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CHOROLOGY

Features of the Spatial Distribution of the Japanese Mud Shrimp *Upogebia major* (De Haan, 1841) (Decapoda: Upogebiidae) in the Vostok Bay, Sea of Japan

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Abstract—In the estuary of the Volchanka River, Vostok Bay, Sea of Japan, the Japanese mud shrimp *Upogebia major* forms a population in the upper sublittoral zone at depths of 0.5–3 m in slightly silted sand. This population covers both open coastal bottom areas and a belt of the eelgrass *Zostera marina*, which is oriented parallel to the shoreline. The population density and biomass of the mud shrimp, as estimated by the abundance of holes on the ground surface, averaged 5.3 ± 4.6 ind./m^2 and 36.46 ± 16.74 g/m^2, respectively, and those calculated from the total sampling at counting sites were 4.2 ± 2.6 ind./m^2 and 28.90 ± 17.89 g/m^2, respectively. The biomass of the macrozoobenthos, which consisted of nine taxa, reached 87 g/m^2. Bivalves dominated in the community by biomass and slightly surpassed crustaceans, among which *U. major* dominated (33.2–41.9% of the total biomass of the macrozoobenthos).

Keywords: *Upogebia major*, spatial distribution, abundance, associated fauna, Peter the Great Bay, Sea of Japan

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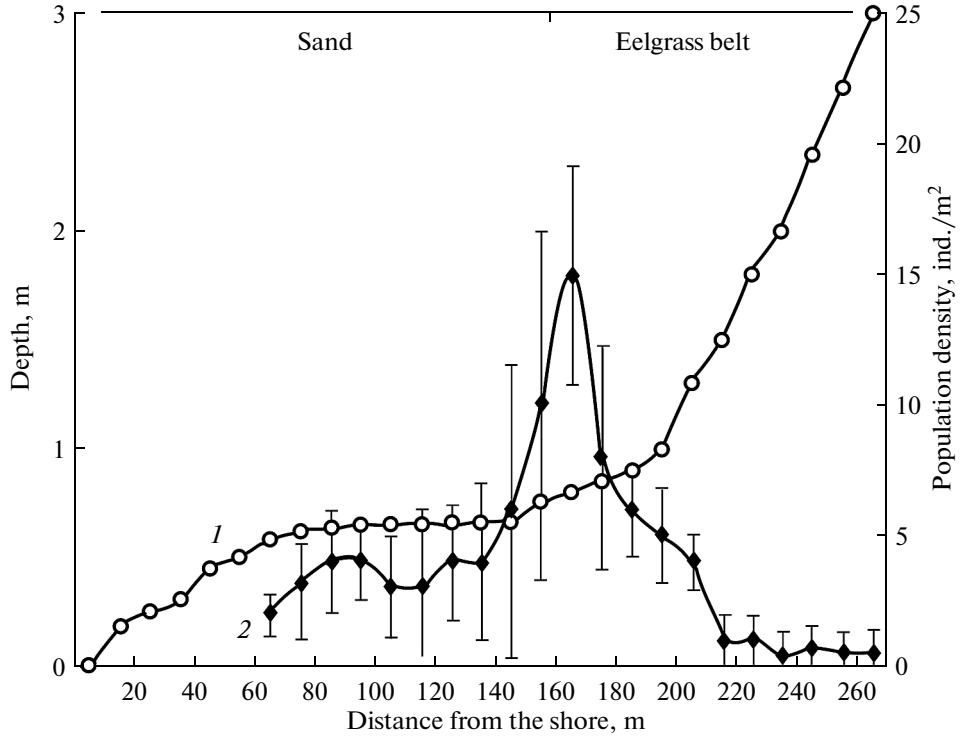
INTRODUCTION

Burrowing decapods are widespread in the oceans [13, 14, 22]. They take a relevant part in the biogeochemistry of marine bottom sediments and in the functioning of communities, creating a favorable environment for various infaunal and commensal organisms [8, 17, 24]. Therefore, in recent decades, the study of their biology has received a large amount of attention [4, 15]. Meanwhile, scientific data on burrowing Decapoda of the Russian waters are very scarce and fragmentary. Most of this data concerns specific findings of various species and brief description of their ranges [2, 5]. All of the above is true for the fairly large burrowing mud shrimp *Upogebia major*, recent data on which was recently supplemented by information on the existence of populations of this species in domestic waters, particularly in the Peter the Great Bay [6].

In this regard, features of the spatial distribution and the place of *U. major* in the composition of the shallow water coastal community of the macrozoobenthos of the Vostok Bay, which is a constituent part of the Peter the Great Bay, were studied.

MATERIALS AND METHODS

The spatial distribution of *Upogebia major* in a vast area of the bottom that extended over 700 meters (about 21 hectares) near the mouth of the Volchanka River, Vostok Bay, Sea of Japan was studied in the first half of June 2014. The abundance of mud shrimp was assessed by two techniques that are used in the study of burrowing crustaceans [12, 20, 23]. Following the first mode, five transects were laid, from the shore to a depth of 3 m at a distance of 140 m from each other crossing the areas of coastal silted sand bottom and the eelgrass *Zostera marina* distribution. The mud shrimp population density was assessed by the number of their burrows within a counting frame that was laid with intervals of 5 m on each transect. One burrow corresponded to two closely spaced holes, which were clearly visible on the sediment surface. According to the second mode, all individuals of *U. major* were sampled by applying a hydrostatic pump within a counting frame with a 1 m^2 area that was randomly allocated on the surveyed bottom site in 30 replications. In these sites, the composition and abundance of the associated macrofauna was analyzed, using the sieve with a mesh size of 1.5 mm for washing of ground excavated to a depth of 20 cm. The animals were identified and weighed in the laboratory. The role of *U. major* in the



The diagram of the spatial variation of the population density of *Upogebia major* from the Volchanka River estuary, Vostok Bay, Sea of Japan. (*1*) depth, (*2*) population density.

community was judged according to the ratio of the biomass of this species to the total biomass of the macrozoobenthos.

RESULTS

Distribution of the mud shrimp. In the surveyed area of the coast at the water's edge and at the point where the river flows into the bay, the bottom area was usually sand, with varying degrees of silting. At some distance from the shore there was a thick belt of the eelgrass *Zostera marina*, whose internal contour did not always follow the contours of the coastline. The width of the eelgrass belt varied from 5–10 to 35–60 m; within the belt, relatively small bottom areas that were not covered by sea grass were found.With a seaward move along the transects, some individuals of *Upogebia major* began to occur from depths of 50–60 cm and distances of 60–65 m from the beach (see the diagram). With a further move from the water's edge, the depth and population density of the mud shrimp increased, as in the area without vegetation and in the belt of *Z. marina*. The maximum values (24 ind./m^2) were observed in the 150–170 m distance from the shore at depths of approximately 1 m. At the seaward boundary of the eelgrass belt, the population density of the mud shrimp was low, viz., 0.3–0.5 ind./m^2. The average value of this parameter based on the abundance of burrows in the areas of five transects was 5.3 ± 4.6 ind./m^2 (mean ± standard deviation); the estimated value of the biomass was 36.46 ± 16.74 g/m^2. According to a quantified assessment of the animal abundance within the counting frames, the population density and biomass of the sea mud shrimp averaged 4.2 ± 2.6 ind./m^2 and 28.90 ± 17.89 g/m^2, respectively.

Associated fauna. Animals of nine large taxa, whose biomass averaged about 87 g/m^2, were recorded in the community structure. The bivalves *Ruditapes philippinarum, Nuttalia obscurata, Spisula sachalinensis, Laternula rostrata*, *Macoma* spp., and *Crassostrea gigas* dominated by biomass, 43.6 ± 36.3 g/m^2 or 50.1% of the total biomass of the fauna. The biomass of the crustaceans *Upogebia major*, *U. yokoyai, Nihonotrypaea japonica, Pagurus* sp., *Alpheus brevicristatus, Hemigrapsus penicillatus, Oratosquilla oratoria*, and several other smaller ones was slightly less, 38.3 ± 29.8 g/m^2 or 44.0% of the total. The biomass of the gastropods *Batillaria cumingii, Assiminea lutea, Cryptonatica janthostoma*, and *Nassarius multigranosus*, and the polychaetes *Pectinaria dimai* and *Abarenicola pacifica* was even less, 3.03 and 0.9 g/m^2, respectively, 4.5% in total. The ratio of turbellarians that regularly occurred in the samples was insignificant in the biomass of the macrozoobenthos, as well as those of nemertines, echiurids, starfishes, and ascidians, at 1.4% of the total.

The level of *U. major* in the estuarine community according to the different methods of biomass assessment reached 33.2 and 41.9%.

DISCUSSION

The peculiarity of the estuarine fauna determines the high scientific interest in the bottom population of this part of the water area. Estuaries of Primorye, whose southern part, the Peter the Great Bay, contains numerous rivers, are not an exception. The flora and fauna of the estuaries of most of these rivers have been well studied. It was found that bivalves, followed by gastropods and polychaetes, usually dominated in the macrozoobenthos according to abundance parameters [1, 3, 9]. However, no data on burrowing crustaceans are available in these studies. One of the causes may be the undercounting of infauna using the equipment that is traditional for domestic hydrobiology, which only enables one to catch animals that live in the upper sediment layers. Like many other species, *Upogebia major* goes deep into its burrow at the slightest disturbance, spreading in the ground up to 1.5–2.5 m in the adults [16, 18].

The validity of our assumption is corroborated by the fact that earlier when using a hydrostatic pump and stratified analysis of the composition of the population in the ground depth, extensive data was obtained. As a result, new species have been revealed in the fauna of the region [8, 21]; for a number of animals known from single finds, the real abundance estimates were obtained for the first time, the features of the spatial distribution and biology of reproduction were defined, and population parameters were given [10–12].

The data that have accumulated to date suggest that burrowing crustaceans, including *U. major*, are a common element of benthic communities of the Peter the Great Bay. Their populations are confined to the upper sublittoral zone, unlike most species from more southern parts of their range, whose densest aggregations were recorded in the littoral zone [19, 23, etc.]. These differences in defining the upper boundary of the distribution of burrowing decapods are caused by regional climate features. A significant number of the coves and bays of the vast area of the Peter the Great Bay are covered with ice in December–March, which limits the penetration of animals into the littoral zone, whose maximum level does not exceed 50 cm. Obviously, only ephemeral summer–autumn population of juveniles that recently settled from the plankton are possible in the intertidal zone.

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