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BIOCENOLOGY

Biocenoses of Anadyr Estuary (Bering Sea) and Conditions of Their Existence

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Abstract—Some bottom biocenoses in the river mouth area of Anadyr Estuary are studied. Seasonal biocenosis of filamentous algae *Acrosiphonia* spp. occurs in the intertidal zone, biocenosis of the bivalve *Macoma balthica* is common at a depth of 4–8 m. Species diversity increases with depth. The distribution of biocenoses and population structure depend on the hydrological regime and substrate type in the surveyed area.

Keywords: biocenosis, Anadyr Estuary, Bering Sea.
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There is actually no data available on the distribution of bottom biocenoses in the Anadyr Estuary (Bering Sea). The only exception is some information on the algae of this estuary gained from diving research in the early 1970s during an expedition of the VNIRO (All-Union Research Institute for Fisheries and Oceanography) [4]. In this regard, new data on the biocenoses of Anadyr Estuary would be of much interest.

MATERIAL AND METHODS

The materials were collected in August–September 1995, using SCUBA (a standard frame 0.1 m^2 in area), Petersen bottom sampler (with a grip area of 0.025 m^2), and bottom trawl (with cod end of 40 by 10 cm). The samples were collected along a hydrobiological transect crossing the Anadyr Estuary northward off Zaseleniya Cape and southward of Aleksandr Cape. Quantitative characteristics were obtained for two frame samples taken in the lower intertidal area and three bottom samples from 4–6 m deep. The samples were washed on sieves with a minimum mesh size of 0.5 mm^2. The trawlings were done for 5–7 min during a drift from aboard the river tow ship "TINRO" at 8 to 20 m deep.

To determine size–weight relationships, all specimens of common species were measured [1]. For these species, linear measurements in relation to age were approximated using a linear modification of the Bertalanffy equation. Biocenoses were distinguished on the basis of species dominating in terms of biomass. The expenses of zoobenthos for energy metabolism were calculated from the parabolic relationship of respiration to mean individual weight and population density (the coefficients of the equations were published earlier). The population production of certain species was calculated from K_2 following the well-known equation [5] and by an integral method [2]. Production of biocenosis was estimated as the sum of the productions in all trophic levels, less the assimilation of populations of predatory and herbivorous animals.

RESULTS AND DISCUSSION

The bottom biocenoses of the Anadyr Estuary in the area of Anadyr City are distributed in a belt-like fashion, and their species diversity increases with depth. This is due to hydrological regime and substrate type. Two types of biocenoses were identified in the investigated area.

A seasonal biocenosis of filamentous algae *Acrosiphonia* spp. is found on stones, pebbles, and sand in low intertidal zone, from 0–0.2 m deep. In addition to the algae, several species of amphipods, chiefly *Gammarus setosus* and an aquatic sowbug *Saduria entomon*, which are typical inhabitants of desalinated waters, commonly occur here in summer. The inhabitants of this biotope are exposed to sharp variations of environmental factors (salinity and temperature, which fluctuates from negative values to 17°C and above) and the abrasive effects of ice. The population density and biomass in the biocenosis are 140 ± 15 indiv./m^2 and 119.2 ± 9.6 g/m^2, respectively. The annual production of the biocenosis is up to 101.5 ± 5.46 kcal/m^2. Modifications of a similar community were encountered along the eastern coast of Chaunskaya Inlet in the East Siberian Sea; however, their annual production was merely 26 ± 7 kcal/m^2, which is due to the harsher environmental conditions [3].

In greater depths, on dense, patchily distributed fine sand, sound sampling was not done; however, amphipods, sowbugs, and polychaete worms evidently occur there.

At depths from 4–8 m, on clayey silt with stones a biocenosis of the bivalve mollusk *Macoma balthica* is found, with a dominant species density and biomass of 210 ± 7 indiv./m^2 and 83.3 ± 34.2 g/m^2 respectively. According to the size–age structure of *M. balthica* population, its life span in Anadyr Estuary is more than 3 years. Judging from the maximum size of shells ($28 \times 23 \times 11$ mm) found in beach mounds, the individual mollusks can live as long as 5 years; the population production of this species is 178 ± 44 kcal/m^2 per year at a relatively high annual metabolic rate (P/B = 1.24). It is noteworthy that the *M. balthica* population inhabiting Chaunskaya Inlet at 1.5–3 m deep at the mouth of the Appapel'khin River in all quantitative characteristics does not differ significantly and produces up to 205 ± 58 kcal/m^2 per years [3].

In the nektobenthic horizon of this biocenosis, the sowbug *S. entomon* and amphipods of at least two species occur. In the epifauna, the bryozoan *Eucratea loricata* and cumacean *Diastylis* sp. are common. The infauna is relatively rich in species; along with *M. balthica* there were found several species of polychaetes, among them the common species *Ampharete vega*, a priapulid *Priapulus caudatus,* and oligochaetes. According to the feeding mode, detritophages are the dominating group. This biocenosis is markedly affected by water freshening, as indicated by the presence of typical brackish-water species. The population density and biomass of the biocenosis are 2310 ± 146 indiv./m^2 and 95.0 ± 34.2 g/m^2 respectively. The production of the biocenosis is 51.7 ± 3.2 kcal/m^2 per year.

The relationship of weight (W, g) to length (L, mm) and width (S, mm) of specimens is $W = 1.2 \pm 0.3L^{2.492 \pm 0.024} \times 10^{-4}$ for *S. entomon*, $W = 1.3 \pm 0.1L^{3.038 \pm 0.001} \times 10^{-4}$ for *M. balthica*, and $W = 3 \pm 0.01S^{2.496 \pm 0.001} \times 10^{3}$ for *A. vega.*

The relationship between length (L, mm) and age (τ years) of specimens was approximated by the Bertalanffy equation: for *S. entomon*, $L = 61.2(1 - \exp(-0.64\tau)$, life span 4+ years; for *M. balthica*, $L = 29.5(1 - \exp(-0.64\tau)$, 3–4 years and somewhat longer; for *A. vega*, the available information was not sufficient to plot an unambiguous curve of growth.

At depths down to 25 m (bottom trawl sampling), on clayey silt, the dominating groups were crustaceans, shrimps and sowbugs. The shrimp *Crangon septemspinosa* dominated in terms of biomass and density. The specimens of this species varied in size from 16–65 mm; all individuals of the maximum size were females with eggs. The largest concentrations of *C. septemspinosa* occurred at depths from 10–12 m.

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