

SEAGRASSES AT THE ISLANDS ITURUP AND URUP OF KURIL ARCHIPELAGO

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ABSTRACT. The islands Iturup and Urup of Kuril Archipelago have been understudied in respect of seagrasses. The research aimed to fill this gap. In 2019 during the expedition of the Russian Geographical Society a part of the coastline has been surveyed by walking, the beached remains of seagrasses and the seagrasses growing on the littoral have been registered. The length of the routes was 95 km. The possible sources of negative anthropogenic impact have been examined. Herbarium collections of several institutions (LE, LECB, MHA, MW, MWG, SAK, Kamchatka Branch of Pacific Geographical Institute of the RAS, the Herbarium of Kronotsky Nature Reserve) have been explored. Three species of seagrasses occur at Iturup and Urup: *Zostera marina* L., *Zostera asiatica* Miki, and *Phyllospadix iwatensis* Makino. The last two species are of particular interest as they are threatened and distributed over a relatively small area. Unlike the habitats of the main part of their range located at the coasts of Japan and Korea, the habitats of the studied islands do not suffer from anthropogenic pressure. The discovered northern refuge is significant for the seagrasses conservation. Current global warming and increasing anthropogenic pressure on the southern habitat would increase its significance. It is especially important for *Phyllospadix iwatensis* as it turned out to be rather numerous at the studied islands. The other two species occur in small numbers there.

KEYWORDS: seagrasses, Zosteraceae, *Zostera marina*, *Zostera asiatica*, *Phyllospadix iwatensis*, Kuril Islands

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INTRODUCTION

Seagrasses are a group of underwater monocotyledonous plants (Monocotylendoneae - Alismatales) widely distributed over coastal waters of all continents except Antarctica (Hogarth 2015). Their congregations form «underwater meadows» providing an environment for numerous animals and algae; these meadows are especially valuable habitats (Nagelkerken and Velde 2004). Seagrasses are sensitive to anthropogenic influences. Economic activity in the coastal zone increases eutrophication, siltation, and turbidity in shallow waters causing the decline of the underwater meadows (Duarte 2002; Short et al. 2011; Unsworth et al. 2014). The intentional extermination of seagrasses by humans also occurs as they are used as raw materials for the manufacture of various products. Many species of seagrasses are declining (Orth 2006; Waycott and Williams 2006). This happens especially dramatically in the case of species having a small range. Such species are known for the coastal waters of Japan, Korea, and neighboring territories of Russia and China. *Phyllospadix iwatensis* Makino and *Zostera asiatica* Miki belong to this category. The first one was assigned to the

«vulnerable» category of the IUCN red list, the second one – to «near-threatened» but approaching «vulnerable»; in Japan, it is considered «vulnerable» (Short and Waycott 2010ab). The northern parts of the range of these species, i.e. coastal waters of Russia are insufficiently studied. Most of the performed studies took place on the southern coasts of the mainland (Kalita and Skriptsova 2014; Levenets and Lebedev 2015; Mitina et al. 2016; Kulepanov and Drobyazin 2018). The relatively northern waters including the Kuril Islands remain especially understudied. The specimens from the Kuril Islands were mentioned in Russian sources, but without details; most of the studies in this field were carried out in the 1960s (Kusakin et al. 1974; Ivanova and Tsurpalo 2017). Moreover, some data on the seagrasses of southern Kuril Islands were obtained in 1990–2000 in process of studies of algae (Evseeva 2007). According to these sources, *Phyllospadix iwatensis* occurs at Iturup Island; and its occurrence at Urup is likely as it was noted at Simushir Island located northwards from Urup. Moreover, *Zostera marina* L. was reported for Iturup. This species is not considered threatened globally and has a big range (Short et al. 2010). However, it still draws attention. In the past, it was especially abundant forming underwater meadows,

but now these meadows are shrinking rapidly. It concerns not only general challenges to biodiversity conservation but commercial fisheries as well, as fishes use them as substrates for spawning (Klimova et al. 2015).

The information of the seagrasses at Kuril Islands required updating. We have done this work for the Urup and Iturup islands, which are the largest islands of the Kuril archipelago. Our hypothesis was that threatened seagrasses are in a good state at these islands in contrast to the main part of the range, because, unlike the latter, the islands are poorly developed in terms of economic activity and settlement. Here we present the results of its testing.

MATERIAL AND METHODS

Iturup and Urup islands are ribbon-shaped with uneven edges stretching out from southwest to the northeast (Fig. 1). Iturup is 200 km long, its width is from 7 to 27 km; Urup is 117 km long and up to 20 km wide. Iturup is populated and developed compared to the other Kuril Islands, but the developed plots occupy a small part of its territory. Only 6500 people live there, while most of the population is concentrated in the middle of the island. The southern half of the island is considered a protected area; visits are usually not allowed there. Urup is almost undeveloped and unpopulated (Atlas of the Kuril Islands 2009). There are two lighthouses located at its southern and northern extremes, where a few people reside. Recently, mining for gold has started on the southern end of the island, and a small shift camp was built. Both islands are distant from the mainland; the possibilities for their survey are limited by short expeditions.

In 2019, an expedition for a comprehensive study of the islands Iturup and Urup was organized by the Russian Geographical Society. It took place from July 17 to September 25. We took this opportunity to study seagrasses. On both islands we surveyed sections of the coastlines by traveling on foot; doing so, we recorded congregations of seagrasses in the water, visible from the shore, as well as the

beached remains. In such a way most of the obtained data concern *Phyllospadix iwatensis* as it inhabits the shallow waters up to the depths of 4.5 m. The other seagrasses usually occur deep, therefore we could only register their beached remains. We described the specifics of surveyed habitats, including possible sources of negative impacts. The length of the routes was 55 km on Iturup and 40 km on Urup (Fig. 1). The herbarium specimens have been collected and stored in Tsitsin Main Moscow Botanical Garden of Academy of Sciences (MHA); they have been used in the studies on phylogeny and morphology (Iurmanov et al., 2020, 2021). The species identification was carried out using the Keys to Plants of the Soviet Far East (Voroshilov 1982).

In addition to the survey we looked for the information on seagrasses at Urup and Iturup islands in the herbarium collections of several institutions: Komarov Botanical Institute (LE), Saint Petersburg State University (LECB), Tsitsin Main Moscow Botanical Garden of Academy of Sciences (MHA), Moscow State University Faculty of Biology (MW), and Faculty of Geography (MWG), Institute of Marine Geology and Geophysics Far Eastern Branch Russian Academy of Sciences (SAK), Kamchatka Branch of Pacific Geographical Institute of the Russian Academy of Sciences (PGI FEB RAS, Petropavlovsk-Kamchatsky, the acronym of the herbarium is missing), the Herbarium of Kronotsky Nature Reserve (KR, Elizovo, the acronym of the herbarium is missing).

RESULTS

We have found *Phyllospadix iwatensis* on both islands. In Iturup islands the growing individuals and beached remains occurred at south-eastern and western coasts. It was registered at the coastline growing on various substrates – boulders, sand plots between stones, or dense tufa (Fig. 1). In some places it formed small underwater meadows, solitary individuals also occurred. The seagrasses growing on tufa had especially big rhizomes; it was up to 7 mm thick; these rhizomes formed dense tussocks. The grasses on sand have not formed such tussocks; they were much thinner;

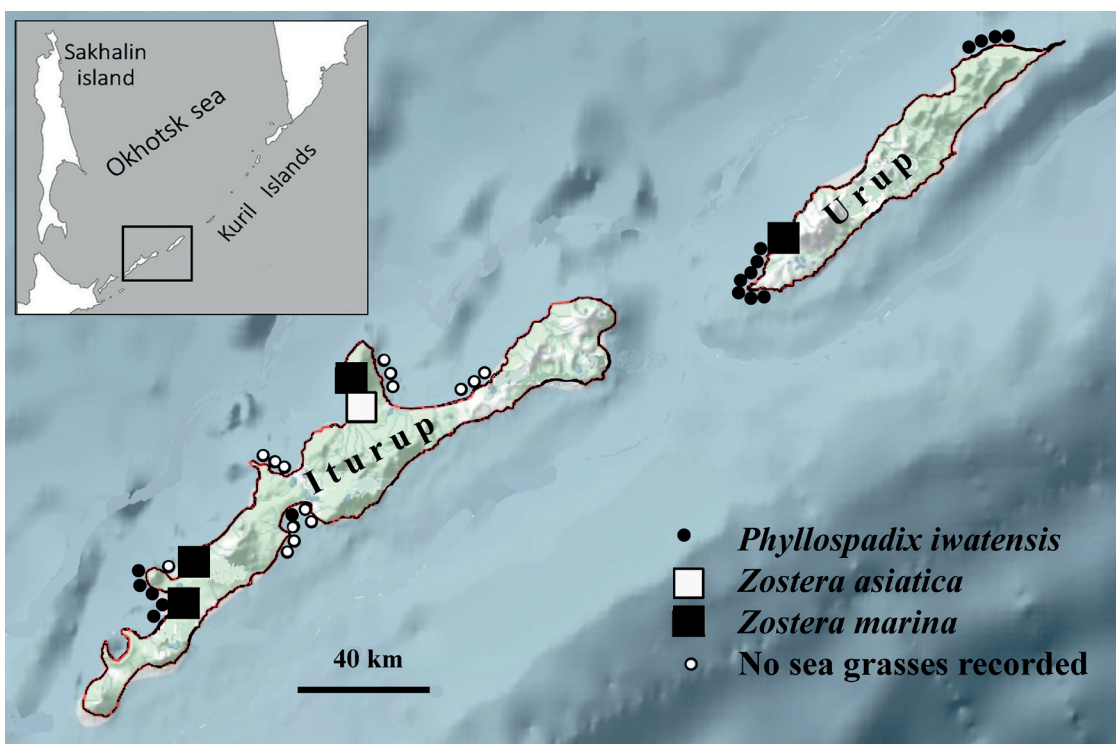


Fig. 1. Study area and the results of the survey: ● – records of *Phyllospadix iwatensis*, ■ – records of *Zostera marina*, □ – record of *Zostera asiatica*, ○ – no sea grasses found (decipher the symbols on the map: square, empty circle, full circle)

their rhizome was about 1.5 thick. The coast section, in which it was not found, represented beaches with sand or peddles. As for the Urup islands, *Phyllospadix iwatensis* was found over the entire surveyed area. Especially big aggregations were observed in the northern section. In addition to *Phyllospadix iwatensis* we registered species of *Zostera*. The beached remains of *Zostera marina* were found in both islands. One specimen of *Zostera asiatica* was found at the Kurilsk City on Iturup; it is the most populated place. All beached remains were not numerous compared to algae. The latter were abundant; they often composed long stripes several meters wide at the coastline. Most of the bottom of the littoral was also covered by algae. The seagrasses usually occupied small depressions between stones covered by algae (Fig. 2).

No strong negative anthropogenic impacts on seagrasses have been identified. All surveyed areas of the coastline and littoral have been in their natural state. Development in the coastal zone affects an insignificant part of the water area – except for a few small berths, we have not seen any constructions. There was no aquaculture in the coastal area. Any other sources of intensive eutrophication were not found. The main economic activity on Iturup is associated with fishing, which is carried out by trap-nets affecting a little the seagrass habitats. The deposit exploration on Urup, at least at the time of the study, was distant from the coastal zone.

The studied herbarium collections do not have specimens from Iturup and Urup. There are some data only for the territory nearby. In the islands located southwards from Iturup the same species were registered, as well as the other species *Zostera japonica*. Northern Kuril Islands represent a gap in collections. Further north, in Kamchatka and Commander Islands, only *Zostera marina* occurs.

DISCUSSION

The obtained data indicate the fact that seagrasses are rather common around the islands Urup and Iturup. However, their biomass is not very big and they hardly form big areas of underwater meadows. Had they been

abundant, their beached remains would be much more numerous. In the case of big numbers of seagrasses, their remains in wrack zone formed barrages up to 1.5 high after storms; their commercial use was possible (Morozova-Vodianitskaya 1939). The amount of such organic materials can be so large that it affects to development of marine shores (Vacchi et al., 2017). In the case of Kurils, the storms can be very strong, but even small «stacks» of seagrasses were not found. Probably, the lack of suitable substrates and relatively small areas of shallow waters restrict their number. Despite this, the revealed habitats are significant at least for *Phyllospadix iwatensis*. A small number of registration sites are known for this species in the main part of the range, and they are located near the coasts exposed to strong anthropogenic pressure. In our case, the habitats occupy a large area and nothing threatens them so far. The economic activity develops slowly and has little effect on seagrasses. The direct extermination of seagrasses is also not expected in a near future over studied area. Seagrasses were harvested in the 1930-1960s in the Russian Far East as stuff for upholstered furniture and a packaging material (Kulepanov 2005), as well as for the manufacture of paper and fertilizers (Kardakova 1953). But currently seagrasses is not in use for the activity. The use of seagrasses is considered in the context of possibilities for extraction of therapeutic and prophylactic substances (Aminina 2005), but large-scale harvesting still does not take place. Although it should be noted that seagrasses are not considered protected in Russia, they are still discussed by scientists in the context of the search for potential raw materials, but not an object requiring conservation measures (Dulenin 2012; Mitina et al. 2016).

Since the seagrasses were not properly investigated in the past in the area under consideration, we do not know for sure whether the *Phyllospadix iwatensis* or *Zostera asiatica* lived there «initially», or they have recently increased in numbers and expanded the range due to climatic changes. Anyway, the surveyed islands turned out to be a «reserve» for vulnerable species of seagrasses, at least for *Phyllospadix iwatensis*. The lack of suitable substrates is believed to be the reason for the limited distribution



Fig. 2. Typical aggregation of *Phyllospadix iwatensis*, the northern coast of Urup Island. 2.09.2019. Photo by Igor Popov

of this species (Iurmanov, 2022a). Unlike most seagrasses it inhabits the specific congregations of stony substrates. Suitable habitats have a small area for natural reason, therefore with an increase of anthropogenic impact the risk of catastrophic decline is high. In the Chinese part of the range, this has already happened because of extensive kelp aquaculture (Short and Waycott 2010a). In our case, the habitats occupy a large area. Probably, the same is true for the northern Kuril Islands. Taking into account the current global warming this extension can be relatively large. The boundaries of the ranges of several species are currently shifting northwards (Loarie et al. 2009). It is possible that this also concerns the seagrasses at the Kuril Islands. When discussing the impact of climate warming on seagrasses, the negative impacts drew main attention: overgrowth of algae, increase of eutrophication, increase of frequency of storms that either directly destroy grasses, or increase turbidity, etc. (Short and Neckles 1999; Björk et al. 2008). However, the impact of climate warming may be rather positive for some species as it contributes the extension of their habitats.

As for the observed *Zostera* species, they remain understudied during our survey, because only beached

remains were registered. They could have been brought from anywhere. However, it is more likely that they sailed from a nearby point than from afar (Iurmanov et al., 2022b). This is especially true for *Zostera asiatica* as it is not abundant. Probably, the Kuril Islands is a «reserve» for this species as well.

CONCLUSIONS

A refuge for the vulnerable seagrasses species was formed at the southern Kuril Islands. There are no negative anthropogenic influences on the habitats of seagrasses. The role of this refuge will increase in the foreseeable future because the main part of their range is located southwards, while in the south the anthropogenic pressure is strong, the habitats of seagrasses are undergoing negative changes. At the same time, northern habitats are becoming more favorable for seagrasses due to global warming. The coastal waters of surveyed islands Urup and Iturup are especially important for the species *Phyllospadix iwatensis*. It turned out to be rather numerous, but it is rapidly declining in the main part of the range located in the waters at Japan, Korea, and the neighboring part of China. ■

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