ISSN 0096-3925, Moscow University Biological Sciences Bulletin, 2024, Vol. 79, No. 1, pp. 15–34. © Allerton Press, Inc., 2024.
Russian Text © The Author(s), 2024, published in Vestnik Moskovskogo Universiteta, Seriya 16: Biologiya, 2024, Vol. 79, No. 1, pp. 28–49.

RESEARCH ARTICLE

Combined Research Expedition "Crillon 2023": First Findings and Preliminary Results

I. I. Gordeev[a,b,*] **(ORCID: 0000-0002-6650-9120), Yu. S. Tokarev**[c] **(ORCID: 0000-0003-0524-0778), E. A. Davydov**[d] **(ORCID: 0000-0002-2316-8506), I. A. Ekimova**[a] **(ORCID: 0000-0002-1846-0780), K. A. Drozdov**[e] **(ORCID: 0000-0002-9014-5398), I. O. Yatsenko**[f] **(ORCID: 0000-0003-4378-8507), O. V. Yatsenko**[f] **(ORCID: 0000-0002-0131-2159), N. A. Kochunova**[g] **(ORCID: 0000-0001-8621-8593), N. V. Bukharova**[h] **(ORCID: 0000-0002-6530-6436), M. S. Kondratyev**[i] **(ORCID: 0000-0001-6717-4206), A. A. Miroliubov**[j] **(ORCID: 0000-0003-3537-2341), I. O. Rozhkova-Timina**[k,l] **(ORCID: 0000-0002-8995-6062), S. S. Makeev**[m] **(ORCID: 0009-0002-1677-4062), D. Yu. Grishina**[a] **(ORCID: 0000-0002-4511-6125), A. D. Plaksin**[n] **(ORCID: 0009-0002-8034-5078), and A. A. Semenov**[n] **(ORCID: 0000-0003-0067-8279)**

[a] *Division of Invertebrate Zoology, Department of Biology, Moscow State University, Moscow, 119234 Russia*
[b] *Russian Federal Research Institute of Fisheries and Oceanography, Moscow, 105187 Russia*
[c] *All-Russian Institute of Plant Protection, Pushkin, St. Petersburg, 196608 Russia*
[d] *Altai State University, Barnaul, 656049 Russia*
[e] *Pacific Institute of Bioorganic Chemistry, Vladivostok, 690041 Russia*
[f] *Tsitsin Main Botanical Garden, Russian Academy of Sciences, Moscow, 127276 Russia*
[g] *Amur Branch of the Botanical Garden-Institute, Far East Branch, Russian Academy of Sciences, Blagoveshchensk, 675004 Russia*
[h] *Federal Scientific Center for Biodiversity of Terrestrial Biota of East Asia, Far East Branch, Russian Academy of Sciences, Vladivostok, 690022 Russia*
[i] *Institute of Cell Biophysics, Russian Academy of Sciences, Pushchino, Moscow oblast, 142290 Russia*
[j] *Zoological Institute, Russian Academy of Sciences, St. Petersburg, 199034 Russia*
[k] *Sakhalin Research Institute of Agriculture, Yuzhno-Sakhalinsk, 693022 Russia*
[l] *Sakhalin State University, Yuzhno-Sakhalinsk, 693000 Russia*
[m] *Sakhalin Branch of the Main Basin Authority on Fishery and Preserving Water Biological Resources, Yuzhno-Sakhalinsk, 693006 Russia*
[n] *White Sea Biological Station, Department of Biology, Moscow State University, Moscow, 119234 Russia*
**e-mail: gordeev_ilya@bk.ru*

Received December 5, 2023; revised April 8, 2024; accepted April 17, 2024

Abstract—In August 2023, the combined expedition "Crillon 2023" was accomplished that exploring the terrestrial, aquatic and marine biotopes in the southeastern part of the Crillon Peninsula (Sakhalin Island, Russia). A group of specialists carried out field work in ichthyology, invertebrate zoology, entomology, botany, lichenology, bryology, mycology, parasitology, microbiology, and marine biology. In the previously underexplored territory of the southeastern part of the peninsula, an appreciable amount of data on species diversity was collected, including more than 200 species of plants, 101 species of lichens, 127 species of mosses, and 117 species of basidial macromycetes. Marine coastal communities of the littoral and sublittoral zones were examined, including those achieved by scientific diving techniques. As many as 119 species of invertebrates and 20 species of seaweed were recorded. Information was collected on 20 species of fish, including data on helminth infection. Parasitological studies included the search for microsporidia in all available animal hosts, as well as search for rhizocephalans: parasites of arthropods. Rare and endangered animal, plant and fungal species were found that are included in the Regional and Federal Red Books as well as those not previously recorded from Sakhalin. The preliminary results indicate great potential for further study of the eastern part of the peninsula from the point of view of biological sciences as well as the prospects for establishment of a biological station in this area for long-term research and development.

Keywords: Sakhalin, biological diversity, lichens, fauna, flora, mycobiota, Aniva Bay, Crillon Peninsula, Far East, East Asia

DOI: 10.3103/S0096392524600546

INTRODUCTION

In August 2023, the combined expedition "Crillon 2023" was undertaken, which involved more than ten specialists from various biological fields as well as young scientists. The expedition covered terrestrial, aquatic, and marine biotopes in the southeastern part of the Crillon Peninsula (Sakhalin Island, Russia).

Sakhalin Island is located between the Sea of Okhotsk and the Sea of Japan and significantly extends from north to south, thereby featuring several belts of climate zones, each with its characteristic dominant flora and, sometimes, fauna species. Cape Crillon is the southernmost tip of Sakhalin and the territory closest to the Japanese Archipelago islands. Therefore, the plant communities are basically formed by species nontypical of central and northern parts of the island, which can be encountered nowhere else in Russia or in the remaining part of Sakhalin [1, 2]. The peninsula territory is categorized into a subzone of the dark coniferous forests with admixture of broadleaf species [3], while the species saturation of plant and animal kingdoms on the peninsula is one of the highest on Sakhalin [4, 5]. The eastern part of the Crillon Peninsula is of particular interest as a prospective biodevirity conservation area and was given the status of a nature protected area between 1972 and 2002.

Overall, the Eastern Asiatic floristic region is among the outstanding global centers of floristic biodiversity and is characterized by a considerable number of not only endemics but also relicts. Results of investigations into higher plants and fungi in the area confirm local occurrence of high diversity of both evolutionary recent and, presumably, ancient species. The entire Sakhalin and particularly Crillon peninsula feature rare and endangered plant species listed both in the Red Books of Sakhalin oblast [6] and Russia [7] and require a close scrutiny and conservation.

Data on biodiversity of fungi of the Russian Far East largely remain fragmented and fail to reflect a true richness of these organisms. As of the dates of the expedition, at least 30 years had elapsed since the last mycological investigations of Sakhalin Island. Besides, no focused research into mycobiota has ever been carried out in the forests of Crillon peninsula to date. Currently, 739 species of basidiomacromycetes are known from Sakhalin oblast, 400 of which belong to agaricoid fungi [8]. Of them, 577 species have been recorded from Sakhalin Island (data from 52 publications). Noteworthy, 67 fungi species are found exclusively in Sakhalin oblast and have not been recorded from the neighboring regions of mainland Russia, while 46 species are known to occur only on Sakhalin. Therefore, considering the vast expanse and a variety of natural conditions on Sakhalin, mycobiota of this area is apparently underexplored, whereas Crillon peninsula remains a "blank spot" altogether.

Our understanding of lichenoflora is somewhat better. According to generalized literature data [9], 943 species were recorded for flora of lichens and lichenophylic fungi from the south of the Far East. A more recent study by Urbanavichyus [10] reports 1107 species for this area, of which 206 are known in Russia from exclusively the south of the Far East. However, lichenologists highlight that the south of the Far East is among the territories whose data on lichenflora is the least complete [11]. Altogether, 736 lichen species are known from Sakhalin Island (data of E.A. Davydov based on generalization and synonymization of 147 works). Sakhalin was unevenly studied with respect to lichens. Crillon peninsula is the most underexplored. Of the substrate groups, the least understood are the lichens growing on stones. The Red Book of Sakhalin oblast includes 35 lichen species [6].

The southeastern portion of Crillon peninsula features a large number of rivers and streamlets (brooks) that flow into Aniva Bay. The largest of them (Taranai, Bachinskaya, Uryum, Tambovka, Ul'yanovka, Kura, Kolkhoznaya, Medvedevka, Naicha, Riflyanka, Moguchi, Anastasiya, and Atlasovka) serve as spawning grounds for salmonids, such as the masu salmon, pink salmon, and chum salmon, as well as Sakhalin taimen listed in the Red Book of Sakhalin oblast [6]. Rivers of the western coast of Aniva Bay are largely shorter, that is, less than 30 km in length. Only Taranai and Uryum rivers are 57 and 51 km long, respectively. Composition of the rivers' and riparian (near-water) biological communities are largely governed by the mountainous character of the channel of the majority of the rivers as well as their flow through the typhoon zone, leading to the high-water overflow phenomena [12–16]. Spawning conditions of commercially valuable fish and occupancy of spawning sites in the rivers of the peninsula are critical indicators, which further provide a basis for the strategy for their commercial harvest, while adhering to the precautionary approach [17].

Aniva Bay does not freeze, which allows for its study in the wintertime as well; however, the coastal area and littoral zone accumulate drift ice and snow, which considerably hampers any logistics. Coastal communities of the southwestern part of Aniva Bay are distinguished by rich species diversity of saltwater fish, which attracts researchers from various fields. Unfortunately, despite the availability of certain amount of data [18], coastal fauna of the Sea of Okhotsk overall and coastal waters of Sakhalin Island in particular is not well understood to date.

This article reports preliminary findings of the expedition Crillon 2023, which encompassed fieldwork in ichthyology, invertebrate zoology, entomol-

Fig. 1. Area explored by the expedition "Crillon 2023." Red point indicates location of the expedition base camp at the Moguchi River mouth.

ogy, botany, lichenology bryology, mycology, parasitology, microbiology, and marine biology.

MATERIALS AND METHODS

The expedition Crillon 2023 was undertaken during the period August 3–25, 2023. The base camp was arranged at the mouth of the Moguchi River (Fig. 1).

Botany and bryology. Terrestrial communities were studied through route-based surveys. Collection of field materials was based on standard methodology [19] and techniques described in meadow research studies [20]. A total of 323 herbarium specimens of mosses and 29 (meadow herbaceous plants) tracheophytes were collected. Latin names of genera and species of vascular plants are cited according to S.K. Cherepanov [3]. The quantitative Bray–Curtis similarity matrix index [21] for cluster analysis was computed in the IBIS 7.2 program [22]. Cluster analysis served to make dominance-determinant classification of meadow vegetation.

Mycology. Fungi were sampled using the route-based method. The investigations embraced the fir-spruce forests with birch and thickets of *Sasa* sp. as well as floodplain forests with the dominant willow and alder. Altogether, 350 fungi specimens, including 180 agaricoid, 149 aphyllophoroid, eight heterobasidioid, and 13 cup fungi (ascomycetes) were collected from the studied area. The entire material was processed and herborized according to the standard methodology [23–25]. After preliminary drying, the specimens were exposed to freeze for two weeks at −60°C to eliminate pest insects. Species identification of fungi was performed by the morphological traits. Formulations were examined in a 10% KOH solution; staining was done with Kongo red when required, while using Melzer's reagent was used to detect amyloidity of the structures. The fungi were identified based on the identifiers, monographs, and publications in separate groups [26–30]. Data on geographic distribution and characteristics of particular species are reported based on the authors' own database of literature sources, summary reports on agaricoid basidiomycetes of Russia [8], and the Global Core Biodata Resource international database (www.globalbiodata.org). Herbarium specimens are deposited in the mycological herbarium of the Federal Scientific Center for Biodiversity of Terrestrial Biota of East Asia, Far East Branch, Russian Academy of Sciences (VLA, Vladivostok) and the collection of higher fungi of the Herbarium of the Amur Branch of the Botanical Garden-Institute, Far East Branch, Russian Academy of Sciences (ABGI, Blagoveshchensk). Data on the herbarium specimens from Crillon peninsula are added to the Digital Herbarium Base of the Botanical Garden-Institute of the Far East Branch, Russian Academy of Sciences (http://botsad.ru/herbarium).

Additionally, samples were collected for comparative study of mycorrhizial fungi of the endemic and invasive *Senecio* sp. of South Sakhalin flora.

Lichenology. Sampling of lichens both from stony and woody substrates was performed at five localities: (1) Aniva Bay, Cape Kanabeeva; (2) right bank of the Naicha River 1 km upstream of the mouth; (3) Aniva Bay, Cape Anastasiya, close to the Vodopadnaya River mouth; (4) the Moguchi River valley; and (5) the Riflyanka River valley. Identification of lichens was made using methods standard in lichenology [31]. Anatomy and morphology of thalli was examined using an Olympus CZ-61 binocular zoom (Olympus, Japan) and ZEISS AxioLabA1 microscope (Carl Zeiss Microscopy GmbH, Germany). Anatomical slices were prepared manually by razor blade and investigated in water; crystals on apothecium slices were examined under polarized light; apical apparatus of asci was stained using Lugol's aqueous iodine. Spot test (color reaction) method was used as an express method for identification of lichen substances: a 10% KOH solution, saturated aqueous solution of $Ca(ClO)_2$, iodine potassium iodide (IKI) or Lugol's iodine, the alcoholic p-phenylenediamine solution $C_6H_4(NH_2)_2$, and concentrated HNO_3. Additionally, fluorescence of selected metabolites was studied in UV light. Composition of secondary metabolites of selected species was examined using thin-layer chromatography standardized techniques [32, 33].

Ichthyology. Pink salmon approach to spawning streams was visually accessed by the common methods [34]. Additionally, gillnetting of pink salmon and masu salmon was performed based on permit no. 6520230317192 issued by the Federal Agency for Fishery of the Russian Federation to fish for scientific and monitoring purposes. Rivers were surveyed on foot attended by a huntsman or gamekeeper. Fishing in streamlets (brooks and creeks), flowing into the Moguchi and Naicha rivers, as well as Riflyanka River, was carried out using a dip net (30 × 40 cm). Biological analysis of the catch was performed by standardized methods [35]. Samples for hematological analysis were likewise collected using the standard methodology [36, 37].

Parasitology. Parasitological dissection of fish and fixation of helminth specimens were performed by standardized methods [38, 39]. All accessible biotopes were explored with respect to the presence of animals that can be potentially infected with microsporidia. To this end, dissection and microscopy were performed of several dozens of specimens of the free-living saltwater (Anomura, Isopoda) and freshwater (Amphipoda, Decapoda), as well as parasitic (Caligidae), crustaceans; larvae of aquatic insects (Odonata, Plecoptera, and Trichoptera); anadromous (Salmonidae) and freshwater fish (Gasterosteidae), as well as their parasites, such as cestodes (Caryophyllidae) and crustaceans (Caligidae). Samples of decapods were collected from the Sea of Okhotsk near the Moguchi River mouth to search for the individuals infected with rhizocephalans (Cirripedia: Rhizocephala). Specifically, hermit crabs (Anomura) and crabs (Brachyura) were chosen as the potential research objects. Hermit crabs and crabs were collected in the coastal zone at a depth from 0 to 1.5 m, as well as at the 10–20 m depths using diving gear from three points: Cape Kanabeeva, Tyulenii Island (Hirano Ridge), and near the Riflyanka River estuary. Infected individuals were separated from all collected decapods. Additionally, samples were fixed to compare the content of low-molecular-weight metabolites in healthy and infected individuals. For this purpose, hermit crabs were entirely fixed and frozen.

Marine biology. The samples were manually collected from a depth of 0.1–0.6 m and littoral pools (thalli of brown and green algae). Additionally, underwater coastal communities were explored by snorkeling; the material was collected from the depths of 0.1–1 m. Collected specimens were preliminary identified, photographed, tagged, and fixed in ethanol for futher morphological and molecular investigations. Also, benthic biotopes were preliminary mapped in the vicinity of the Moguchi River mouth at a depth down to 22 m by scientific diving techniques [40]. Visual observations of marine mammals were made.

Entomology and freshwater invertebrates. Insects were manually collected by standardized methods [41], by sweep-net method, as well as using light pan traps with a 20-W UV bulb (Aspectek Ultraviolet Tube 20 W; Aspectek, Canada). Freshwater invertebrates, including amphibiotic larval insects, were sampled by methods described in a monograph by T.S. Vshivkova et al. [42]. The insects, including those for the purposes of study of microsporidia infection rates, were freeze-dried for the subsequent analysis.

Microbiology and biophysics. Microbiological and secretions sampling was taken from various vertebrate and invertebrate animals, plants, and soil; the material collected for the chemical and microbiological analysis included samples of objects and liquids (water from springs, puddles, and sea) as well as samples of plastics from Aniva Bay. Microbiological samples were collected by standardized methods with sterility assurance of the collected samples.

RESULTS AND DISCUSSION

Botany and bryology. The work resulted in collection of data on frequency of occurrence of more than 200 species of vascular plants, of which eight species were detected that are listed in the Red Book of the Russian Federation and 15 species in the Red Book of Sakhalin oblast [6]. More than 30 specimens of plant seeds, fruits, and propagules were additionally selected for introduction to botanical gardens. Novel species, as well as species not previously reported in the literature for this region were found, such as *Arisaema sadoënse* Nakai, *Cakile edentula* (Bigelow) Hook., *Cremastra variabilis* (Blume) Nakai, *Juniperus sargentii* (A. Henry) Takeda ex Koidz., *Kalopanax septemlobus* (Thunb.) Koidz., *Padus ssiori* (Fr. Schmidt) C.K. Schneid, and *Phacellanthus tubiflorus* Siebold et Zucc.

Plant communities of the surveyed area are basically formed by herbaceous plants (*Leymus mollis* (Trin.) Pilg., *Artemisia vulgaris* L., *Sasa kurilensis* (Rupr.) Makino & Shibata, *Senecio pseudoarnica* Less., *Leptorumohra amurensis* (Christ) Tzvel., *Equisetum hyemale* L. *Petasites amplus* Kitam., and *Senecio cannabifolius* Less.), shrubs (*Duschekia maximowiczii* (Call. ex C.K. Schneid.) Pouzar, *Ilex rugosa* Fr. Schmidt, *Ribes sachalinense* (Fr. Schmidt) Nakai, *Rosa rugosa* Thunb., *Rubus sachalinensis* Lévl., and *Sambucus racemosa* L.), trees (*Abies sachalinensis* Fr. Schmidt, *Alnus hirsuta* (Spach) Fisch. ex Rupr., *Betula ermanii* Cham., *B. platyphylla* Sukacz., *Phellodendron sachalinense* (Fr. Schmidt) Sarg., *Picea jezoensis* Carr., *Salix schwerinii* E. Wolf subsp. *yezoensis* (C.K. Schned.) Worosch., *Salix udensis* Trautv. et Mey., and *Sorbus commixta* Hedl.), and lianas (*Actinidia kolomikta* (Maxim.) Maxim., *Hydrangea petiolaris* Siebold et Zucc., and *Vitis coignetiae* Pulliat ex Planch.) (Fig. 2). The rare and protected species include *Aralia cordata* Thunb., *Aralia elata* (Miq.) Seem., *Cardiocrinum cordatum* (Thunb.) Makino, *Cremastra variabilis* (Blume) Nakai, *Diphylleia grayi* Fr. Schmidt, *Hydrangea petiolaris* Siebold et Zucc., *Ilex crenata* Thunb., *Juniperus sargentii* (A. Henry) Takeda ex Koidz., *Kalopanax septemlobus* (Thunb.) Koidz., *Mecodium wrightii* (Bosch) Copel., *Padus ssiori* (Fr. Schmidt) C.K. Schneid., *Phacellanthus tubiflorus* Siebold et Zucc., *Phellodendron sachalinense* (Fr. Schmidt) Sarg., *Phyllitis japonica* Kom., and *Taxus cuspidata* Siebold et Zucc. ex Endl. (Fig. 3).

Thirty-eight relevés of the meadow communities were completed. A total of 70 plant species, belonging to 61 genera of 24 families was recorded from meadows. The family–species histogram is shown in Fig. 4.

Several formations of meadow communities were distinguished in the Moguchi River mouth area on Crillon peninsula: (1) tallgrass valley communities with the dominant *Angelica ursina* Regel., *Reynoutria sachalinensis* Nakai, *Petasites amplus*, *Filipendula camtschatica* (Pall.) Maxim., *Senecio cannabifolius*, *Cirsium kamtschaticum* Ledeb. ex DC., and *Cacalia robusta* Tolm.; (2) *Leymus* marine coastal communities with the dominant *Leymus mollis* and more rarely encountered *Lathyrus japonicus* Willd., *Artemisia vulgaris*, and *Ligusticum scoticum* L.; (3) mixed grasses-forbs communities, in which dominance in equal measure belongs to *Rumex obtusifolius* L., *Agrimonia viscidula* Bunge., *Artemisia vulgaris*, *Phleum pratense* L., *Dactylis glomerata* L., *Phalaroides arundinacea* (L.) Rausch., *Poa pratensis* L., and *Senecio pseudoarnica*; and (4) *Phragmites–Sasa* communities with the dominant *Sasa kurilensis* and *Phragmites australis* (Cav.) Trin. ex Steud. as well as an occurrence of *Senecio cannabifolius, Aster glehnii* Fr. Schmidt, and *Artemisia vulgaris*.

In the course of the work, 323 herbarium specimens of mosses were collected and subsequently deposited in the Herbarium of the Main Botanical Garden of the Russian Academy of Sciences. Of the species identified to date, "arthrodontous" mosses (Bryopsida) number 64 species of 30 families (Fig. 4), while liverworts (Marchantiophyta) number ten species of eight families. The most commonly observed mosses in the studied area include *Trachycystis flagellaris*, *Callicladium haldanianum*, *Thamnobryum neckeroides*, *Myuroclada longiramea*, *Sciuro-hypnum reflexum*, and *Aquilonium adscendens*. Besides, the moss species listed in the Red Book of Sakhalin oblast was found, specifically, *Forsstroemia japonica*.

Mycology. Summarizing the preliminary identifications, 50 species of aphyllophoroid and 67 species of agaricoid fungi were detected, of which 46 species were the first findings for Sakhalin Island. In regard to basidiomycetes found on Crillon peninsula, seven species of aphyllophoroid and 36 of agaricoid fungi were recorded from Sakhalin oblast for the first time, while two species are new to mycobiota of the Russian Far East.

The majority (89%) of detected aphyllophoroid fungi species (Fig. 6) belong to xylotrophes, causing a decay of wood at various decomposition stages, including 18 fungi species capable of attacking living trees (*Fomitiporia punctata*, *Fomitopsis pinicola*, *Ganoderma applanatum*, *Inonotus obliquus*, *Laetiporus cremeiporus*, *Mensularia radiata*, *Phaeolus schweinitzii*, *Phellinus gilvus*, *Ph. hartigii*, *Ph. jezoënsis*, etc.).

Biota of agaricoid fungi (Fig. 7) is well-represented by ecological-trophic mycorrhizial groups (with frequent occurrence of *Amanita flavipes*, *A. rubescens*, *Boletus edulis*, *Russula foetens*, *Xerocomus subtomentosus*, etc.) and xylotrophs on dead wood (*Gymnopilus junonius*, *Hypholoma fasciculare*, *Lentinellus ursinus*, *Pleurotus pulmonarius*, *Pluteus cervinus*, and etc.), as well as by a group of forest floor saprotrophs (e.g., *Gymnopus dryophilus*, *Lepiota clypeolaria*, *Marasmius siccus*, and *Paralepista flaccida*).

As observed, habitats overgrown by thickets of *Sasa* sp. proved to be unfavorable for growth of agaricoid fungi. *Sasa* serves as a limit fruitbodies to basidia germination in pileate fungi since it creates adverse conditions (excessive moisture, poor aeration, and reduced fruitbody). Basidia abundance was the most remarkable in open habitats in the forests with the most weakly pronounced herbaceous cover and well-developed forest litter. It was additionally found that the second half of August is particularly favorable for agaricoid fungi fruiting in the studied area under optimal combination of moisture and temperature.

Fig. 2. Dominant vegetation components of Crillon Peninsula southeast. (a) *Abies sachalinensis*; (b) *Phellodendron sachalinense*; (c) *Hydrangea petiolaris*; (d) *Sasa* sp.

New locations of occurrence were discovered of the rare species *Ganoderma lucidum* and *Strobilomyces strobilaceus* listed in the Red Book of Sakhalin oblast [6] and the Red Book of Russia [7].

It is planned to complete identification of species allocation of the other specimens. Additionally, 13 specimens of the cup fungi (Ascomycota) collected in the explored area will be transferred to specialists for further study.

Lichenology. Fieldwork resulted in finding 101 lichen species, including 43 saxicolous and 58 epiphytic and terricolous species. The focus was on lichens on rocky substrates. It takes a long time for saxicolous lichens to grow and develop; therefore, they occupy only relatively stable substrates. Despite an abundance of pebbles and boulders (greater than 20 cm in diameter) in the intertidal zone of the marine coast, lichens are rarely encountered at the site, only under particular conditions. New rocky (stony) outcrops, emerging in the forest, rather rapidly overgrow with tall herbaceous and subsequently, woody vegetation, thus making these habitats unsuitable for lichens due to the nearly entire absence of light. Under the conditions of Crillon Peninsula, saxicolous lichens largely occupy the marine steep bluffs or cliffs, and rapids as well as large boulders and overgrowing stones fragments scattered in the forest. A total of 43 lichen

Fig. 3. Rare and endangered species found in Crillon Peninsula southeast. (a) *Juniperus sargentii*; (b) *Mecodium wrightii*; (c) *Cremastra variabilis*; (d) *Phyllitis japonica*.

species were detected on the coastal bluffs and cliffs. The most common are *Caloplaca atroflava* (Turner) Mong., *Flavoplaca flavocitrina* (Nyl.) Arup et al., *Lecanora argentea* Oxner et Volkova, *Candelariella vitellina* (Hoffm.) Müll. Arg., *Lecidella carpathica* Körb., *Lecanora polytropa* (Hoffm.) Rabenh., *L. sulphurea* (Hoffm.) Ach., *Physcia caesia* (Hoffm.) Fürnr., *Porpidia crustulata* (Ach.) Hertel et Knoph, *Rusavskia elegans* (Link.) S.Y. Kondr. et Kärnefelt, and *Scoliciosporum umbrinum* (Ach.) Arnold, *Rhizocarpon* sp. and *Ramalina* sp., etc. (Fig. 8). The majority of lichens is reported from Sakhalin for the first time over the last few years from one or two occurrence locations [43–46]. The occurrence locations on Crillon peninsula provide further insight into their distribution on Sakhalin.

Forest ecosystems of Crillon peninsula are characterized by a diversity of tree species, whose bark and branches serve as habitats for epiphytic lichens. The most commonly occurring in the coniferous-broadleaf forests are *Anaptychia isidiza* Kurok. *Cetrelia olivetorum* (Nyl.) W.L. Culb. et C.F. Culb. *Lopadium disciforme* (Flot.) Kullh. *Menegazzia subsimilis* (H. Magn.) R. Sant., *Mikhtomia gordejevii* (Tomin) S.Y. Kondr. et al., *Parmelia fertilis* Müll. Arg., *P. squarrosa* Hale; species of the genera *Hypogymnia, Lecanora, Phaeophyscia,* and *Polyblastidium*; etc. Floodplain

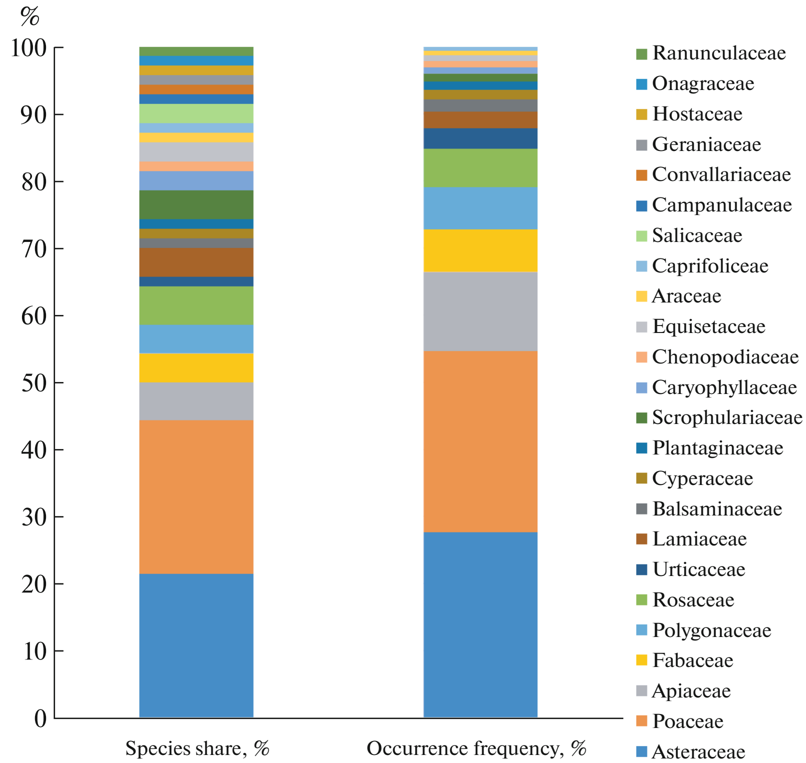

Fig. 4. Family–species histogram of plant spectrum of meadow communities.

Fig. 5. Mosses of southeast Crillon Peninsula. (a) *Sphagnum riparium*; (b) *Polytrichum piliferum*.

forests additionally feature *Collema* sp. and *Leptogium* sp., *Flavoparmelia caperata* (L.) Hale, *Heterodermia speciosa* (Wulfen) Trevis., *Melanohalea olivacea* (L.) O. Blanco et al., etc. Terricolous species are mostly absent due to the failure to compete with herbaceous vegetation. Occasional *Cladonia* and *Peltigera* sp. settle at the base of the tree trunks, lumber, or stony forest floor. Altogether, 58 lichen species were found in the

Fig. 6. Aphyllophoroid fungi of Crillon Peninsula southeast. (a) Bleeding oak crust *Stereum gausapatum*; (b) *Pistillaria petasitis*; (c) *Hymenochaete cruenta*; (d) lacquered bracket *Ganoderma lucidum*.

forest ecosystems, which do not exhaust their diversity. We identified six lichen species protected at the federal and regional levels. Of them, four are listed in the Red Book of Sakhalin Region [6] and four in the Red Book of the Russian Federation [7]. All the species were found in the Moguchi River valley, in the coniferous-broadleaf and floodplain forests and one species, *Menegazzia subsimilis*, in the Naicha River valley. All the discovered localities are new and were not mentioned in the most recent edition of the Red Book of Sakhalin Region (Table 1, Fig. 9).

Ichthyology. Investigation of spawning grounds in the minor rivers produced results characterizing an intensity of spawning migration (run) of the pink salmon *Oncorhynchus gorbuscha*, the number of the individuals in the river, and their density on spawning grounds. Additionally, a conversion calculation of the spawning grounds occupancy was made based on the nominal area. The results proved to be rather modest, in that spawning grounds occupancy of the pink salmon producers at the majority of the rivers did not exceed 20%. This is largely associated with high-water overflow phenomena triggered by the typhoon passage in August 2023; the majority of the individuals that entered to spawn were washed out to sea. In addition to pink salmon, the brooks and creeks flowing into the Moguchi and Naicha rivers featured other salmonids, such as the masu salmon juveniles (Fig. 10) and dwarf males (*Oncorhynchus masou)*.

A total of 48 pink salmon individuals were examined. In females (14), SL (standard body length) was 39.6–55 cm and averaged 45.68 ± 0.46 cm. Weight ranged from 885 to 2325 g, 1280 ± 41.53 g. Females (14) were 42.1–48.3 cm in length (SL), 44.5 ± 0.45 cm on average. Weight varied between 1015 and 1712 g and averaged 1210.5 ± 46.33 g. Gonad weight ranged from 95.3 to 189 g (average 148.06 ± 8.6). The gonadosomatic index (GSI) varied between 7.6 and 22.69% and averaged 15.26 ± 1.05%. In all but one female, gonads were at maturity stages IV–V. Males (34) were 39.6–55 cm long (SL), 46.15 ± 6.14 on average. Weight ranged from 885 to 2325 g and averaged 1308.47 ± 55.1. Gonad weight varied between 56 and 126 g (88.81 ± 3.55 on average). GSI ranged from 4.82 to 13.76% (7.97 ± 0.36 on average). Gonads were at maturity stages III–IV (62%), IV (29%), and IV–V (9%).

Fig. 7. Agaricoid fungi of Crillon Peninsula southeast. (a) *Gymnopilus junonius*; (b) *Amanita flavipes*; (c) *Lepiota clypeolaria*; (d) *Strobilomyces strobilaceus.*

Length of the examined juvenile masu salmon individuals (SL) varied between 43 and 117 mm, measuring 69.01 ± 2.12 mm on average. Weight ranged from 0.8 to 16.2 g, 4.29 ± 0.36 g on average. Dwarf male was 350 mm in length and weighed 62.6 g.

Genetic specimens of the masu and pink salmons were deposited in the Russian National Collection of Standard Genetic Materials (Russian Federal Research Institute of Fisheries and Oceanography).

Additionally, the Arctic lamprey *Lethenteron camtschaticum*, Siberian stone loach *Barbatula toni*, *Rhynchocypris percnura sachalinensis*, chum salmon *Oncorhynchus keta*, southern Dolly Varden *Salvelinus curilus*, whitespotted char *Salvelinus leucomaenis*, Sakhalin sculpin *Cottus amblystomopsis*, freshwater Far Eastern goby *Gymnogobius urotaenia*, and the Amur stickleback *Pungitius sinensis* were recorded from the rivers and their tributaries.

Marine coastal waters featured big-scaled redfin *Pseudaspius hakonensis*, starry flounder *Platichthys stellatus*, cresthead flounder *Pseudopleuronectes schrenki*, *Zoarces elongatus*, Pacific sand lance *Ammodytes hexapterus*, Okhotsk atka mackerel *Pleurogrammus azonus*, *Myoxocephalus brandtii*, Steller's sculpin *M. stelleri*, etc.

The Sakhalin taimen *Parahucho perryi* listed in the Red Book of the Russian Federation [7] and Sakhalin

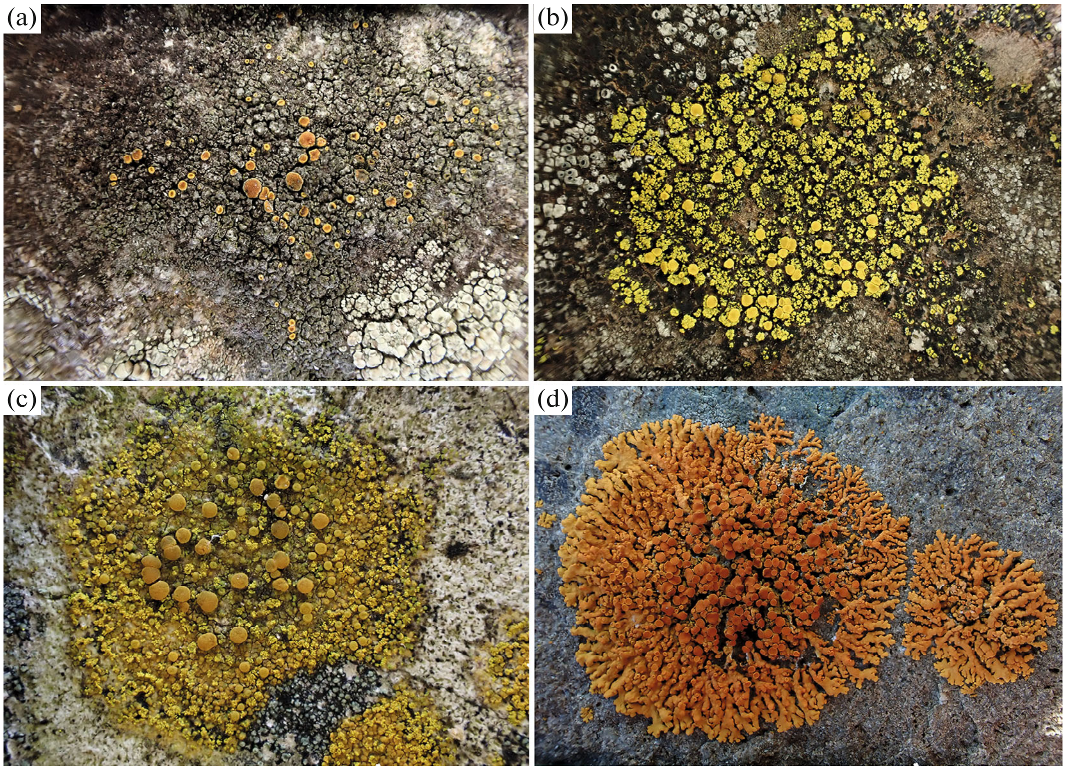

Fig. 8. Common lichens of stony outcrops in southeast Crillon Peninsula. (a) *Caloplaca atroflava*; (b) *Candelariella vitelline*; (c) *Flavoplaca flavocitrina*; (d) *Rusavskia elegans*.

oblast [6] reproduces in all major rivers of the peninsula (Uryum, Tambovka, Ul’yanovka, and Naicha), but the most numerous population was recorded from the Moguchi River.

Parasitology. Three rhizocephalan species were detected in the area of the Moguchi River mouth. In rock outcrop biotope near Cape Kanabeeva, one hermit crab individual was found presumably infected

Table 1. Protected lichens in southeast Crillon Peninsula

No.	Latin name	Status in the Red Book of Sakhalin oblast [6]	Status in the Red Book of the Russian Federation [7]	Occurrence location
1.	*Hypogymnia duplicatoides*	2a	—	Right bank of the Moguchi River near the mouth
2.	*Hypogymnia fragillima*	3e	3(VU) III	Right bank of the Moguchi River near the mouth
3.	*Lobaria pulmonaria*	3b	2(NT) III	Moguchi River Valley, 3 km from the mouth
4.	*Menegazzia subsimilis*	—	3(VU) III	Right bank of the Naicha River, 1 km upstream of the mouth; Right bank of the Moguchi River near the mouth; the Moguchi River valley, 5 km from the mouth
5.	*Leptogium burnetiae*	—	3(NT) III	Moguchi River valley, 3 km from the mouth
6.	*Usnea diffracta*	3b	—	Right bank of the Moguchi River near the mouth

Fig. 9. Protected lichen species of southeast Crillon Peninsula. (a) *Hypogymnia duplicatoides*; (b) *Menegazzia subsimilis*; (c) *Lobaria pulmonaria*; (d) *Hypogymnia fragillima*.

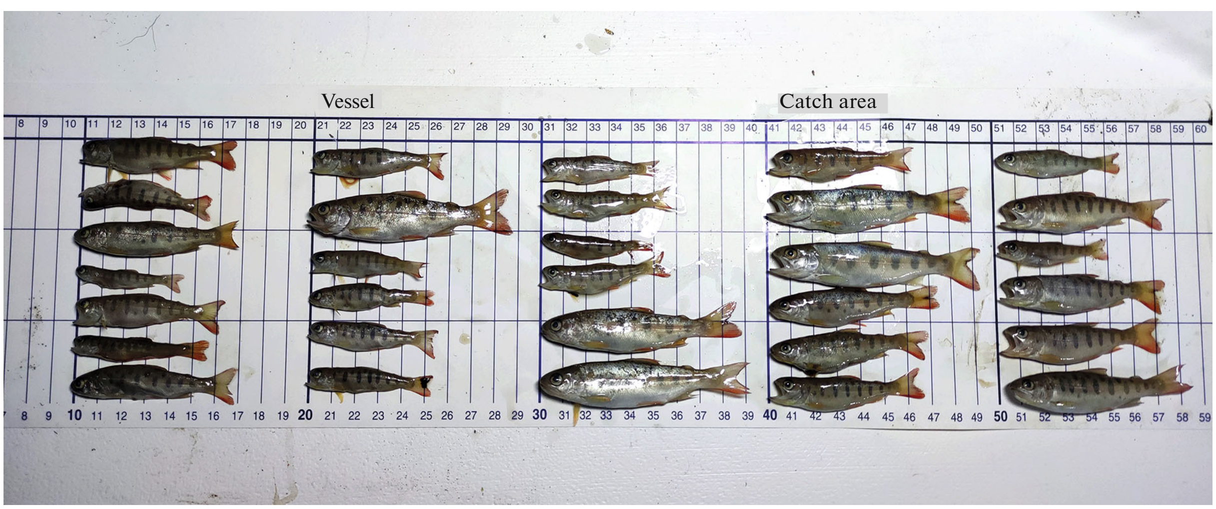

Fig. 10. Juveniles of *Oncorhynchus masou*.

with the parasitic *Peltogasterella gracilis* (invasion extensiveness or prevalence ~0.125%). One of the externae (in rhizocephalans, a body part located outside the host's body that fulfills reproductive function) exhibited a male larva (cyprid) settled on the externa cuticle in proximity to a mantle pore. This finding is of a particular value since the moment when male larva attaches to female externa can be rarely observed in the wild. Another hermit crab of the genus *Pagurus* (not yet identified) was found to have a parasite presumably belonging to the genus *Peltogaster* (invasion extensiveness ~0.125%). Our assumption is that this species can be described as novel since neither the host nor the parasite have been previously described from the Sea of Okhotsk. We collected 25 mitten crabs *Eriocheir* sp. in the Moguchi River estuary, nine of which proved to be infected with rhizocephalan *Polyascus gregarius* (invasion extensiveness 36%) (Fig. 11). Level of the extensiveness this high is rare in the wild in natural populations making this species a convenient model for a variety of studies using both the traditional morphological and molecular techniques. Of other parasites associated with hermit crabs, we found parasitic isopods belonging to the family Bopyridae. These ectoparasites commonly occur on abdomen and in gill chamber of the host. Besides, aggregations of microsporidia spores were encountered in hemocoele of hermit crabs. The crabs were infected not only with the parasitic rhizocephalans but also with trematode metacercariae.

Lack of microsporidia infection in other species of the same hermit crab genus (*Pagurus*) suggests that the infection is primarily transmitted in this case vertically (from parent to offspring).Otherwise, the horizontal pathway of infection transmission, involving an exchange between individuals of the same generation, would result in approximately the same probability (or incident rate) of infection among the cohabitating individuals of different species. At least, generally speaking, closely related host species are equally susceptible to one and microsporidia species [47, 48]. In hermit crab, infection manifested itself in the form of strong hypertrophy of the viscera with distinctive white patches visible through abdomen integument in the individuals removed from the shell (Fig. 12a). In contrast to the healthy crabs, the hemocoel in infected individuals was filled with hypertrophied tissue (Fig. 12b). Microscopic examination of smear revealed numerous spores, forming eight-spore groups (octospores), in the so-called sporophorous vesicle (Fig. 12c).

Investigation of levels of microparasitic infection in fish showed a significant rate of nematode *Salvelinema* sp. and *Salmonema* sp. infection in the masu salmon juveniles. Additionally, cestodes of the genus *Cyathocephallus* were recorded from the intestine of the masu salmon. Parasitological dissection of pink salmon showed the infection with plerocercoids of *Pelichnibothrium* sp., nematodes of the family Anisakidae, and the trematodes *Brachyphallus crenatus*.

Marine biology. Our findings indicate a high biological diversity of intertebrates and algae in the littoral and subtidal areas of Crillon peninsula. The littoral zone features two major biotopes silted up by sandy substrates with seagrasses of *Zostera* sp. as well as stony bottoms and rock outcrops. Various brown, coralline,

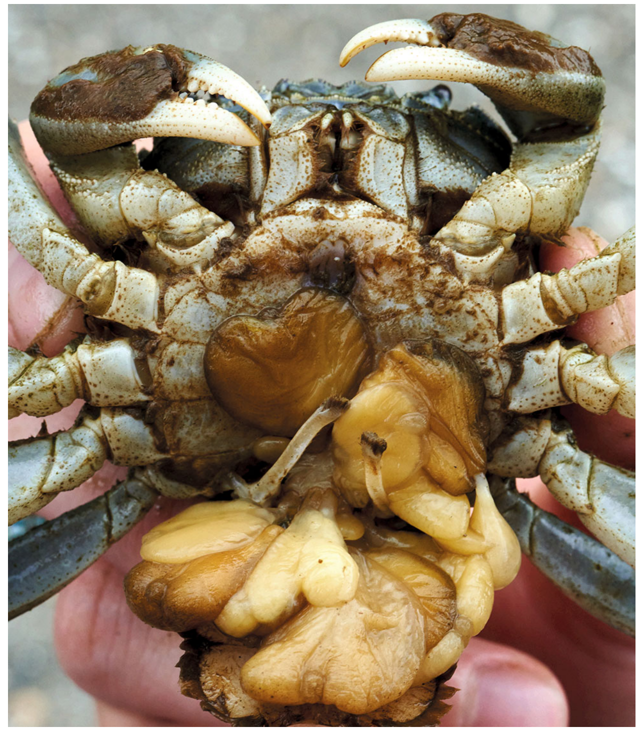

Fig. 11. Crab *Eriocheir* sp. infected with rhizocephalan *Polyascus gregarius*.

and green algae (chlorophytes) grow in the tidal pools. *Laminaria* communities occupy the depths from 0.5 m down. Seaweed was recorded to comprise red algae *Corallina officinalis*, *C. pilulifera*, *Congregatocarpus kurilensis*, *Neohypophyllum middendorffii*, *Neorhodomela larix*, *Ptilota asplenioides*, *Devaleraea* spp., *Constantinea subulifera*, *Besa japonica*, *Chondrus armatus*, and *Mazzaella* spp.; brown algae *Fucus distichus*, *Stephanocystis crassipes*, and *Alaria angusta*; and chlorophytes *Ulva lactuca* and *Chaetomorpha* sp. Alos, *Phyllospadix iwatensis* (phylum Magnoliophyta) were noted to occur.

In regard to the lower metazoan animals, the littoral zone and sublittoral fringe (0.5–1 m depths) are inhabited by sponges *Halichondria* spp.; sea anemones *Epiactis japonica* and *Anthopleura artemisia*; hydrozoan polyps *Sertularella* sp., *Sertularia* sp., *Orthopyxis* cf. *matsuensis*, and *Obelia longissima*; and stalked jellyfish *Haliclysthus borealis* (Staurozoa). Polychaetes (Polychaeta) were represented by the large number of species, namely, *Abarenicola pacifica*, *Chone* cf. *ecaudata*, *Eteone* spp., *Capitella* spp., *Harmathoe imbricata*, *Harmathoe* sp., *Glycinde* sp., *Nereis vexillosa*, *Nereis* sp., *Naineris* spp., *Eumida* sp., *Phyllodoce* sp., Syllidae gen. spp., and other species of the families Polynoidae, Spionidae, Sabellidae, Orbiniidae, Nereididae, Phyllodocidae, Maldanidae, Cirratulidae, and Terebellidae. Malacofauna included the chitons *Cryptochiton stelleri*, *Tonicella zotini*, *Boreochiton* sp., and *Schizoplax brandtii*; bivalves *Callista brevisiphonata*, *Ciliato-*

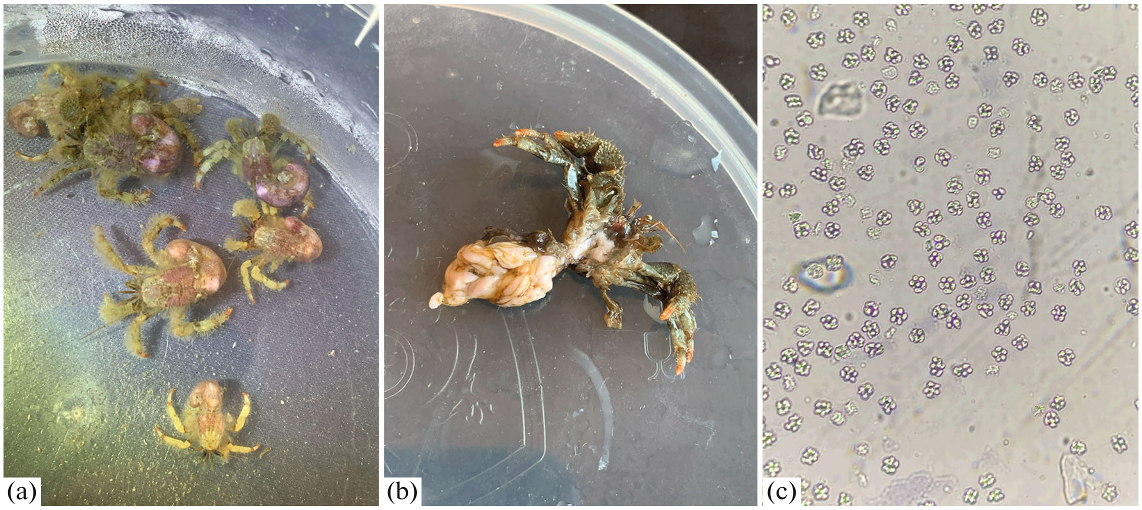

Fig. 12. Microsporidia infection in hermit crab *Pagurus* sp. (a) Appearance of infected individuals removed from the shell; (b) hypertrophied tissue of the viscera due to the parasite exposure; (c) spores of the parasite on fresh smear from infected tissues.

cardium sp., *Crenomytilus grayanus*, *Entodesma* sp., *Leucoma* sp., *Mizuhopecten yessoensis*, *Mytilus trossulus*, *Ruditapes philippinarum*, S*iliqua alta*, *Crassostrea gigas* (oyster), *Spisula sachalinensis* (surf clam), *Swiftopecten swiftii* (scallop), *Turtonia minuta*, and Veneridae gen. sp.; gastropods *Lottia borealis*, *L. instabilis*, *Mitrella burchardi*, *Nucella heyseana*, *Neptunea arthritica*, *Nassarius fratercuis*, *Buccinum percrassum*, *Ocinebrellus lumarius*, *Neptunea arthritica*, *Euspira pila*, *Lacuna* sp., common periwinkle *Littorina squalida*, *L. mandshurica*, and *L. sitkiana*, *Onoba* s.l., and *Cryptonatica janthostoma*; as well as *Eubranchus alexeii*, *E. rupium*, and *Cuthonella soboli* (nudibranchs). Of the detected ribbon worms, *Kulikovia manchenkoi*, *Tortus tokmakovae*, *Quasitetrastemma stimpsoni*, *Cephalotrix* spp., *Zygonemertes* sp., and *Oerstedia venusta* were found. In crustaceans, the highest diversity is characteristic of the amphipods *Ampithoe* sp., *A. valida*, *Trinorchestia* sp., *Spasskogammarus spasskii*, *Spasskogammarus* sp., *Platorchestia* sp., *Monocorophium indisiosum*, *Parallorchestes* spp., *Ishyrocerus* sp., *Jassa marmorata, Protohyale triangulata,* and Corophiidae gen. sp. Other crustacean species are represented by crabs: Japanese mitten crab *Eriocheir japonica*, helmet crab *Telmessus cheiragonus*, shore crab *Hemigrapsus takanoi*, red vermillion crab *Paralomis verrilli*; hermit crabs of *Pagurus* spp., mysids *Archaeomysis articulata*; isopods *Cliamenella fraudatrix*, *Idothea okhotensis*, and *Ianiropsis* sp., and barnacles *Chthamalus dalli*, *Megabalanus rosa*, and *Lepas anatifera*. Echinoderm fauna included sea urchins *Strongylocentrotus intermedius*, starfish *Asterias amurensis*, *Patiria pectinifera*, and brittle stars *Amphiopholis pugetana*. Photographs of the selected aforementioned species are shown in Figs. 13 and 14.

For a small number of species, this was the first record from Sakhalin; specifically, nudibranchs *Eubranchus rupium* and *E. alexeii*, limpets *Lottia boreali*s, and ribbon worm *Oerstedia venusta*. Findings of the amphipods *Protohyale triangulata*, *Platorchestia* cf. *pacifica*, and *Ampithoe valida* require additional verification by specialists on this group. At the same time, although the majority of species represented in our material are rather common littoral species dwelling in marine habitats of different seas in the Far East, they have morphological and genetic distinctions that might point to the hidden biodiversity. Our preliminary results indicate the need for a large-scale revision of biological diversity of various taxonomic groups both on Sakhalin and in the Far Eastern seas altogether, particularly in the case of Polychaeta, Amphipoda, and Hydrozoa, as well as several species of the phyla Mollusca and Nemertini. Molecular genetic studies of these specimens will form the basis for future taxonomical studies and lay the foundation for further insight into evolutionary relationships among groups of marine invertebrates in Russian seas and relations between separate biotas of the Northwestern Pacific as well as subsequent activities on monitoring of fauna of the Far Eastern seas.

Marine mammals, such as the spotted seal *Phoca lagra* and ringed seal *Pusa hispida* were recorded from Hirano Ridge (approximately 70 individuals) and close to the Anastasiya River mouth (250–300 individuals).

Mapping of marine benthic biotopes revealed an occurrence of their several types in the vicinity of the Moguchi River mouth: (1) silty gravel rock (stony, lentic biotope); (2) gravel rock with broken shelly limestone and smaller amount of silt (similar to silty gravel rock, but contains more stones of different sizes and a smaller number of silty patches); (3) silty sandstone (lotic biotope with the bottom formed of silted sand; and (4) rock outcrops. Each biotope features a charac-

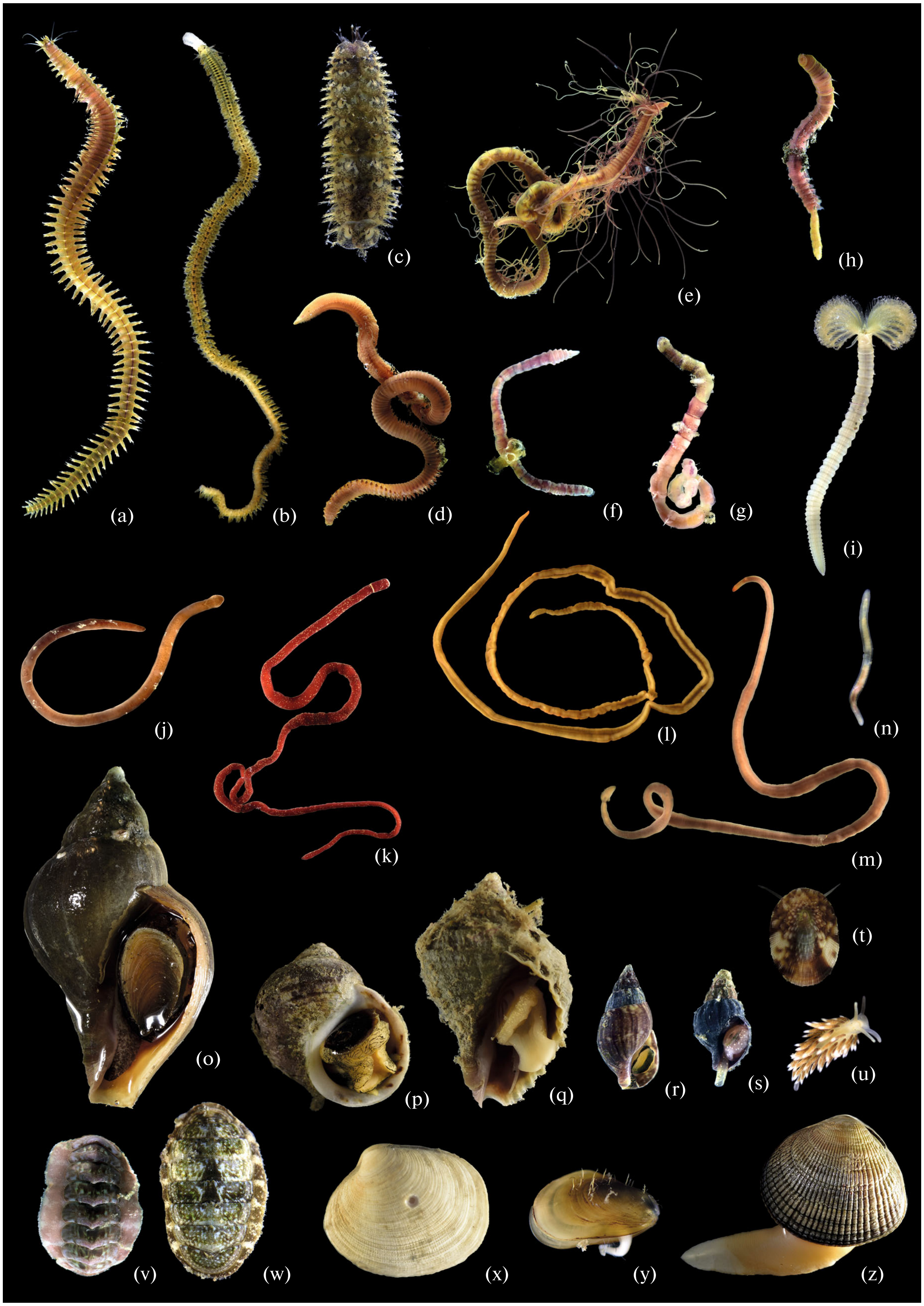

Fig. 13. Species of marine invertebrate animals in the littoral zone and sublittoral fringe (a) *Nereis vexillosa*; (b) *Phyllodoce* sp.; (c) *Harmathoe* sp.; (d) *Naineris jacutica*; (d) *Cirratulus* sp.; (f) *Capitella* sp.; (g) *Nicomache* sp.; (h) *Abarenicola pacifica*; (i) *Chone* cf. *ecaudata*; (j) *Tortus tokmakovae*; (k) *Kulikovia manchenkoi*; (l) *Cephalothrix* cf. *mokievskii*; (m) *Cephalothrix* sp.; (n) *Zygonemertes* sp.; (o) *Neptunea arthritica*; (p) *Littorina squalida*; (q) *Nucella heyseana*; (r) *Mitrella buchgardtii*; (s) *Nassarius fraternicus*; (t) *Lottia instabilis*; (u) *Cuthonella soboli*; (v) *Boreochiton* sp.; (w) *Shizoplax brandtii*; (x) *Ruditapes philippinarum*; (y) *Mytilus trossulus*; (z) *Ciliatocardium* sp.

Fig. 14. Species of marine invertebrate animals in the littoral and upper sublittoral zones. (a) *Eriocheir japonica*; (b) *Hemigrapsus takanoi*; (c) *Pagurus middendorffii*; (d) *Lepas anatifera*; (e) *Chthamalus dalli*; (f) *Megabalanus rosa*; (g) *Archaeomysis articulata*; (h) *Idothea okhotensis*; (i) *Cliamenella fraudatrix*; (j) *Caprella* sp. 1; (k) *Caprella* sp. 2; (l) *Spasskogammarus* sp.; (m) *Spasskogammarus spasski*; (n) *Platorchestia* cf. *pacifica*; (o) *Ampithoe valida*; (p) *Ampithoe* sp.; (q) *Jassa marmorata*; (r) *Ischyroceros* sp.; (s) *Parallorchestes* sp.; (t) *Protohyale triangulata*.

Fig. 15. Yellow-tail *Euproctis similis* reared in laboratory conditions. (a) Caterpillars, (b) prepupa, (c) pupa, (d) butterfly. Photo by D.S. Kireeva (All-Russia Institute of Plant Protection).

teristic unique community of invertebrate animals and algae.

Entomology and freshwater invertebrates. A collection of terrestrial insects was built up, representing the orthopterans (Acrididae), coleopterans (Cerambicidae and Chrysomelidae), lepidopterans (Erebidae, Crambidae, Pyralidae, and Lycaenidae), dipterans, and hymenopterans. Light trap assisted in catching the adults of the caddisflies *Dolophilodes nomugiensis*, *Eubasilissa regina*, *Goera japonica*, *Hydatophylax minor*, *Limnephilus orientalis*, and *L. sparsus*. This collection was created as a starting point for subsequent research into biodiversity of insects of South Sakhalin as well as their symbionts.

A focus of caterpillars of the first-second instar of the yellow-tail *Euproctis similis* was detected on nettle during a survey of herbaceous plants at the Moguchi River mouth. The species was identified based on the appearance of the caterpillars grown to the third to fourth instar. Foliage suitability of various herbacious and woody species was tested for caterpillar rearing in an artificial environment both during the expedition and after its completion in a laboratory setting (Fig. 15). The insects eagerly fed on leaves of a number of the woody plants widely distributed across Russia. In the absence of preferred plants, the caterpillars also consumed leaves of some herbaceous plants. On the other hand, multiple plants, growing on a large scale on South Sakhalin, were not damaged by the caterpillars in the field experiment.

Adults of the great tiger moth *Arctia caja* were trapped at the Naicha River mouth; the progeny was produced. This allowed us not only to determine a spectrum of plants adaptable for laboratory feeding of the caterpillar but also conduct an experiment on their rearing on artificial nutrient medium. These results offer a wide range of opportunities for a study of a dependence of insects' physiology and infectious pathology on nutritive conditions.

In freshwater communities of the surveyed area, occurrence of planarians, amphipods *Gammarus koreanus*; caddisflies *Apatania* sp., *Arctopsyche palpata*, *Dicosmoecus jozankeanus*, *Ecclisomyia kamtshatica*, *Hydatophylax* sp., Limnephilidae gen. sp., *Neophylax*

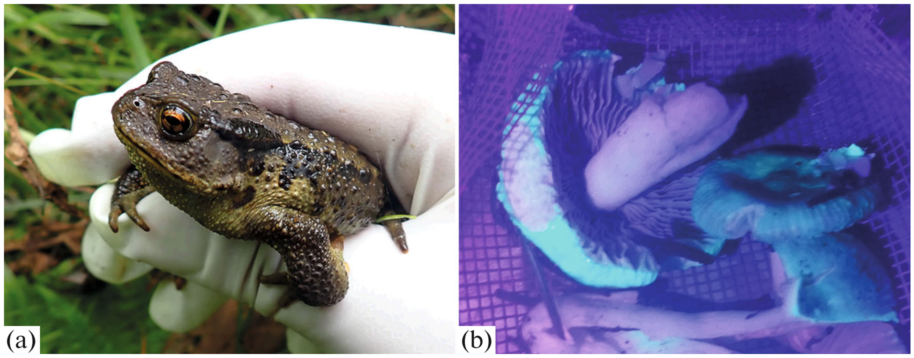

Fig. 16. (a) Sakhalin toad *Bufo sachalinensis*. (b) Induced fluorescence of the fruitbodies of *Russula nauseosa*.

ussuriensis, *Rhyacophila* spp., *Oligotricha lapponica*, and *Stenopsyche* aff. *marmorata;* mayflies *Baetis pseudothermicus*, *Drunella cryptomeria*, *Drunella* sp., *Ecdyonurus aspersus*, *Epeorus pellucidus*, *Ephemera japonica*, *Iron maculatus*, and *Rhitrogena lepnevae*; larvae of beetles as well as dipterans of the families Chironomidae, Culicidae, Tipulidae, and Limoniidae was noted. Besides, bivalves *Dahurinaia laevis* were recorded.

Microbiology and biophysics. Microflora samples from root systems of timothy-grass *Phleum pratense*, Siberian wild rye *Elymus sibiricus*, and Chishima Zasa *Sasa kurilensis* will be used to search for the possible symbionts that assist plants in breaking down and assimilating nutrients. According to the literature data, mucus of amphibians contains both the biologically active macromolecules (peptides and toxins) and entire communities of bacteria and viruses. For their study, mucus samples were collected from Sakhalin toad *Bufo sachalinensis* (Fig. 16a), Asiatic toad *Bufo gargarizans*, and Dybowski's frog *Rana dybowskii*. Examination of the found fungi samples in UV light (370 nm) allowed for detection of induced fluorescence of mucus in nauseous brittlegill *Russula nauseosa* (Fig. 16b), presumably due to mucus-hosted microorganisms collected for the analysis. Sampling and species identification of sea anemones was likewise accompanied by the momentary test exposure to UV light (370 nm) in a laboratory setting. One of the species identified as *Anthopleura artemisia* produced fluorescence of the tentacles in visible green spectrum.

Microbiological samples collected from substrate and water of the Moguchi, Naicha, and Riflyanka rivers will be used for further examination and biomolecule isolation as well as a design of novel biologically-derived antimicrobial formulations.

CONCLUSIONS

Data on species diversity was collected in an under-explored area of a southeastern part of the peninsula; specifically, more than 200 plant species, 101 lichen species, 74 moss species, and 117 species of basidiomycetes were recorded from the territory. Investigations were conducted, including by scientific diving, on marine communities in the sublittoral and littoral zones, from which 119 invertebrate species and 20 seaweed species were recorded. Information was collected for approximately 20 fish species, including the infection levels with helminths. Parasitology activities involved a search for microsporidia in all the available host animals as well as search for rhizocephalans, which are the arthropod parasites. Of the found animals, fungi, and plants, rare and endangered species were encountered, which are listed in the Regional and Federal Red Books as well as those previously not recorded from Sakhalin. Altogether, Sakhalin and neighboring islands, and particularly Crillon peninsula have a great introduction potential both from a perspective of biodiversity conservation and introduction to cultivation of ornamental plants. Our findings point to a great potential of further exploration of the eastern part of the peninsula from the biological perspective as well as prospect for establishment in this area of a biological station that will form the basis for conducting long-term studies and experiments as well as for applied research.

ACKNOWLEDGMENTS

We are grateful to L.S. Yakovchenko (Federal Scientific Center for Biodiversity of Terrestrial Ecosystems, Far East Branch, Russian Academy of Sciences, Vladivostok) and A.K. Ezhkin (Institute of Marine Geology and Geophysics, Far East Branch, Russian Academy of Sciences, Yuzhno-Sakhalinsk) for their assistance in lichens identification; A.D. Lyanguzova (St. Petersburg State University) for the assistance in parasitological analysis of crustaceans; as well as D.S. Kireeva (All-Russian Institute of Pant Protection, St. Petersburg) for conducting the experiments on laboratory rearing of lepidopteran insects and providing the photographs.

FUNDING

The work was supported by the Nonprofit Charitable Foundation Support for Biological Research, project nos. 1/2023-gr–10/2023 gr. Research on vascular plants (section of results Botany and Bryology) was carried out with the support of the state task “Biological diversity of natural and cultural flora: fundamental and applied issues of study and conservation”, State Registration no. 122042700002-6.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

No approval of research ethics committees was required to accomplish the goals of this study, except fish processing, because experimental work was conducted with an unregulated invertebrate species. Appropriate euthanasia techniques following American Veterinary Medical Association Guidelines for the Euthanasia of Animals (2013) were used during the fish study.

CONFLICT OF INTEREST

The authors of this work declare that they have no conflicts of interest.

REFERENCES

1. Tolmachev, A.I., *Geobotanicheskoe raionirovanie ostrova Sakhalina* (Geobotanical Zonation of Sakhalin Island), Moscow: Akad. Nauk SSSR, 1955.
2. Popov, M.G., *Rastitel’nyi mir Sakhalina* (The Plant World of Sakhalin), Moscow: Nauka, 1969.
3. Cherepanov, S.K., *Sosudistye rasteniya Rossii i sopredel’nykh gosudarstv* (Vascular Plants of Russia and Adjacent States (the Former USSR)), St. Petersburg: Mir Sem’ya, 1995.
4. Khomenko, Z., *Spravochnik po fizicheskoi geografii Sakhalinskoi oblasti* (Handbook of Physical Geography of the Sakhalin Region), Yuzhno-Sakhalinsk: Sakhalin. Kn. Izd., 2003.
5. Bogatov, V.V., Pitch, T.U., Storozhenko, S.Yu., Barkalov, V.Yu., Lelei, A.S., Kholin, S.K., Krestov, P.V., Kostenko, V.A., Makarchenko, E.A., Prozorova, L.A., and Shed’ko, S.V., Origin patterns of the terrestrial and freshwater biota of Sakhalin Island, *Vestn. Dal’nevost. Otd. Ross. Akad. Nauk*, 2006, vol. 2, pp. 32–47.
6. *Krasnaya kniga Sakhalinskoi oblasti: Rasteniya i griby* (Red Book of the Sakhalin Region: Plants and Fungi), Eremin, V.M. and Taran, A.A., Eds., Kemerovo, 2019.
7. Garibova, L.V., Bondartseva, M.A., Ivanov, A.I., Zmitrovich, I.V., Kotkova, V.M., Kovalenko, A.E., Morozova, O.V., Nezdoiminogo, E.L., Popov, E.S., and Rebriev, Yu.A., Fungi, in *Krasnaya kniga Rossiiskoi Federatsii* (*rasteniya i griby*) (Red Book of the Russian Federation (Plants and Fungi)), Moscow: KMK, 2008, pp. 753–782.
8. Bolshakov, S., Kalinina, L., Palomozhnykh, E., Potapov, K., Ageyev, D., Arslanov, S., Filippova, N., Palamarchuk, M., Tomchin, D., and Voronina, E., Agaricoid and boletoid fungi of Russia: the modern country-scale checklist of scientific names based on literature data, *Biol. Commun.*, 2021, vol. 66, no. 4, pp. 316–325.
9. Chabanenko, S.I., *Konspekt flory lishainikov yuga rossiiskogo Dal’nego Vostoka* (Conspectus of Lichens of the South of the Russian Far East), Vladivostok: Dal’nauka, 2002.
10. Urbanavichyus, G.P., *Spisok likhenoflory Rossii* (List of the Lichen Flora of Russia), St. Petersburg: Nauka, 2010.
11. Urbanavichyus, G.P., Features of the diversity of lichen flora in Russia, *Izv. Ross. Akad. Nauk, Ser. Geogr.*, 2011, vol. 1, pp. 67–78.
12. Dyldin, Yu.V., Orlov, A.M., Velikanov, A.Ya., Makeev, S.S., Romanov, V.I., Moruzi, I.V., and Ganel’, L., *Ikhtiofauna zaliva Aniva* (*ostrov Sakhalin, Okhotskoe more*) (Ichthyofauna of Aniva Bay (Sakhalin Island, Sea of Okhotsk)), Novosibirsk: Zolotoi Kolos, 2020.
13. Dyldin, Yu.V. and Orlov, A.M., Annotated list of ichthyofauna of inland and coastal waters of Sakhalin Island. 1. Families Petromyzontidae—Salmonidae, *J. Ichthyol.*, 2021, vol. 61, no. 1, pp. 48–79.
14. Dyldin, Yu.V. and Orlov, A.M., Annotated list of ichthyofauna of inland and coastal waters of Sakhalin Island. 2. Families Osmeridae—Scombridae, *J. Ichthyol.*, 2021, vol. 61, no. 6, pp. 519–553.
15. Dyldin, Yu.V. and Orlov, A.M., Annotated list of ichthyofauna of inland and coastal waters of Sakhalin Island. 3. Families Priacanthidae—Sebastidae, *J. Ichthyol.*, 2021, vol. 61, no. 6, pp. 832–866.
16. Dyldin, Yu.V. and Orlov, A.M., Annotated list of ichthyofauna of inland and coastal waters of Sakhalin Island. 4. Families Triglidae—Agonidae, *J. Ichthyol.*, 2022, vol. 62, no. 1, pp. 34–68.
17. Shevlyakov, E.A., Fel’dman, M.G., Ostrovskii, V.I., Volobuev, V.V., Kaev, A.M., Golub’, E.V., Barabanshchikov, E.I., and Golovanov, I.S., Limits and operational evaluation of the spawners escapement to the spawning grounds as tools for prospective and short-term management of the pacific salmon stocks in the rivers of the Far-Eastern fisheries basin, *Izv. Tikhookeansk. Nauchno-Issled. Rybokhoz. Tsentr*, 2019, vol. 196, pp. 23–62.
18. Shchukina, G.F., Galanin, D.A., Balkonskaya, L.A., Shpakova, T.A., Yakovlev, A.A., Sergeenko, V.A., and Chumakov, A.A., Structure and distribution of coastal bottom communities in the Aniva Bay, *Tr. Sakhalin. Nauchno-Issled. Inst. Rybn. Khoz. Okeanogr.*, 2003, vol. 5, pp. 3–24.
19. *Polevaya geobotanika* (Field Geobotany), Leningrad: Akad. Nauk SSSR, 1959–1972, vols. 1–2.
20. Shepeleva, L.F., *Struktura i dinamika lugovykh soobshchestv poimy Srednei Obi* (Structure and Dynamics of Meadow Communities in the Middle Ob Floodplain), Tomsk: Tomsk. Univ., 2019.
21. Bray, J.R. and Curtis, J.T., An ordination of the upland forest of the Southern Wisconsin, *Ecol. Monogr.*, 1957, vol. 27, no. 4, pp. 325–349.
22. Zverev, A.A., Methodological aspects of using indicator values in biodiversity analysis, *Contemp. Probl. Ecol.,* 2020, vol. 13, no. 4, pp. 321–332.

23. Bondartsev, A.S. and Zinger, R.A., *Rukovodstvo po sboru vysshikh bazidial'nykh gribov dlya nauchnogo ikh izucheniya* (Handbook to Collecting Higher Basidiomycetes for Scientific Study), Leningrad: Bot. Inst. im. *Komarova*, 1950, vol. II, no. 6, pp. 499–542.
24. Vasil'eva, L.N., Study of macroscopic fungi as components of plant communities, in *Polevaya geobotanika* (Field Geobotany), Moscow: Akad. Nauk SSSR, 1959, vol. 1, pp. 387–398.
25. Skvortsov, A.K., *Gerbarii. Posobie po metodike i tekhnike* (Herbaria: Introduction to Methods and Techniques), Moscow: Nauka, 1977.
26. Bondartseva, M.A., A critical review of the newest systems of the family Polyporaceae, *Bot. Zh.*, 1961, vol. 46, no. 4, pp. 587–593.
27. Bernicchia, A. and Gorjón, S.P., *Fungi Europaei,* Vol. 12: *Corticiaceae s. l.,* Alassio: Edizioni Candusso, 2010.
28. Dai, Y.C., Hymenochaetaceae (Basidiomycota) in China, *Fungal Diversity*, 2010, vol. 45, no. 1, pp. 131–343.
29. *Funga Nordica: Agaricoid, Boletoid, Clavarioid, Cyphelloid, and Gastroid Genera*, Copenhagen: Nordsvamp, 2012.
30. Cui, B.K., Li, H.J., Ji, X., Zhou, J.L., Song, J., Si J., Yang, Z.Li., and Dai, Y.C., Species diversity, taxonomy, and phylogeny of Polyporaceae (Basidiomycota) in China, *Fungal Diversity*, 2019, vol. 97, pp. 137–392.
31. Andreev, M.P., Akhti, T., Voitsekhovich, A.A., Gagarina, L.V., Gerasimova, Yu.V., Gimel'brant, D.E., Davydov, E.A., Konoreva, L.A., Kuznetsova, E.S., Makryi, T.V., Nadeina, O.V., Randlane, T., Saag, A., Sokolova, I.S., Stepanchikova, I.S., and Urbanavichyus, G.P., *Flora lishainikov Rossii: Biologiya, ekologiya, raznoobrazie, rasprostranenie i metody izucheniya lishainikov* (The Lichen Flora of Russia. Biology, Ecology, Diversity, Distribution, and Methods to Study Lichens), Moscow: KMK, 2014.
32. Culberson, C.F. and Kristinsson, H.A., A standardized method for the identification of lichen products, *J. Chromatogr. A,* 1970, vol. 46, pp. 85–93.
33. Vainshtein, E.A., Ravinskaya, A.P., and Shapiro, I.A., *Spravochnoe posobie po khemotaksonomii lishainikov* (A Handbook to Lichen Chemotaxonomy), Leningrad: Bot. Inst., 1990.
34. *Metodicheskie rekomendatsii po uchetu chislennosti tikhookeanskikh lososei v rekakh Sakhalinskoi oblasti* (Methodological Recommendations for Counting the Number of Pacific Salmon in the Rivers of the Sakhalin Oblast), Yuzhno-Sakhalinsk: Sakhalin. Nauchno-Isslef. Inst. Rybn. Khoz. Okeanogr., 2013.
35. Pravdin, I.F., *Rukovodstvo po izucheniyu ryb* (Guide to the Study of Fish), Moscow: Pishch. Prom-st., 1966.
36. Glagoleva, T.N., *Instruktsiya po klinicheskomu analizu krovi molodi lososevykh ryb v usloviyakh rybovodnykh khozyaistv s tsel'yu otsenki ikh fiziologicheskogo sostoyaniya i differentsial'noi diagnostiki zabolevanii* (Instruction for Clinical Analysis of Blood of Salmon Juveniles in Fish Farms to Evaluate Their Physiological Status and Differential Diagnostics of Diseases), Riga: Balt. Nauchno-Issled. Inst. Rybn. Khoz., 1985.
37. Ivanova, N.T., *Atlas kletok krovi ryb* (The Atlas of Blood Cells of Fish), Moscow: Legk. Pishch. Prom-st, 1983.
38. Bykhovskaya-Pavlovskaya, I.E., *Parazity ryb. Rukovodstvo po izucheniyu* (Fish Parasites: A Guide to Learning), Leningrad: Nauka, 1985.
39. Klimpel, S., Kuhn, T., Münster, J., Dörge, D.D., Klapper, R., and Kochmann, J., *Parasites of Marine Fish and Cephalopods,* New York: Springer-Verlag, 2019.
40. Blinova, E.I., Vilkova, O.Yu., Milyutin, D.M., Pronina, O.A., and Shtrik, V.A., Methods of landscape research and assessment of stocks of benthic invertebrates and algae of the marine coastal zone, in *Izuchenie ekosistem rybokhozyaistvennykh vodoemov, sbor i obrabotka dannykh o vodnykh biologicheskikh resursakh, tekhnika i tekhnologiya ikh dobychi i pererabotki* (Study of Ecosystem of Commercial Fishery Water Bodies, Collection and Treatment of Data on Aquatic Biological Resources, and the Technique and Technology of Their Collection and Processing), Moscow: VNIRO, 2005, vol. 3.
41. Dunaev, E.A., *Metody ekologo-entomologicheskikh issledovanii* (Methods of Ecological and Entomological Research), Moscow: MosgorSYuN.
42. Vshivkova, T.S., Ivanenko, N.V., Yakimenko, L.V., and Drozdov, K.A., *Vvedenie v biomonitoring presnykh vod* (Introduction to Freshwater Biomonitoring), Vladivostok: Vladivost. Gos. Univ. Ekon. Servisa, 2019.
43. Konoreva, L.A., Chesnokov, S.V., Yakovchenko, L.S., Ohmura, Y., and Davydov, E.A., New records to the lichen biota of Russia, 1: Sakhalin oblast, with new records for the Russian Far East and the Asian part of Russia, *Botanica Pacifica*, 2020, vol. 9, no. 2, pp. 161–173.
44. Ezhkin, A.K., Lichens of the Natural Monument "Highlands of Chekhov Mountain," Sakhalin Island, *Biota Sreda Zapov. Territ.*, 2020, no. 4, pp. 25–38.
45. Yakovchenko, L., Davydov, E.A., Paukov, A., Konoreva, L., Chesnokov, S., and Ohmura, Y., New records of arctic-alpine lichens from the Russian Far East, *Herzogia*, 2020, vol. 33, no. 6, pp. 455–472.
46. Davydov, E.A., Yakovchenko, L.S., Galanina, I., Paukov, A., Frolov, I., and Ahti, T., New records of lichens from the Russian Far East. III. Lichens of coastal habitats, *Turczaninowia*, 2021, vol. 24, no. 1, pp. 25–36.
47. Issi, I.V., Microsporidia as a phylum of parasitic protozoa, *Protozoologiya*, 1986, vol. 10, pp. 6–135.
48. Tokarev, Y.S., Kireeva, D.S., Ignatieva, A.N., Ageev, A.A., Gerus, A.V., Yaroslavtseva, O.N., Kononchuk, A.G., and Malysh, Y.M., Ecological vs. physiological host specificity: the case of the microsporidium *Nosema pyrausta* (Paillot) Weiser, 1961, *Acta Biol. Sib.*, 2022, vol. 8, pp. 297–316.

Translated by E. Kuznetsova

Publisher's Note. Allerton Press remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.