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EXPERIMENTAL ARTICLES

Arenicolous Mycelial Fungi from the Littoral of the Vostok Bay (Peter the Great Bay, the Sea of Japan)

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Abstract—The taxonomic composition of marine mycelial fungi was determined in the interstitial habitats of the Vostok Bay littoral (Peter the Great Bay, the Sea of Japan). A total of 39 species of ascomycetes and anamorphic fungi were detected and identified. The predominant species of the intertidal zone were *Corollospora maritima, C. lacera, Carbosphaerella leptosphaerioides, Arenariomyces trifurcatus* (*Ascomycota*), *Alternaria alternata, Scolecobasidium arenarium*, and *Zalerion maritimum* (anamorphic fungi). The complete list of species of obligately marine ascomycetes and anamorphic fungi from the interstitial habitats of the Vostok Bay littoral is presented for the first time

Key words: marine mycelial fungi, arenicolous fungi, *Ascomycota*, anamorphic fungi, the Vostok Bay, the Sea of Japan.

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The intertidal zone (littoral), including its upper part (spray zone), is a border between sea and seashore, inhabited by both marine and terrestrial fungi [1–4]. Sands are among the most widespread kinds of ground for both the littoral and offshore area; they occupy up to 40% of the area of the sea bottom [5].

The interstitial environments of the intertidal zone and spray zone where algae and seaweed are delivered are a habitat for the obligately marine mycelial micromycetes, including ascomycetes, anamorphic fungi, and zygomycetes. These fungi are well adapted to this biotope; they survive friction of sand particles, drying during the low tide period (viability of dry fungi is retained for several days), high air temperatures, and irradiation with the ultraviolet part of the solar spectrum [2, 6].

The fungi of interstitial environments are an important component of the littoral trophic chain; they decompose organic matter (cellulose and lignin from higher plants [7–10], alginates and laminarin from brown algae [11–13], and agar from red algae); these compounds are not utilized by the interstitial animals which feed on fungal hyphae and spores [2]. Fungal mycelium probably participates in the bioturbation processes, increasing the permeability of the surface layer of sandy soils [5].

In the interstitial biotopes, mycelial stages of marine fungi develop and sporiferous structures (ascoma and conidia) are formed. Mature ascospores and conidia are delivered to the water column and then to the sea foam. Spores of mycelial fungi, easily identifiable due to their characteristic appendages, are routinely detected in the foam [2].

Monitoring of marine biodiversity within the framework of the regional complex project of the Far East Division, Russian Academy of Sciences, is carried out on the Vostok Marine Biological Station, Zhirmunskii Institute of Marine Biology, located in the area of the Zaliv Vostok marine preserve [14].

Long-term investigation of arenicolous mycelial fungi in the Vostok Bay was carried out in spring–summer 1996–2006.

The goal of the work was investigation of the taxonomic composition of mycelial fungi developing in the interstitial habitats of the Vostok Bay littoral (Peter the Great Bay, the Sea of Japan).

MATERIALS AND METHODS

The fungi were collected from sand samples of the littoral zone, sea foam, and wooden (pine) test blocks ($5 \times 5 \times 2$ cm) buried in the littoral sand for a month.

The following techniques were used [1, 2]: collection and light microscopy of sand samples, detection of the fruiting bodies on sand grains and shell fragments in a Bogorov chamber under a dissection microscope; light microscopy of ascoma; collection and light microscopy of foam samples for detection of ascospores and conidia; and exposure of wooden test blocks in the littoral sand in the vicinity of the Vostok Marine Biological Station, in the Tikhaya Zavod' Bay

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Arenicolous Mycelial Fungi from the Littoral of the Vostok Bay

Fungal species	Interstitial habitats		Sea foam
	Sand grains	Test blocks	
Ascomycota			
Amylocarpus encephaloides Curr.	–	+	+
Arenariomyces trifurcatus Höhnk	+	–	+
Carbosphaerella leptosphaerioides I. Schmidt	+	–	+
Ceriosporopsis circumvestita (Kohlm.) Kohlm.	–	+	+
Ceriosporopsis halima Linder	–	+	+
C. tubulifera (Kohlm.) P.W. Kirk ex Kohlm.	–	+	+
Chaetomium globosum Kunze : Fr.	–	+	–
Corollospora cinnamomea Koch	+	–	–
C. filiformis Nakagiri et Tokura	+	–	–
C. intermedia E.B.G. Jones	–	–	+
Corollospora lacera (Linder) Kohlm.	+	–	+
C. maritima Werderm.	+	+	+
C. pulchella Kohlm., I. Schmidt et Nair	–	+	+
*C. pseudopulchell*a Nakagiri et Tokura	–	–	+
Crinigera maritima I. Schmidt	–	–	+
Halosphaeria appendiculata Linder	–	+	+
Halosphaeriopsis mediosetigera (Cribb et J.W. Cribb) T.W. Johnson	–	+	+
Lindra thalassiae Orpurt, Meyers, Boral et Simms	–	–	+
Lulworthia crassa Nakagiri	+	–	+
L. fucicola G.K. Sutherl.	+	+	+
Marinospora calyptrata (Kohlm.) A.R. Caval.	–	+	+
Nereiospora comata (Kohlm.) E.B.G. Jones, R.G. Johnson et S.T. Moss	–	+	+
22	8	12	19
Anamorphic fungi			
Alternaria alternata (Fr.:Fr.) Keisl.	–	+	+
Alternaria tenuissima (Kunze: Fr) Wiltshire	–	+	+
Asteromyces cruciatus Moreau et M. Moreau ex Hennebert	–	+	+
Cladosporium cladosporioides (Fresen.) G.A. de Vries	–	+	–
C. sphaerospermum Penz.	–	+	–
Epicoccum purpurascens Ehrenb. ex Schlecht.	–	+	–
Humicola allopallonella Meyers et R.T. Moore	–	+	–
Monodictys pelagica (T. Johnson) E.B.G. Jones	–	+	–
Paecilomyces carneus (Duché et Heim) A.H.S.Br. et G. Sm.	–	+	–
Sigmoidea luteola Nakagiri et Tubaki	–	+	–
Scolecobasidium arenarium (G.K. Sutherl.) M.B. Ellis	–	+	+
S. salinum (G.K. Sutherl.) M.B. Ellis	–	+	–
Stachybotrys atra Corda	–	+	–
Trichocladium achrasporum (Meyers et Moore) Dixon ex Shearer et Crane	–	+	–
Zalerion maritimum (Linder) Anastasiou	–	+	+
Z. varium Anastasiou	–	+	–
Phoma spp.	–	+	–
17	0	17	5
Total number of species: 39	8	29	24

(the Vostok Bay). Prior to the experiment, the test blocks were autoclaved; after exposure to marine biotopes, they were incubated under sterile conditions in moist chambers (desiccators) with sterile seawater in order to obtain the sporiferous structures of marine fungi. The samples were fixed with 4% formalin.

A total of 119 sand samples, 217 sea foam samples, and 44 wooden (pine) test blocks were treated.

Marine fungi were identified using identification guides and keys, as well as original articles [2, 15–20].

The complete species list of obligate marine ascomycetes and anamorphic fungi detected in the interstitial habitats of the Vostok Bay (Peter the Great Bay, the Sea of Japan) is presented here for the first time.

RESULTS AND DISCUSSION

In the littoral interstitial habitats of the Vostok Bay, 39 species of mycelial fungi were revealed, including 22 species of 13 ascomycete genera and 17 species of 13 genera of anamorphic fungi (Table). Previously, four species of obligate marine ascomycetes were found in the sandy habitats of the Peter the Great Bay, the Sea of Japan; their fruiting bodies were attached to sand grains. In sea foam, ascospores and conidia of eleven species of mycelial fungi were found [3, 21].

Application of different research techniques enabled us to detect marine fungi of different ecologo-taxonomic groups. Fruiting bodies of eight obligate marine ascomycetes (*Corollospora maritima, C. lacera, Carbosphaerella leptosphaerioides,* etc.) were found on sand grains (Table). These species are well adapted to interstitial habitats: in ammocolous species of the genera *Corollospora* and *Carbosphaerella*, sporangiocarps have thick, rigid carbonate walls; the neck is short or absent; and the ostiole is not noticed and is usually located at the base, close to the attachment site [2, 6]. In the littoral of the Vostok Bay, in interstitial habitats, fruiting bodies (pyrenocarps) of the ascomycete *Corollospora cinnamomea* were recovered once from sand grains. This species is known as a tropical one [22]. Its detection may be explained by anomalously high August water temperatures in the recent years (up to 28°C according to the data of the Hydrological Service, Institute of Marine Biology, Russian Academy of Sciences, Far East Division). Such conditions promoted introduction of subtropical or even tropical fungal species in the sampling area.

Mycelium and ascospores of 12 ascomycete species, as well as conidia of 17 species of obligate and facultative marine anamorphic fungi were detected on test blocks after incubation.

Ascospores of 19 ascomycete species and conidia of five species of obligate marine anamorphic fungi were detected in the sea foam (Table).

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