+	+	+		p. wb.
Familia Tonicellidae							
<i>Boreochiton granulatus</i> (Jakovleva, 1952) [= <i>Tonicella granulata</i> Jakovleva, 1952]	+	+		+			as. wb.
<i>Tonicella submarmorea</i> (Middendorff, 1847)	+						p. wb.

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Taxa	E		W		S		BG
	1951-1964	1987-1991	1951-1964	1991	1951-1964	1991	
<i>Tonicella zotini</i> Jakovleva, 1952	+						as. lb.
Classis Gastropoda							
Clade Patellogastropoda							
Familia Lottiidae							
<i>Erginus (Problacmaea) sybariticus</i> (Dall, 1871) [= <i>Problacmaea sybaritica</i> (Dall, 1871)]	+						p. wb.
<i>Lottia ochracea</i> (Dall, 1871) [= <i>Collisella patina</i> (Eschscholtz, 1833)]			+	+			p. wb.
<i>Lottia pelta</i> (Rathke, 1833) [= <i>Collisella cassis</i> (Eschscholtz, 1833)]	+	+	+	+			p. wb.
<i>Lottia persona</i> (Rathke, 1833) [= <i>Collisella radiata</i> (Eschscholtz, 1833)]	+	+	+	+			p. wb.
<i>Nipponacmaea moskalevi</i> Chernyshev et Chernova, 2002 [= <i>Acmaea grano-striata</i> (Schrenck, 1867)]					+		as. lb.
<i>Niveotectura pallida</i> (Gould, 1859) [= <i>Acmaea pallida</i> (Gould, 1859)]	+	+					as. st.-lb.
<i>Notoacmea concinna</i> (Lischke, 1870)					+		as. st.-lb.
<i>Notoacmea schrenckii</i> (Lischke, 1868)					+		as. st.-lb.
Lottiidae gen. spp.	+	+			+		
Clade Vetigastropoda							
Familia Trochidae							
<i>Lirularia iridescens</i> (Schrenck, 1863) [= <i>Minolia</i> <i>iridescens</i> (Schrenck, 1863); <i>Isanda iridescens</i> (Schrenck, 1863)]					+	+	as. lb.
<i>Margarites helcinus</i> (Phipps, 1774)	+		+				b.-a.
<i>Margarites pilsbryi</i> Kuroda et Habe, 1952	+		+				as. lb.
Familia Turbinidae							
<i>Homalopoma sangarense</i> (Schrenck, 1867) [= <i>Turbo</i> <i>sangarenensis</i> Schrenck, 1867; <i>Leptothyra sangarenensis</i> Pilsbry, 1888]			+	+	+		as. lb.
Clade Caenogastropoda							
Familia Barleeidae							
<i>Ansola angustata</i> (Pilsbry, 1901) [= <i>Barleeia angustata</i> (Pilsbry, 1901)]		+			+		as. st.-lb.
Familia Batillariidae							
<i>Batillaria cumingii</i> (Crosse, 1862) [= <i>Potamides aterrima</i> (Dunker, 1882)]					+	+	as. st.-lb.
Familia Buccinidae							
<i>Buccinum baeri</i> (Middendorff, 1848)	+						p. hb.
<i>Buccinum middendorffi</i> Verkrüzen, 1882			+	+	+		as. lb.
<i>Buccinum mirandum mirandum</i> E.A. Smith, 1875	+	+					as. wb.
<i>Buccinum percrassum</i> Dall, 1883	+						as. wb.
<i>Buccinum</i> sp. [as <i>Buccinum tricarinatum</i> Dall, 1877]					+		
<i>Neptunea arthritica</i> (Valenciennes, 1858)	+		+		+	+	as. lb.
<i>Neptunea bulbacea</i> (Valenciennes, 1858)	+						as. lb.
<i>Volutharpa ampullacea</i> (Middendorff, 1848)					+		p. wb.
Familia Caecidae							
<i>Caecum derjugini</i> Golikov et Kussakin in Golikov et Scarlato, 1967 [= <i>Brochina derjugini</i> Golikov, 1967]			+	+			as. lb.
Familia Calyptraeidae							

Taxa	E		W	S		BG
	1951–1964	1987–1991	1951–1964 1991	1951–1964	1991	
<i>Crepidula derjugini</i> Golikov et Kussakin, 1962			+			as. lb.
<i>Crepidula grandis</i> Middendorff, 1849	+		+			p. wb.
<i>Crepidula</i> spp.	+		+		+	
Familia Cerithiopsidae						
<i>Cerithiopsis stejnegeri</i> Dall, 1884	+				+	p. wb.
Familia Columbellidae						
<i>Mitrella burchardi</i> (Dunker, 1877) [= <i>Columbella dunkeri</i> sensu Kussakin, 1956, non Tryon, 1883; <i>Pyrene varians</i> (Sowerby I, 1832)]	+	+	+	+	+	as. lb.
Familia Falsicingulidae						
<i>Falsicingula athera</i> Bartsch in Golikov et Scarlato, 1967			+	+	+	as. lb.
<i>Falsicingula kurilensis</i> (Pilsbry, 1905) [= <i>Cingula kurilensis</i> Pilsbry, 1905]	+	+	+	+	+	as. wb.
<i>Falsicingula mundana</i> (Yokoyama, 1926) [= <i>Falsicingula elegans</i> Golikov et Kussakin in Golikov et Scarlato, 1967]			+			as. lb.
Familia Littorinidae						
<i>Epheria decorata</i> (A. Adams, 1861)			+			as. lb.
<i>Epheria turrita</i> (A. Adams, 1861)	+		+	+	+	as. lb.
<i>Haloconcha minor</i> Dall, 1919 [= <i>Lacuna minor</i> (Dall, 1919)]	+	+		+		p. wb.
<i>Littorina brevicula</i> (Philippi, 1844)					+	as. st.-lb.
<i>Littorina mandshurica</i> Schrenk, 1867	+		+			as. lb.
<i>Littorina sitkana</i> Philippi, 1846 [= <i>Littorina kurila</i> Middendorff, 1848]	+	+	+	+	+	p. wb.
<i>Littorina squalida</i> Broderip et Sowerby I, 1829	+	+	+	+	+	p. wb.
<i>Stenotis uchidai</i> Habe, 1953 [= <i>Lacuna uchidai</i> (Habe, 1953)]	+		+			as. lb.
Familia Muricidae						
<i>Boreotrophon candelabrum</i> (Reeve, 1848) [as <i>Trophon clathratus</i> (Linnaeus, 1767)]	+		+		+	as. lb.
<i>Nucella elongata</i> Golikov et Kussakin, 1974 [as <i>Thais lamellosa</i> (Gmelin, 1791)]	+		+		+	as. lb.
<i>Nucella freycinetii</i> (Deshayes, 1839) [= <i>Purpura freycinetii</i> Deshayes, 1839]	+	+	+		+	p. wb.
<i>Nucella heyseana</i> (Dunker, 1882)	+	+	+	+		as. lb.
<i>Nucella lima</i> (Gmelin, 1791) [= <i>Thais lima</i> (Gmelin, 1791)]	+		+		+	p. wb.
<i>Ocenebra inornata</i> (Rècluz, 1851) [= <i>Tritonalia japonica</i> (Dunker, 1860); <i>Ocenebra japonica</i> Pilsbry, 1895]	+				+	as. st.-lb.
Familia Nassariidae						
<i>Nassarius fraterculus</i> (Dunker, 1860) [= <i>Tritia fratercula</i> (Dunker, 1860)]	+	+	+	+	+	as. st.-lb.
<i>Nassarius multigranosus</i> (Dunker, 1847) [= <i>Tritia acutidentata</i> (E.A. Smith, 1879); <i>Alectrion festiva</i> (Powis, 1835)]	+				+	as. st.-lb.
Familia Naticidae						
<i>Cryptonatica affinis</i> (Gmelin, 1791) [= <i>Cryptonatica clausa</i> (Broderip et Sowerby I, 1829); <i>Natica clausa</i> Broderip et Sowerby I, 1829]	+		+		+	b.-a.
<i>Cryptonatica hirasei</i> (Pilsbry, 1905) [= <i>Boreonatica hirasei</i> (Pilsbry, 1905)]	+		+	+	+	as. lb.
<i>Cryptonatica janthostoma</i> (Deshayes, 1839)	+					as. wb.
<i>Lunatia pila</i> (Pilsbry, 1911) [= <i>Euspira pila</i> (Pilsbry,	+					as. lb.

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Taxa	E		W	S		BG
	1951-1964	1987-1991	1951-1964 1991	1951-1964	1991	
1911)]						
Familia Pomatiopsidae						
<i>Cecina manchurica</i> A. Adams, 1861 [= <i>Truncatella tatarica</i> Schrenck, 1867]			+	+		as. wb.
Familia Ranellidae						
<i>Fusitriton oregonensis</i> (Redfield, 1846)	+					p. wb.
Familia Rissoidae						
<i>Alvania</i> sp.	+					
<i>Pusilina plicosa</i> (Smith, 1875) [= <i>Thapsiella plicosa</i> (Smith, 1875)]				+	+	as. lb.
Familia Velutinidae						
<i>Velutina coriacea</i> Pallas, 1788 [= <i>Velutina litoralis</i> Golikov et Kussakin, 1967]	+					as. wb.
<i>Velutina tarasovi</i> Derjugin, 1950 [= <i>Velutina fraudatrix</i> Golikov et Kussakin, 1962]	+					as. wb.
<i>Velutina</i> spp.	+	+				
Clade Heterobranchia						
Familia Cylichnidae						
<i>Decorifer matusimanus</i> (Nomura, 1939) [= <i>Acteocina insignis</i> (Pilsbry, 1904)]			+			as. st.-lb.
Familia Flabellinidae						
<i>Coryphella athadona</i> Bergh, 1875			+			p. wb.
Familia Pyramidellidae						
<i>Iolaea dubia</i> Golikov et Kussakin, 1967			+	+		as. lb.
<i>Pyrgolampros rufofasciata</i> (E.A. Smith, 1875)			+			as. lb.
Familia Rissoellidae						
<i>Jeffreysina violacea</i> Golikov et Kussakin, 1971	+					as. lb.
Familia Siphonariidae						
<i>Siphonacmea oblongata</i> (Yokoyama, 1926)				+		as. lb.
Classis Bivalvia						
Ordo Arcida						
Familia Glycymerididae						
<i>Glycymeris yessoensis</i> (Sowerby III, 1889) [as <i>Glycymeris albolineata</i> (Lischke, 1872)]	+	+	+	+		as. lb.
Ordo Myida						
Familia Myidae						
<i>Mya arenaria</i> Linnaeus, 1758			+	+		b.-a.
<i>Mya japonica</i> Jay, 1857				+		p. wb.
Familia Pholadidae						
<i>Penitella penita</i> (Conrad, 1837)	+					p. wb.
Familia Teredinidae						
<i>Teredo navalis</i> Linnaeus, 1758			+			ab., st.-lb.
Ordo Mytilida						
Familia Mytilidae						
<i>Adula schmidtii</i> (Schrenck, 1867)			+			as. lb.
<i>Modiolus kurilensis</i> Bernard, 1983 [= <i>Modiolus modiolus</i> (Linnaeus, 1758)]	+	+		+		as. st.-b.
<i>Musculista senhousia</i> (Benson in Cantor, 1842) [= <i>Brachidontes senhousia</i> (Benson in Cantor, 1842)]			+	+		?as. st.-lb.

Taxa	E		W	S		BG
	1951–1964	1987–1991	1951–1964 1991	1951–1964	1991	
<i>Musculus laevigatus</i> (Gray, 1824)			+		+	b.-a.
<i>Mytilus trossulus kussakini</i> Scarlato et Starobogatov, 1979 [as <i>Mytilus edulis</i> Linnaeus, 1758]			+		+	as. wb.
<i>Vilasina pillula</i> Bartsch in Scarlato, 1960			+		+	as. lb.
Ordo Ostreida						
Familia Ostreidae						
<i>Crassostrea gigas</i> (Thunberg, 1793)			+			as. st.-lb.
Ordo Pectinida						
Familia Pectinidae						
<i>Mizuhopecten yessoensis</i> (Jay, 1856)			+	+	+	as. lb.
Ordo Pholadomyida						
Familia Lyonsiidae						
<i>Entodesma navicula</i> (A. Adams et Reeve, 1850) [= <i>Entodesma naviculoides</i> Yokoyama, 1922]			+			as. lb.
<i>Entodesma</i> sp.			+			
<i>Lyonsia</i> sp.				+		
Ordo Venerida						
Familia Cardiidae						
<i>Clinocardium californiense</i> (Deshayes, 1839) [= <i>Keenocardium californiense</i> (Deshayes, 1839)]			+			p. wb.
Familia Lasaeidae						
<i>Mysella kurilensis litoralis</i> Scarlato et Ivanova, 1974				+	+	as. wb.
Familia Mactridae						
<i>Spisula sachalinensis</i> (Schrenck, 1861) [= <i>Mactra sachalinensis</i> Schrenck, 1861]			+			as. lb.
Familia Psammobiidae						
<i>Nuttallia ezonis</i> Kuroda et Habe in Habe, 1955					+	as. lb.
<i>Nuttallia obscurata</i> (Deshayes in Reeve, 1857) [= <i>Nuttallia olivacea</i> (Jay, 1857)]					+	as. st.-lb.
Familia Tellinidae						
<i>Cadella lubrica</i> (Gould, 1861) [= <i>Moerella salmonea</i> Carpenter, 1864]			+			as. st.-lb.
<i>Macoma incongrua</i> (Martens, 1865)					+	as. st.-lb.
<i>Megangulus luteus</i> (Wood, 1828) [= <i>Peronidia lutea</i> (Gray, 1828)]			+		+	p. wb.
<i>Megangulus venulosus</i> (Schrenck, 1861) [= <i>Tellina venulosa</i> Schrenck, 1861; <i>Peronidia venulosa</i> (Schrenck, 1861)]			+		+	as. lb.
Familia Veneridae						
<i>Protothaca euglypta</i> (Sowerby III, 1914) [as <i>Protothaca staminea</i> (Conrad, 1837)]			+	+	+	as. st.-lb.
<i>Ruditapes philippinarum</i> (A. Adams et Reeve, 1850) [= <i>Venerupis philippinarum</i> (A. Adams et Reeve, 1850); <i>Venerupis japonica</i> (Deshayes, 1853)]			+		+	as. st.-lb.
<i>Turtonia minuta</i> (Fabricius, 1780)			+	+	+	ab.
Incerti ordinis						
Familia Hiatellidae						
<i>Hiatella arctica</i> (Linnaeus, 1767) [= <i>Saxicava arctica</i> (Linnaeus, 1767)]			+	+	+	b.-a.
<i>Panomya</i> sp.			+			

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Taxa	E		W	S		BG
	1951-1964	1987-1991	1951-1964 1991	1951-1964	1991	
<i>Panopea japonica</i> A. Adams, 1850			+			as. lb.
Familia Pharidae						
<i>Siliqua alta</i> (Broderip et Sowerby I, 1829) [as <i>Siliqua pulchella</i> (Dunker, 1852)]	+			+		p. wb.
Phylum Bryozoa						
Classis Gymnolaemata						
Ordo Cheilostomata						
Familia Bugulidae						
<i>Bugula pacifica</i> Robertson, 1905			+			p. wb.
<i>Dendrobeania flustroides</i> (Levinsen, 1887)			+			b.-a.
Familia Calloporidae						
<i>Cauloramphus echinus</i> (Hincks, 1882)	+					p. wb.
<i>Cauloramphus spiniferum</i> (Johnston, 1832)	+			+		ab.
Familia Candidae						
<i>Tricellaria ternata</i> (Ellis et Solander, 1786)	+					b.-a.
Familia Celleporidae						
<i>Celleporina nordenskjoldi</i> (Kluge, 1929) [= <i>Cellepora nordenskjoldi</i> Kluge, 1929]	+	+		+		b.-a.
Familia Cryptosulidae						
<i>Cryptosula zavjalovenssis</i> Kubanin, 1976 [= <i>Lepralia pallasiana</i> (Moll, 1803)]	+	+				p. wb.
Familia Hippothoidae						
<i>Celleporella hyalina</i> (Linnaeus, 1767) [= <i>Hippothoa hyalina</i> (Linnaeus, 1767)]	+	+	+	+		b.-a.
Familia Microporellidae						
<i>Fenestulina malusii</i> (Audouin, 1826) [= <i>Microporella malusii</i> (Audouin, 1826)]				+		p.-o.
Familia Smittinidae						
<i>Smittina minuscula</i> (Smitt, 1868)	+					b.-a.
Ordo Ctenostomata						
Familia Alcyonidiidae						
<i>Alcyonidium mamillatum</i> Alder, 1857				+		b.-a.
<i>Alcyonidium mytili</i> Dalyell, 1847	+					b.-a.
Familia Flustrellidridae						
<i>Flustrellidra cervicornis</i> (Robertson, 1900)	+					p. hb.
<i>Flustrellidra corniculata</i> (Smitt, 1872) [= <i>Flustrella corniculata</i> (Smitt, 1872)]	+	+				b.-a.
Familia Vesiculariidae						
<i>Bowerbankia composita</i> Kluge, 1955			+			b.-a.
<i>Bowerbankia</i> sp.					+	
Classis Stenolaemata						
Ordo Cyclostomata						
Familia Lichenoporidae						
<i>Lichenopora</i> sp.			+			
Familia Tubuliporidae						
<i>Tubulipora</i> sp.					+	
Phylum Echinodermata						
Classis Asteroidea						

Taxa	E		W	S		BG
	1951–1964	1987–1991	1951–1964 1991	1951–1964	1991	
Ordo Forcipulatida						
Familia Asteriidae						
<i>Aphelasterias japonica</i> (Bell, 1881)			+			as. lb.
<i>Asterias amurensis</i> Lütken, 1871	+		+	+		?at.
<i>Distolasterias elegans</i> Djakonov, 1931			+	+		as. lb.
<i>Evasterias retifera</i> Djakonov, 1938			+	+		p. wb.
<i>Leptasterias (Eoleptasterias) kussakini</i> Baranova, 1962			+			?as. lb.
<i>Leptasterias (Eoleptasterias) similispinis</i> (H.L. Clark, 1908)	+					as. lb.
<i>Lethasterias fusca</i> Djakonov, 1931			+	+		as. lb.
<i>Lethasterias nanimensis chelifera</i> (Verrill, 1914)			+			p. wb.
Asteriidae gen. sp.		+				
Familia Pycnopodiidae						
<i>Lysastrosoma anthosticta</i> Fischer, 1922			+			as. lb.
Ordo Spinulosida						
Familia Echinasteridae						
<i>Henricia tumida</i> Verrill, 1914			+			p. wb.
<i>Henricia</i> sp.					+	
Ordo Valvatida						
Familia Asterinidae						
<i>Asterina pectinifera</i> (Müller et Troschel, 1842) [= <i>Patiria pectinifera</i> (Müller et Troschel, 1842)]					+	as. st.-lb.
Classis Ophiuroidea						
Ordo Ophiurida						
Familia Ophiactidae						
<i>Ophiopholis aculeata</i> (Linnaeus, 1767)	+		+			ab.
Classis Echinoidea						
Ordo Camarodonta						
Familia Strongylocentrotidae						
<i>Strongylocentrotus intermedius</i> (A. Agassiz, 1863)	+	+	+	+		as. wb.
Classis Holothuroidea						
Ordo Aspidochirotida						
Familia Stichopodidae						
<i>Apostichopus japonicus</i> (Selenka, 1867)					+	as. st.-lb.
Ordo Dendrochirotida						
Familia Sclerodactylidae						
<i>Eupentacta fraudatrix</i> (Djakonov et Baranova in Djakonov et al., 1958) [= <i>Cucumaria fraudatrix</i> Djakonov et Baranova in Djakonov et al., 1958]	+		+			as. wb.
<i>Eupentacta</i> sp. [as <i>Cucumaria chronhjelmi</i> Théel, 1886]	+					
Ordo Synaptida						
Familia Synaptidae						
Synaptidae gen. sp.					+	
Phylum Chordata						
Classis Ascidiacea						
Ordo Aplousobranchia						

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Taxa	E		W		S		BG
	1951-1964	1987-1991	1951-1964	1991	1951-1964	1991	
Familia Holozoidae							
<i>Distaplia</i> spp.	+		+		+		
Ordo Stolidobranchia							
Familia Styelidae							
<i>Botryllus schlosseri</i> (Pallas, 1766)			+				p.-o.
Classis Actinopterygii							
Ordo Perciformes							
Familia Gobiidae							
Gobiidae gen. sp.					+		
Familia Pholididae							
<i>Pholis nebulosus</i> (Temminck et Schlegel, 1845)	+						as. lb.
<i>Pholis pictus</i> (Kner, 1868)	+						as. wb.
<i>Rhodymenichthys dolichogaster</i> (Pallas, 1814) [= <i>Pholis dolichogaster dolichogaster</i> (Pallas, 1814)]	+						p. wb.
Familia Stichaeidae							
<i>Alectrias alectrolophus</i> (Pallas, 1814)	+	+		+			p. wb.
<i>Opisthocentrus ocellatus</i> (Tilesius, 1811)						+	as. wb.
<i>Pholidapus dybowskii</i> (Steindachner, 1880) [= <i>Opisthocentrus dybowskii</i> (Steindachner, 1880)]	+						as. wb.
<i>Stichaeopsis nana</i> Kner et Steindachner, 1870	+						as. lb.
Stichaeidae gen. sp.						+	
Familia Zoarcidae							
<i>Zoarces elongatus</i> Kner, 1868 [= <i>Zoarces viviparus elongatus</i> Schmidt, 1950]	+						as. wb.
Ordo Pleuronectiformes							
Familia Pleuronectidae							
Pleuronectidae gen. spp.			+		+		
Ordo Scorpaeniformes							
Familia Cottidae							
<i>Myoxocephalus stelleri</i> Tilesius, 1811	+		+		+		as. wb.
<i>Porocottus allisi</i> (Jordan et Starks, 1904)			+				as. lb.
Cottidae gen. spp.	+		+		+		
Familia Hemitripterae							
<i>Blepsias cirrhosus</i> (Pallas, 1814)	+						p. wb.
Familia Hexagrammidae							
<i>Hexagrammos octogrammus</i> (Pallas, 1810)	+						p. wb.
Familia Scorpaenidae							
<i>Sebastes schlegeli</i> Hilgendorf, 1880	+						as. lb.