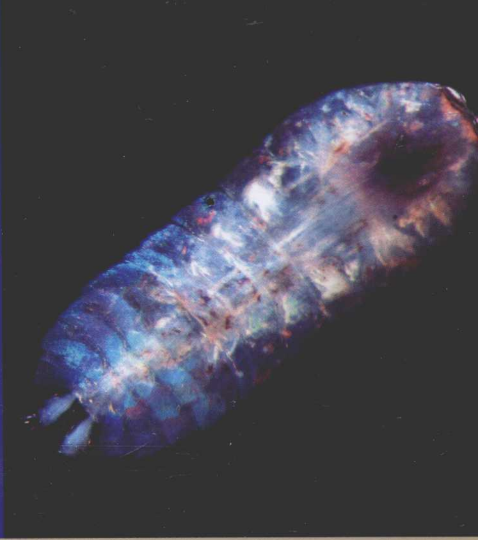
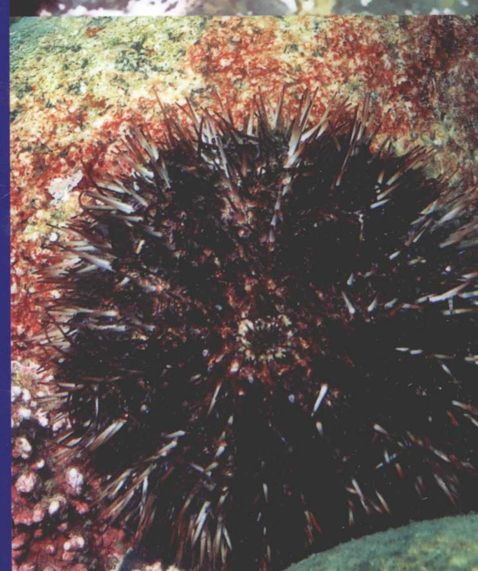


Marine Biodiversity and Ecosystem Dynamics of the Northwest Pacific Ocean



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PREFACE

It is widely recognized that marine biodiversity and ecosystem dynamics are important determinants of ecosystem functioning. The Northwest Pacific region is characterized by a high diversity of marine and coastal species, from boreal to subtropical. At the same time, it is undergoing modifications due to increasing climate change and human impact. There are still not enough synthesis studies to understand the status and changes in biodiversity and ecosystem dynamics in this area. In order to achieve the better protection and reasonable exploitation of marine biodiversity for the sustainable development of the Northwest Pacific ecosystem, it is an urgent need to improve our understanding on marine biodiversity and ecosystem status by international collaboration in this area.

This book is prepared jointly by the Institute of Oceanology, Chinese Academy of Sciences (IOCAS, Qingdao) and A.V. Zhirmunsky Institute of Marine Biology, Far Eastern Branch of the Russian Academy of Sciences (IMB FEB RAS, Vladivostok) as an outcome of collaboration in the field of marine ecology and biodiversity studies. Both institutes play an important role in the study of marine biodiversity and ecosystem dynamics in the Northwest Pacific Ocean. The collaboration between the two institutes is more and more important to reveal the changes on marine biodiversity and resources under the pressure of the global change in the Northwest Pacific Ocean.

Previously, the IOCAS and the IMB FEB RAS has held three workshops on marine ecosystems and biodiversity: two in Qingdao, in 2007 and 2010, and one in Vladivostok, in 2012, which were highly successful in terms of exchange by ideas and research findings and discussions between marine biologists of our countries studying the same ocean. Both organizations play an important role in marine ecology and biodiversity research in the Northwest Pacific.

This book is a collective effort of scientists from both institutions and it covers various topics of ecosystem research, biodiversity, biogeography, environmental safety of the East China, Yellow and Japan seas, focusing on the common problems in both countries. In this book, we have tried to cover a wide range of biological oceanographic issues and invited leading scientists to present comprehensive review papers. We hope that this book would be useful not only by national researchers, but is of broad interest for neighboring countries and worldwide. We also hope that this book would provide scientific support for the development and management of the Northwest Pacific coastal ecosystems.

This book was supported by the Key Program of National Natural Science Foundation of China (No. 41230963), the "Strategic Priority Research Program" of the Chinese Academy of Sciences (No. XDA11020305), the National Basic Research Program of China (No. 2011CB403600) and the External Cooperation Program from Chinese Academy of Sciences "Comparison on marine biodiversity in the Northwest Pacific Ocean (GJHZ200808). Russian researches were supported by grants from the FEB RAS nos. 12-I-P4-02, 12-I-P28-02, and 12-I-P30-70.

Editors

June 2013

CONTENTS

Chapter 1

Biodiversity in the Sea of Japan: more than a century of Russian research

Andrey V. Adrianov, Konstantin A. Lutaenko

Abstract: An overview of the Russian national researches on biodiversity of the Sea of Japan is presented along with a brief history. Russian studies of the biota of the sea started in the second half of the 19th century and were carried out by many institutions with major contributions from the Pacific Fisheries Research Center (TINRO), Zoological Institute RAS, P.P. Shirshov Institute of Oceanology RAS, A.V. Zhirmunsky Institute of Marine Biology FEB RAS and Far Eastern Federal University. Modern achievments include biotic inventories, through publications of taxonomic catalogues and atlases on the entire biota of Peter the Great Bay, intertidal biota, various groups (nemerteans, ostracods, amphipods, gastropods, bivalves, fish, algae, phytoplankton), serial *Biota of the Russian Waters of the Sea of Japan* (9 volumes up to date) and deep-sea research of the biodiversity in the northern Sea of Japan. New video monitoring methods are shown to be useful in mapping and understanding of the biodiversity in the protected areas and in deep-sea.

Key words: biodiversity, Sea of Japan, taxonomic inventories, deep-sea research.

1.1 Introduction

The term "biodiversity" (hereafter, BD) was first introduced in 1986 (Wilson, 1997) and originally referred to the number of species. At present it is believed that BD covers all heredity-based variations at all levels of living matter from genetic diversity within a local population to the diversity within a local community to the diversity of communities and global ecosystems on the Earth (Adrianov, 2004a). The number of species (species richness) remains the major characteristic of BD. About 1.7–1.8 million species were inventoried up to date and from 10–100 million in total are remaining to be discovered (Lovejoy, 1997; Bouchet, 2006). Although only 274,000 marine species have been described up to date, it is expected that merely the diversity of bottom-dwelling marine invertebrates (zoobenthos) can be at the level of 25 to 30 million species (Adrianov, 2004a). Coastal ecosystems and marine biodiversity are affected by human activities that degrade these ecosystems at an increasing rate and this is a part of global change. Millions of people depend upon marine ecosystems/BD for their livelihood that provide a wide range of vital goods and services: food products, building materials, natural protection to shorelines, nurseries for other species and resources for tourism and recreation (Harvey et al., 2004). However, our understanding of the marine BD and its changes due to human impact is insufficient and incomplete.

The Sea of Japan is the southernmost and deepest among Russian Far Eastern seas, and its coastline is most populated and economically developed. Biodiversity of the sea seems to be the richest among other Russian marine areas, and studies of this area started more than 150 years ago. Here, we highlight the most important milestones in Russian research on biodiversity and marine biology in the Sea of Japan. Detailed history of the biota studies in the Far Eastern seas is described in a number of publications (Brodsky, 1993; Stepanjants, 1993; Chavtur, 1999; Kussakin, Chavtur, 2000a; b; Chavtur, Stovbun, 2007).

Owing to the shallowness of the straits connecting the Sea of Japan with the Pacific Ocean, the sea has a special position among the Far Eastern seas of Russia (Zenkevich, 1963). Sea of Japan is a relatively young marginal basin with a deep area (depths more than 3500 m) isolated by straits (depths less than 150 m) since the Cenozoic period (Kobayashi, 1985). In the Pleistocene time, the sea was completely isolated from the ocean. In the most recent time, between 85,000 and 27,000 years ago, the warm Tsushima Current did not flow into the Sea of Japan, so cold surface water conditions prevailed; environmental situation at the seafloor fluctuated between dysaerobic to weakly oxic conditions (Oba et al., 1991). Between 27,000 and 20,000 years ago, freshwater input to the Sea of Japan stratified the water column, and the severe anoxic conditions eliminated the most benthic fauna, while between 20,000 and 10,000 years ago the cold Oyashio Current flowed into the Japan Sea through the Tsugaru Strait, reestablishing deepwater ventilation. About 10,000 years ago, the warm Tsushima Current started to flow into the Sea of Japan through the Tsushima Strait to establish the modern oceanographic regime, which has been existing since around 8,000 years ago (Oba et al., 1991).

The Sea of Japan is directly connected with the Sea of Okhotsk through the Tatarsky (Mamiya) Strait, with the East China Sea through the Tsushima and Korea Straits (between Korea and Kyushu Island); Tsugaru (between Honshu and Hokkaido) and La Perouse (or Soya; between Sakhalin and Hokkaido) Straits connect the sea with the Pacific Ocean. The sea is rather isolated, as all these straits are shallow: the maximum depth of Korea Strait is 150 m,

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Tsugaru Strait, 200 m; Nevelskogoko Strait (northernmost Tatarsky Strait) has a sill depth of 5 m, La Perouse Strait, 53 m. The Sea of Japan is unique among the enclosed seas of the northwestern Pacific in having strong ocean currents in the form of powerful streams (Nishimura, 1983; Yurasov, Yarichin, 1991). The sea is divided by the frontal zone into two distinct areas: the southeastern warm-water area washed by the Tsushima Current with three branches, and the northwestern area dominated by the cold Liman(ian), Primorskoye and North Korean Currents. The Tsushima Current enters the sea particularly through the Korea Strait and flows northeastward in three meanders including the East Korean Current. The Tsushima Current flows out into the Pacific Ocean, mostly through the Tsugaru Strait and partly through the La Perouse (Soya) Strait into the Sea of Okhotsk but its northernmost part reaches middle Sakhalin Island in Tatarsky Strait. The northern cold area of the Sea of Japan is washed by three cold currents collectively known in Japanese literature as the Liman Current, but the latter by itself is a current washing continental coast of the northern Sea of Japan – between Tatarsky Strait and mid-Primorye. It is believed that the cold currents, whose volume, transport and speed are notably limited as compared to those of the Tsushima Current, are counter-or compensation currents of the latter (Nishimura, 1983).

The main peculiarity of the underwater relief of the Sea of Japan is the steepness of the continental slope reaching 20–25° and somewhere, in the southern Primorye coasline, about 45°; thus, at a distance of several miles the depth increases to 1,000 m and more. Such an angle of steep slopes prevents sedimentation and favors a direct and rapid transportation of organic-rich deposits from neighboring coastal areas to the deep areas of the basin.

1.2 A brief history of the Russian biodiversity research

Russian contribution to the study of the biodiversity of the Sea of Japan is well-known and constitute a significant portion of our knowledge on the fauna and flora of the area. The first expeditions to collect animals and plants were sent in the second half of the 19th century: in 1853–1857, Leopold von Schrenck (Figure 1) traveled to the Sea of Okhotsk and the Sea of Japan and brought back to St.-Petersburg Zoological Museum large zoological collections; later, von Schrenck became academician of the Russian Imperial Academy of Sciences and published a voluminous work on mollusks (Schrenck, 1867). Among other collectors who worked in the Sea of Japan, we should mention V.K. Brazhnikov (Tatarsky, or Mamiya Strait, 1899–1902), P.Yu. Shmidt (Sea of Okhotsk and Sea of Japan, including Korean coast, 1900–1901), A.F. Derbek (1908–1910, 1912), N.G. Shiryaev (1913), R.G. Meder (1914) and some others. All zoological samples obtained were sent to the Zoological Museum of the Imperial Academy and are still available for study.

In the Soviet period, the important landmark in BD research in the Sea of Japan was establishment of the Pacific Ocean Scientific Fishery Research Station (Russian abbreviation TONS; later on the research station became the Pacific Research Institute of Fisheries and Oceanography, TINRO) in Vladivostok headed by famous hydrobiologist K.M. Derjugin (see about him: Ushakov, Kussakin, 1978) (Figure 2). The station staff started to explore the coastal zone of Peter the Great Bay and Primorye, made many collections and described for the first time bottom and plankton communities (Derjugin, 1928, 1939). In the 1930s, the State Hydrological Institute organized a series of expeditions into the Sea of Japan and neighboring seas and conducted for the first time deep-water sampling under the leadership of N.I. Tarasov and K.M. Derjugin (Derjugin, 1934). In 1934, the Zoological Institute of the USSR Academy of Sciences sent an expedition to the Sea of Japan to work north of Cape Povorotny; a volume published contributed much to understanding of fauna of polychaetes, isopods, amphipods, hermit crabs, echinoderms, fishes, and algae (Lindberg, 1938). Before World War II, Zoological Institute also published several volumes in the series "Fauna of the USSR" dealing with marine invertebrates of the Far Eastern seas. S.D. Stepanjants (1993) and V.G. Chavtur (1999) described in detail numerous marine biological researches and surveys of the Imperial, and then USSR Academy of Sciences in the Pacific Ocean.

After World War II, Institute of Oceanology of the USSR Academy of Sciences started to study the intertidal and partly subtidal zone of the Sea of Japan – from De-Kastri (Chikhacheva) Bay in the north to Possjet Bay in the south; special attention was paid to flora and fauna of Putyatin Island in Peter the Great Bay (Stschapova et al., 1957; Mokyevsky, 1960). Later on the Institute of Oceanology carried out mostly deep-sea research in the Far Eastern seas, including the Sea of Japan (Levenstein, Pasternak, 1976; Kussakin, Chavtur, 2000b; see more about deep-sea research: Malyutina, Brandt (2013)). In the 1960s–1980s, most important zoological and hydrobiological studies

Figure 1 Academician Leopold von Schrenck (1826–1894).

Figure 2 Professor Konstantin M. Derjugin (1878–1938).

were conducted in Possjet Bay (southernmost part of the Russian Far East) (Baranova, 1967, 1971), in Vostok Bay (Kasyanov, 1976), in Chikhacheva (De-Kastri) Bay (northern Sea of Japan) (Sirenko et al., 1988), along the coast of Primorye (Kussakin, 1980; Kafanov, 1984; Fadeev, 1991; see for review: Shuntov, 2001) and around Moneron Island (Kussakin, 1985). Many invertebrate groups and plants were studied for the first time, and bottom and plankton communities of the coastal zones of the Sea of Japan have been described in detail. In the 1963–1967, G.N. Volova (1972) studied the ecology and distribution of benthic organisms in brackish-water lakes and lagoons in Primorye. In 1970, the TINRO carried out large-scale benthic sampling aboard the R/V *Tamango*, the most comprehensive research since Derjugin's surveys (Klimova, 1971). This institution continues the BD and ecosystem researches with great contribution to the study of fish, parasites of marine animals, mollusks, etc. (Shuntov, 2001). In 1973–1975, Far Eastern University undertook intertidal and subtidal investigations in Amursky Bay using both bottom samplers and SCUBA-diving (Volova, 1985). As a part of ecological monitoring in Peter the Great Bay, the Far Eastern Research Hydrometeorological Institute carried out limited BD/ecological researches of bottom communities in the 1980s–1990s (Belan, 2003, and others).

O.G. Kussakin and V.G. Chavtur (2000) presented the history of hybrobiological and BD research by central Russian institutes after World War II with a detailed list of major books published; they listed 13 volumes in the series "Investigations of the Fauna of the Seas" (Zoological Institute), 13 volumes in "Fauna of the USSR" (same inst.), 34 volumes in "Guide-Books on the Fauna of the USSR Published by the Zoological Institute of the USSR Academy of Sciences", and 44 collections of papers and books published by the Zoological, Botanical, Oceanology and other institutes. A majority of these books contained data on the BD of the Sea of Japan. Additional information on the BD research in the Sea of Japan can be found in the book by L. Zenkevitch (1963).

With the organization of the Department (1967), and then Institute of Marine Biology, Far Eastern Branch of the Russian Academy of Sciences in Vladivostok (hereafter, IMB) in 1970, a new stage of the BD research in the Russian waters of the Sea of Japan began. Below, we briefly describe the **recent and ongoing** projects and activities of the IMB and some other institutions on the study of BD in the Sea of Japan.

1.3 Inventory of the biota

The IMB has conducted many BD projects in the Sea of Japan since 1967. One of the outstanding activities was a detailed study in the intertidal zone of all Russian Far Eastern seas led by Prof. O.G. Kussakin (Figure 3). In the Sea of Japan, 27 special intertidal expeditions were carried out in the 1970s–1990s along the continental coast and in Sakhalin Island (Figure 4). As a result, the biota composition, distribution patterns, and biomasses and multi-year changes of the intertidal zone were described. The full list of the intertidal biota of all Russian Far Eastern seas contains 2772 species of animals, plants and fungi (Kussakin et al., 1997).

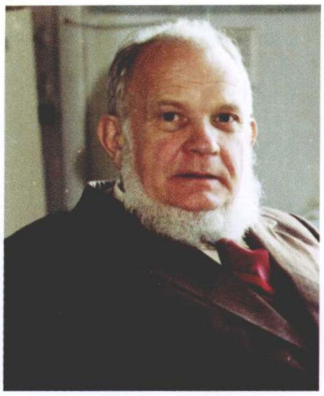

Figure 3 Academician Oleg G. Kussakin (1930–2001).

Russian waters of the Sea of Japan are most rich in terms of species number. Because of a unique combination of warm and cold currents, climate conditions, and a variety of bottom and coastal landscapes and, thus richnes of the biota, there was a great need to compile a check-list of all known marine organisms living in the area. Rich biodiversity of the southernmost part of the Russian Far East, Peter the Great Bay, was recognized in the 1970s with publication of the important guide-book *Animals and Plants of Peter the*

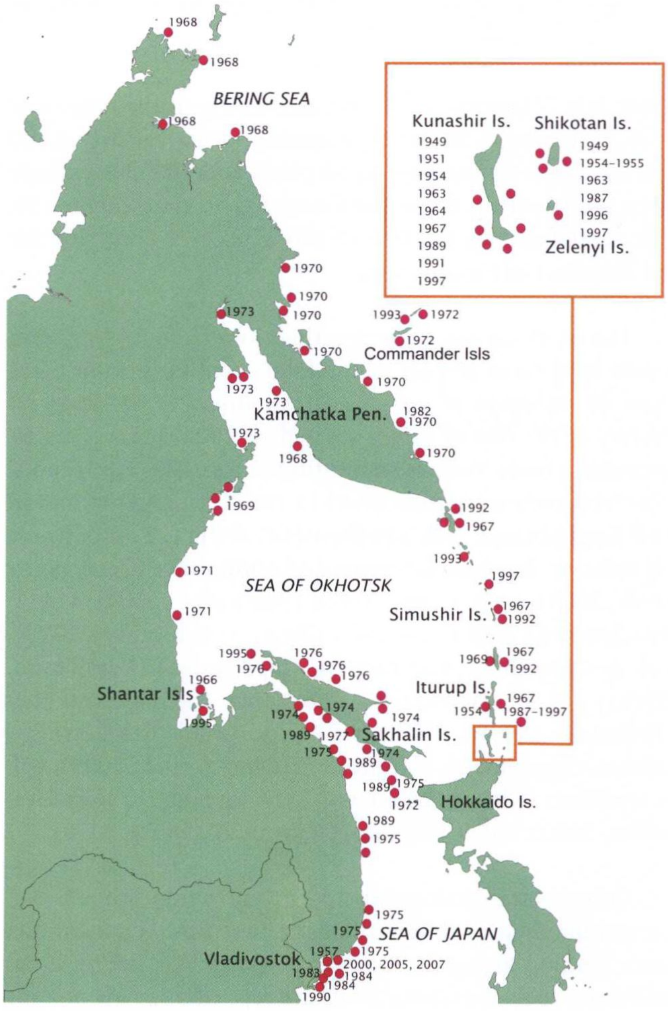

Figure 4 Map of intertidal expeditions carried out by the A.V. Zhirmunsky Institute of Marine Biology FEB RAS and the Far Eastern Federal University in the Sea of Japan and adjacent areas (modified after: Ivanova, Tsurpalo, 2012).

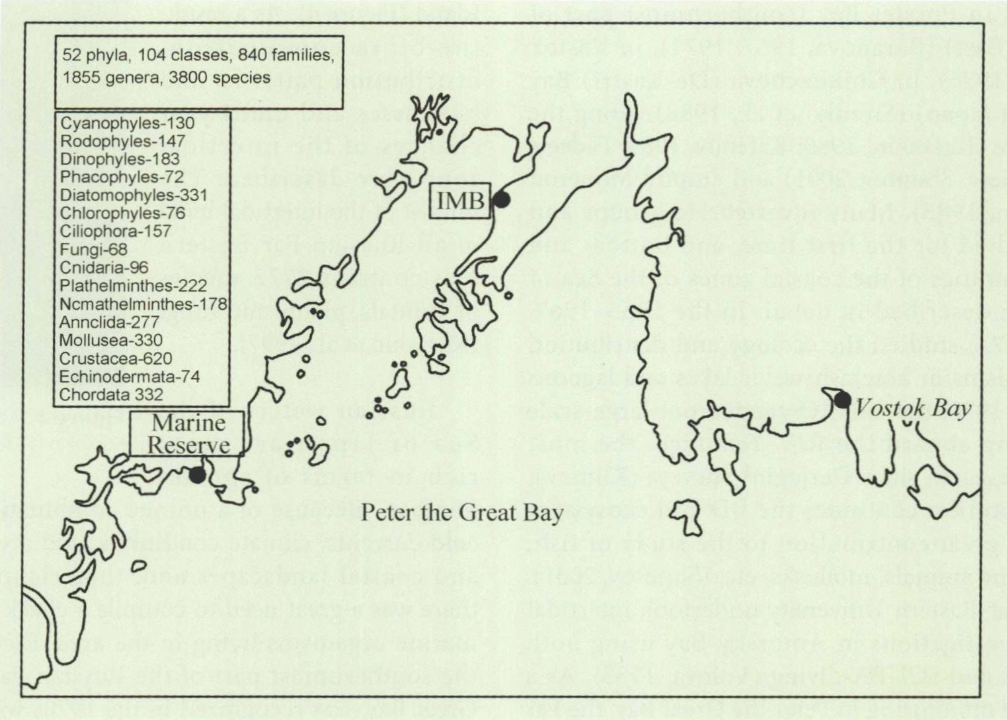

Figure 5 Taxonomic diversity in Peter the Great Bay (Sea of Japan) (after Adrianov (2004b)). Circles indicate the location of submarine transects for long-term biodiversity monitoring; IMB – A.V. Zhirmunsky Institute of Marine Biology FEB RAS.

Great Bay (Zhirmunsky, 1976). According to the catalogue of A.V. Adrianov and O.G. Kussakin (1998), nearly 4,000 marine species belonging to 52 phyla and 105 classes have been registered in Peter the Great Bay to date (Figure 5). The catalogue was the first of this kind ever compiled for the Russian Far Eastern seas.

The work on inventorying the biota is continued with a new long-term project of the IMB – publication of more than 40 volumes of serial edition *Biota of the Russian Waters of the Sea of Japan* started in 2004, it involves 67 specialists from various institutions in Russia. Up to now, nine volumes were published in two languages, Russian and English: vol. 1: Crustacea (Cladocera, Leptostraca, Mysidacea, Euphausiacea) and Pycnogonida (Petryashev et al., 2004); vol. 2: Prokaryota (Mikhailov, 2004); vol. 3: Brachiopoda and Phoronida (Zezina, Temereva, 2005); vol. 4: Caprellids (Amphipoda: Caprellidea) (Vassilenko, 2006); vol. 5: Crustacea (Thoracica and Facetotecta) (Poltarukha et al., 2006); vol. 6: polyclad turbellarians, leeches, oligochaetes, echiurans (Tokinova et al., 2008); vol. 7: reptilians (Kharin, 2008); vol. 8: Dinophyta (Konovalova, Selina, 2010); vol. 9: Isopoda (Golovan, Malytina, 2010).

Other biota cataloguing and inventorying projects can be summarized as follows. For the first time, Octocorallia were studied along the Russian coast of the Sea of Japan and three species of gorgonians are reported as new records for the northwestern Sea of Japan; one of them has been described as a new species (Dautova, 2007). An annotated check-list of the hydromedusae of the northwestern part of the Sea of Japan has been recently compiled; it includes 25 species belonging to the 20 families and 5 orders (Dautova, Petrova, 2008). E.E. Kostina (1985; 2009) described sea anemone fauna of Amursky Bay (Peter the Great Bay), Far Eastern Marine Reserve and some other areas of the Sea of Japan; in total, 96 cnidarians were known in Peter the Great Bay by the end of the 1990s (Adrianov, Kussakin, 1998).

Marine free-living nematodes were studied in the Sea of Japan mostly by O.I. Belogurov and his co-workers in the 1970s–1990s (Belogurov, Belogurova, 1988; 1989; 1992). A total of 178 species of Nematoda were known from Peter the Great Bay by the 1990s (Adrianov, Kussakin, 1998).

The sipunculan fauna of the Russian waters of the Sea of Japan now comprises 12 valid species; totally, the fauna of the Sea of Japan is now estimated as having 31 valid species of sipunculans (Mayorova, Adrianov, 2013).

The nemertean fauna of Peter the Great Bay and other areas of the Sea of Japan was studied by A.V. Chernyshev during the last decades (Chernyshev, 2008; Crandall et al., 2002). A total of 100 nemertean species is now known from the Sea of Japan (Chernyshev, present book).

No books or comprehensive reviews of the entire fauna of annelids were published during the last two decades, but there were studies of many regional/local faunas and taxonomic revisions of some groups (Buzhinskaya, Britayev, 1992; Radashevsky, 1992; Koblikov, 1977; and others). A total of 277 species of Annelida were known from Peter the

Great Bay by the 1990s (Adrianov, Kussakin, 1998).

Prof. O.G. Kussakin, the famous Russian carcinologist and marine biologist, published 5-volume monograph on the isopods of the Northern Hemisphere including data on the Sea of Japan (last volume: Kussakin, 2003). The latest researches show that the Russian waters of the Sea of Japan are inhabited by 91 species of isopods belonging to 48 genera, 22 families and 7 suborders (Golovan, Malyutina, 2010). E.I. Schornikov (2006), based on long-term studies, presented an annotated checklist of 194 species of ostracods from Peter the Great Bay. Some ostracod researches were devoted to the fauna of South Korea as results of joint Korean-Russian collaboration (Lee et al., 2000; Chavtur et al., 2007). L.L. Budnikova and R.G. Bezrukov (2008) summarized data on the taxonomic composition, abundance and local distribution of amphipods in Peter the Great Bay and enumerated 349 species collected in a depth range of 7–280 m.

The Russian bivalve molluscan fauna of the northwestern Pacific was first summarized in a comprehensive book by Scarlato (1981), and then in annotated (but not illustrated) catalogues by A.I. Kafanov (1991) and Yu.I. Kantor and A.V. Sysoev (2005). Three atlases with selected species from the Sea of Japan appeared in the 1990s–2000s (Bogdanov, Sirenko, 1993; Yavnov, 2000; Evseev, Yakovlev, 2006). K.A. Lutaenko and R.G. Noseworthy (2012) published a catalogue of the recent bivalve mollusks of the continental coast of the Sea of Japan (from Busan in the south to Tatarsky Strait in the north). The catalogue is illustrated in color and contains 367 species and subspecies belonging to 57 families. For each species, the regional province-wise distribution in Korea and in the historical region of Primorye in Russia, for two areas – southern and middle/northern Primorye, is given along with verified zonal-geographical characteristics and taxonomic and/or distributional notes. Bivalve mollusks of Yeongil Bay in South Korea were studied jointly by Russian and Korean malacologists (Lutaenko et al., 2003). In a series of papers, V.V. Gulbin (2004, 2006) and V.V. Gulbin and E.M. Chaban (2007) summarized the gastropod faunas of Peter the Great Bay, Moneron Island and the entire area of the Russian waters of the Sea of Japan. A total of 332 species and subspecies of gastropods are known for Russian waters of the Sea of Japan.

During the last decade, five important books on fish of the Sea of Japan were published (Novikov et al., 2002; Sokolovsky et al., 2007, 2009, 2011; Sokolovsky, Sokolovskaya, 2008). A.S. Sokolovsky, T.G. Sokolovskaya and Yu.M. Yakovlev (2011) summarized the fish fauna of Peter the Great Bay and published a guide-book with descriptions, color photographs, distributional and ecological data; the book includes descriptions and illustrations of 316 species belonging to 87 families and 26 orders of fish. Other books deal with the entire fish fauna of the Russian waters of the Sea of Japan (365 species, 89 families, 27 orders) (Sokolovsky et al., 2007) and eggs, larvae, and fry (Sokolovsky, Sokolovskaya, 2008). Other researches include new records of fish and their distribution (Balanov et al., 2006; Dolganov, 2012; Dolganov et al., 2008; and others).

G.V. Konovalova et al. (1989) published an atlas of phytoplankton of the Sea of Japan. Diatoms of the order Chaetocerotales of the Russian waters including the Sea of Japan were described in a book by P.M. Gogorev et al. (2006). L.P. Perestenko (1994) published a guide-book on red algae of the Far Eastern seas, and K.L. Vinogradova (1979) – on green algae. L.P. Perestenko (1980) described in detail with many drawings the entire macroalgae flora of Peter the Great Bay (in total, 225 species). N.G. Klochkova (1996) studied the macroalgae of the northern Sea of Japan – Tatarsky Strait, and summarized this flora with many ecological and distributional data enumerating 311 species. I.R. Levenets (2011) studied macroalgae in fouling communities of Peter the Great Bay. E.A. Titlyanov and T.V. Titlyanova (2012) published a comprehensive review of marine plants of the Asia-Pacific region with a guide to identification of 162 species of marine algae illustrated in color. Many researches on distribution and stock of commercial algae were conducted by TINRO in last decades.

Also, worth mentioning are ecological/BD studies on meibenthos and its role in bottom communities (Pavlyuk et al., 2007; 2008; and others).

Among other guide-books published during the last two decades, there is a series of atlases illustrated with color photographs and published by the Pacific Fisheries Research Center on common species of bivalve mollusks (Yavnov, 2000), echinoderms and ascidians (Yavnov, 2010a), starfishes (Yavnov, 2010b), decapod crustaceans (Slizkin, 2010), cephalopod mollusks (Katugin et al., 2010), buccinid gastropod mollusks (Nadtochy, Prokopenko, 2006), polychaetes, sponges, bryozoans, opistobranch mollusks and some others minor groups (Yavnov, 2012). Although they deal with animals from all Far eastern seas, many species are recorded in the Sea of Japan too. Far Eastern University published a useful identification pocket book "Plants and Animals of the Japan/East Sea" in Russian and English (Vrisch, 2007).

Peter the Great Bay is home for the only in Russia Far Eastern Marine Biosphere Reserve established in 1978. Twenty-five years of BD research and monitoring in this area were summarized in the biota volume comprising the complete list of organisms of the reserve (Tyurin, Drozdov, 2004).

1.4 Deep-sea studies of biodiversity

In 2010, the IMB in collaboration with a number of German research organizations organized a complex Russian-German deep-sea expedition of **SoJaBio** project (Sea of Japan Biodiversity Studies) aboard the R/V *Akademik M.A. Lavrentyev* (51st cruise) to the slope and deep-sea basin of the Sea of Japan (Figure 6). The expedition started from Vladivostok and took place between August 11 and September 5, 2010 under the leadership of Dr. Marina V. Malytina (IMB) and Prof. Angelika Brandt (Biozentrum Grindel und Zoologisches Museum, Hamburg) (Malyutina, 2012; Malyutina, Brandt, 2012; 2013). Internationally, SoJaBio was implemented within the frameworks of the Special Russian Federal Program "World Ocean", programs of the FEB RAS "Biodiversity Changes in Some Areas of the World Ocean with Space and Time", "Marine Biota Response to the Changes of Environment and Climate", as well as other international projects and programs: "Census of the Diversity of Abyssal Marine Life" (CeDAMar) and "Circulation Research in East Asian Marginal Seas" (CREAMS) within the North Pacific Marine Science Organization (PICES) (Malytina, Brandt, 2013). These studies have shown significant biodiversity on slope and "abyssal" of the Sea of Japan. Among 621 species of invertebrates collected from depths 500–3,660 m, 201 species are new to science, and 105 species were recorded for the first time in the Sea of Japan. It should be mentioned that during 10 years implementation of the CeDAMar, more than 500 species (among them, 246 are crustaceans) were described as new (Malyutina, 2012). A volume of the international journal *Deep-Sea Research Part II: Topical Studies in Oceanography* (2013, vols. 86–87, 238 p.) with 23 papers was devoted to biological results of the expedition. Descriptions of three new genera, 16 new species and redescriptions and detailed studies of more than 30 poorly known species of Tanaida, Isopoda, Nematoda, Nemertina, Hirudinea, Gastropoda, Hydrozoa and Anthozoa based on the new SoJaBio collections are presented in this volume; the results from of the SoJaBio expedition confirm that the deep-sea fauna of the Sea of Japan consists mainly of eurybathic species, although almost all studied taxa include few true low bathyal-abyssal species, which have already successfully colonized the young but optimal for life deep-sea environments of the Sea of Japan (Malyutina, Brandt, 2013).

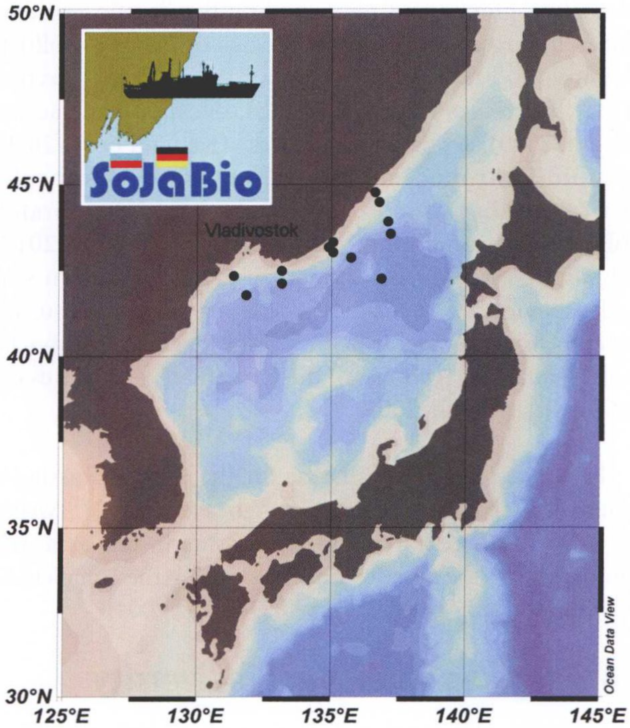

Figure 6 Sampling station of the R/V *Akademik M.A. Lavrentyev* (51st cruise) during SoJaBio deep-sea expedition in the Sea of Japan in 2010 (modified after: Malyutina, Brandt, 2012).

1.5 Climatic and environmental changes and biodiversity monitoring

Coastal zones contribute to the life support systems of human societies and, in turn, experience significant pressure in terms of modifications of marine environments, biological communities, etc. Coastal changes are part of *global environmental changes*, a hot issue of modern science over the last two decades. Sea level rise, temperature increase, pollution, eutrophication, geomorphological changes and all other results of human activities affect marine ecosystems, and their future can be understood and predicted only on the basis of comprehensive integrated research. These modified ecosystems are termed "novel ecosystems" (or "emerging ecosystems") – they contain new combinations of species that arise through human action, environmental change, and the impacts of deliberate and inadvertent introduction of species from other regions; novel ecosystems increase in importance, but are relatively little studied (Hobbs et al., 2006).

In 1996–1999, the IMB conducted extensive surveys on the environment and biota of the Tumen (Tumangan) River mouth in Peter the Great Bay and published three summarizing volumes under the common title *The State of Environment and Biota of the Southwestern Part of Peter the Great Bay and the Tumen River Mouth* (Kasyanov et al., 2001a, b, c). This area lies next to the Far Eastern Biosphere Marine Reserve, the only reserve of such kind in Russia and with rich biota, and Tumen River runoff influences significantly the coastal waters through China land-based pollution. In course of the project, the distribution and seasonal dynamics of phyto- and zooplankton and distribution of benthos, including ostracods, amphipods, fish species and marine birds were studied.

In 2003–2007, the IMB in collaboration with other research institutes implemented a sub-program "*Investigations of Nature of the World Ocean*" in frames of the Federal Program "*The World Ocean*". The results were published in a series of papers and in a comprehensive synthesis book *Dynamics of Marine Ecosystems and Modern Problems of Conservation of Biological Resources of the Russian Seas* (Tarasov, 2007). The book contains data on the state of biological resources, ecological safety and anthropogenic impacts on marine ecosystems, including these of the Sea of Japan. Problems of bioinvasions, harmful algal blooms and biosafety of the Russian Far Eastern seas are discussed in the paper by A.V. Adrianov (present book).

During 2003–2009, the IMB developed successful proposals to the Asia-Pacific Network for Global Change Research (APN) for the projects dealing with marine biodiversity of the coastal zones in the northwest Pacific and its status, regional threats, expected changes and conservation. In the course of projects implementation, new data on intertidal biota of Russky Island (Sea of Japan) were obtained and recent changes in the species composition and abundance are described on the basis of quantitative characteristics of 23 benthic communities, represented by 50 macrophytic and 181 animal species. Russky Island, with nearly untouched nature, has been developed since 2008 as a new part of Vladivostok City, with construction of a bridge from continent, a large campus of the Far Eastern Federal University, Primorsky Aquarium and residential areas, thus, this study is important in terms of future biodiversity and ecosystem monitoring. An important outcome of the APN projects was publication of the book *Ecological Studies and the State of the Ecosystem of Amursky Bay and the Estuarine Zone of the Razdolnaya River (Sea of Japan)* in two volumes (Lutaenko and Vaschenko, 2008, 2009). Papers of these volumes on foraminiferans, nemerteans, cumaceans, ostracods, sea anemones, meroplankton and zooplankton, microalga resting stages and birds add much to knowledge on biodiversity of coastal waters of Amursky Bay and adjacent areas and would serve as a basis for long-term monitoring of the state of biota and biological communities in the most polluted and human-pressed area of the Russian part of the Sea of Japan.

The IMB participated in several complex regional projects of the Russian Academy of Sciences and its Far Eastern Branch (FEB RAS), namely, Complex Regional Project "*Scientific Bases of Conservation of Biodiversity of the Russian Far East*" (Program of the RAS "*Scientific Bases of Conservation of Russia's Biodiversity*", 2003–2005) and "*Response of Marine Biota to Environmental and Climatic Changes*" (Program of the RAS "*Changes of Environment and Climate: Nature Disasters*", 2003–2006). Two books were published as collective monographs as the results of implementation of the projects dealing with methodology of biodiversity monitoring, biota inventorying, hydrological and hydrochemical changes of environments under the human impact, impact of pollution on bottom communities, bioinvasions and marine biofouling, long-term dynamics of fish fauna, phytoplankton changes, etc. (Adrianov, 2006, 2007). A review paper by A.V. Adrianov et al. (2008) deals with the major findings and outcomes of the projects.

1.6 New methods of biomonitoring

Since Peter the Great Bay includes the Far East Marine Reserve and Vostok Bay Marine Sanctuary, the IMB has developed, for the first time in Russia, the method of video monitoring of marine biota along the long-term fixed transects, which run through all types of bottom landscapes (Adrianov, 2004b; Adrianov et al., 2005; Adrianov, Tarasov, 2006). Regular video scanning of the seafloor along long-term transects in no-touch areas was initially developed and applied to study the biological diversity of the coral reefs; this method was shown to be highly useful for assessing and controlling the dynamics of reef communities. In the marine reserve, the video monitoring method allows to estimate common species of zoobenthos and perform seasonal monitoring of their abundance. This method is also useful in detection and identification of rare animals *in situ* in bathyal depths of the Sea of Japan (Figure 7).

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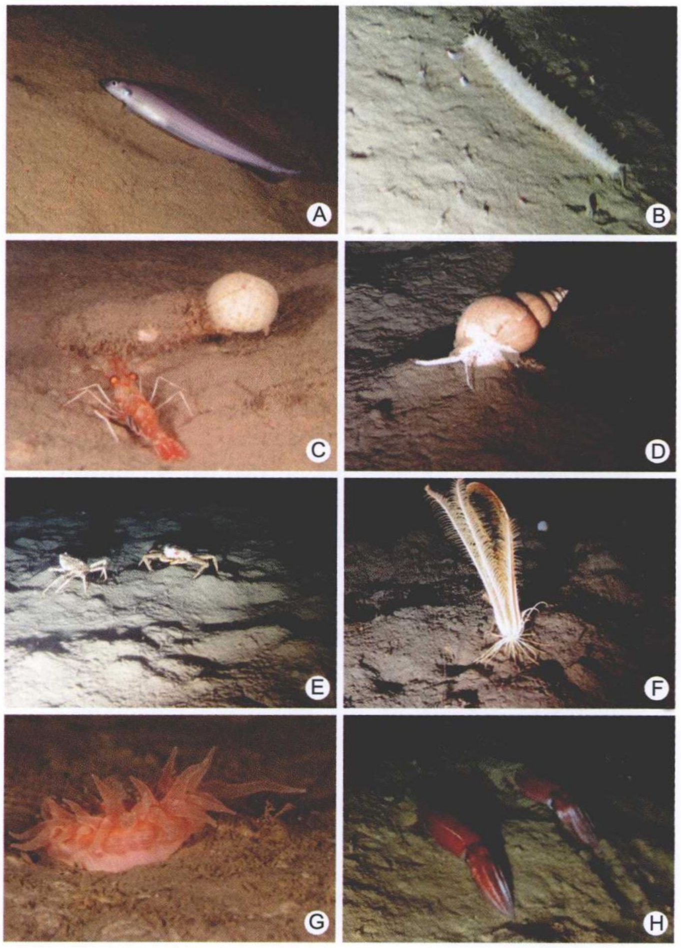

Figure 7 Photographs of animals taken in bathyal depths in Peter the Great Bay with ROV *Falkon*: **A**–the Japan Sea eelpout, *Bothrocara hollandi* (Jordan et Hubbs, 1925), Peter the Great Bay, depth 800 m; **B**–a holothurian and mysids, Peter the Great Bay, depth 400 m; **C**–a shrimp, Peter the Great Bay, depth 800 m; **D**–a buccinid gastropod (*Buccinum* (?) sp.), Peter the Great Bay, depth 200 m; **E**–snow crab, *Chionoecetes opilio* (O. Fabricius, 1788), Peter the Great Bay, depth 200 m; **F**–crinoid, *Heliometra glacialis* (Owen, 1833), Peter the Great Bay, depth 300 m; **G**–sea anemone *Cribrinopsis* sp., Peter the Great Bay, depth 800 m; **H**–gonatid squid *Berryteuthis magister* (Berry, 1913), Peter the Great Bay, depth 400 m.

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