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Quantitative studies on the infauna of an Arctic estuary Nottinghambukta, Svalbard

ABSTRACT: The infauna of the soft bottom of Nottinghambukta was studied quantitatively. The distribution of 5 most abundant species: *Liocyma fluctuosa* (Bivalvia), *Dendrodoa grossularia* (Ascidiacea), *Priapulus caudatus* and *Halicryptus spinulosus* (Priapulida) and *Chone duneri* (Polychaeta), in this Arctic estuary has been presented.

Key words: Arctic, Svalbard, benthos.

Introduction

Quantitative studies of Svalbard biocenoses are still not numerous. Some quantitative data on the bottom fauna of the shelf waters of this archipelago are to be found in the papers by Różycki and Gruszczyński (1981, 1986), Gulliksen, Holte and Jakola (1985) and Węsławski, Gromisz and Różycki (1986).

Estuarine waters of Nottinghambukta were thoroughly described in the paper by Legeżyńska *et al.* (1984), where abiotic factors and their influence upon the bottom fauna distribution has been discussed. The present paper is a continuation of these studies and includes quantitative data on chosen species of bottom macrofauna. Quantitative information can be good indicator of ecological adaptation of fauna exposed in the Arctic estuary to a very strong environmental stress.

Investigated area

Nottinghambukta (Nottingham Bay) is situated some 20 km north of Hornsund (Fig. 1). The main hydrological parameters characterizing this Bay come from the paper by Legeżyńska *et al.* (1984), whereas our classifications of sediments of Nottinghambukta, based on granulometric analysis, differs from that presented by the above authors. Sediments structure is shown in Fig. 1.

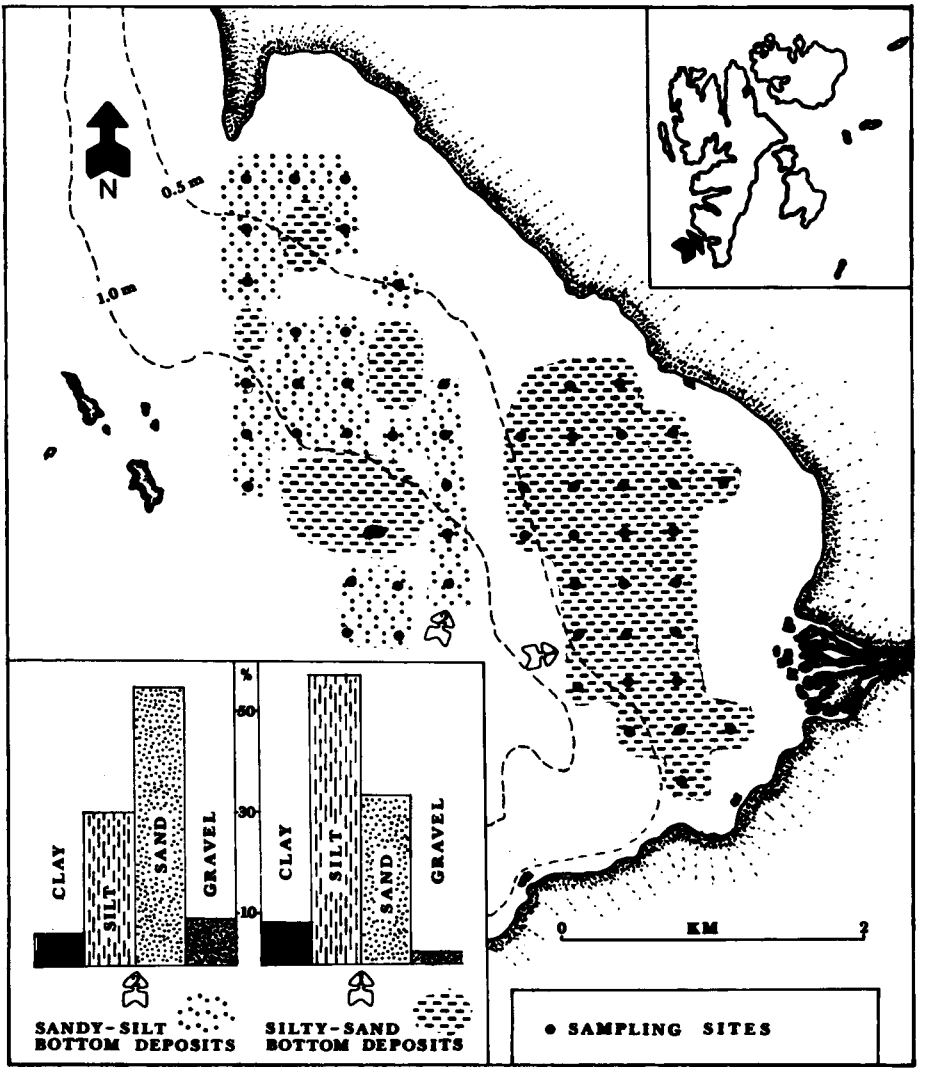

Fig. 1. Geographical position of study area. Distribution of bottom deposits and sampling stations in Nottinghambukta

Silty-sandy bottom of the Bay occurs mainly at the depths of 0–0.5 m and salinity of this area varies bewteen 0 and 5‰. This part of the Bay is exposed during each falling tide. Surface sediment of glacial origin freezes in winter down to the depth of some 20 cm.

Sandy silty bottom occurs mainly at the depths of 0.5–1.0 m and is exposed only during extreme neap tides. In this area of the Bay the most intense variations of temperature and salinity (6–20‰) occur.

In both investigated parts of the Bay sediments are covered with a thin, several mm thick clayey layer characteristic for glacial sediments. Vegetation and bottom fauna in these areas are in high degree destroyed by ice in winter. Ice cover stays long in Nottinghambukta, for instance in 1977 tight ice sheet extending to the bottom was observed on 18 June and ice fully retreated from the Bay on 15 July (Węsławski 1978). In 1980 winter ice stayed in vast parts of the Bay on 5 and 6 July.

Material and methods

Samples were collected in summer 1980, namely in August (40 samples) and at the beginning of September (14 samples). Out of these 54 samples 28 were taken from the silty-sandy bottom, whereas 26 — from sandy-silty bottom. Sampling sites are indicated in Fig. 1.

Materials were collected quantitatively in shallow parts exposed during tides using a shovel. Squares 50 × 50 cm (0.25 m^2) were cut to the depth of 2–20 cm down to the hard bottom. Samples were washed and preserved separately. From similar squares sediments were taken for granulometric analyses.

Results

In the samples 13 species of macrobenthos were determined. For silty-sandy bottom 11 species were recorded, whereas for sandy-silty bottom — 10 species. The list is presented in Tab. 1.

In total 4.142 specimens were determined (54.6% from silty-sandy bottom and 45.4% from sandy-silty one). Collected animals were mostly the representatives of infauna; necto-benthic species were scarce, represented by few specimens of two crustacean species.

In samples taken from silty-sandy bottom 5 to 9 species occurred; 78.6% of samples contained 6 to 9 species. In samples collected in sandy-silty bottom 1 to 9 species were noted and in 57.6% of these samples there were only 1 to 5 species. These data on the fauna diversity in two different bottom types are presented in Tab. 2.

In Tab. 3 the frequency (in samples) and dominance (in all collected materials) indices are presented. In the silty-sandy bottom the most frequent

Table 1

Soft bottom fauna of estuarine part of Nottinghambukta

Taxon	Sediment		Number of specimens
	silty--sandy	sandy--silty	
POLYCHEATA			
Antinoëlla sarsi (Kinberg, 1865)		+	20
Brada granulata Malmgren, 1865	+	+	88
Travisia forbesi Johnston, 1847	+		29
Chone duneri Malmgren, 1867	+	+	183
PRIAPULIDA			
Priapulus caudatus Lamarck, 1816	+	+	321
Halicryptus spinulosus Siebold, 1849	+	+	429
CRUSTACEA			
Onisimus littoralis (Kröyer, 1846)	+		51
Anonyx sarsi Shoemaker, 1930		+	1
GASTROPODA			
Astyris rosacea (Gould, 1840)	+	+	2
Cylichna alba (Brown, 1827)	+	+	27
BIVALVIA			
Mya truncata Linné, 1758	+	+	21
Liocyma fluctuosa (Gould, 1841)	+	+	2537
ASCIDIACEA			
Dendrodoa grossularia Van Beneden, 1846	+	+	433

Table 2

Number of samples with various number of infauna species

Number of species	Sediment (number of samples)	
	silty--sandy	sandy--silty
2	—	1
3	—	2
4	—	6
5	6	6
6	9	5
7	8	5
8	4	—
9	1	1

Table 3

Dominance (D %) and frequency (F %) indices for particular species in the investigated area

Taxon	Sediment			
	silty-sandy		sandy-silty	
	F	D	F	D
Antinoëlla sarsi	—	—	34.6	1.1
Brada granulata	28.5	0.8	61.5	3.8
Travisia forbesi	60.8	1.5	—	—
Chone duneri	57.1	6.3	38.4	2.1
Priapulus caudatus	100.0	7.5	73.0	8.2
Halicryptus spinulosus	96.4	9.8	53.5	10.8
Onisimus littoralis	75.0	2.4	—	—
Anonyx sarsi	—	—	3.8	0.3
Astyris rosacea	7.1	0.1	—	—
Cylichna alba	10.7	0.1	42.3	1.2
Mya truncata	10.7	0.2	24.6	1.0
Liocyma fluctuosa	100.0	58.8	92.3	64.1
Dendrodoa grossularia	100.0	12.5	69.1	7.4

(frequency over 50%) were species: *Liocyma fluctuosa, Dendrodoa grossularia, Halicryptus spinulosus, Onisimus littoralis, Travisia forbesi* and *Chone duneri,* whereas in the sandy-silty bottom — 5 species occurred in a frequency over 50%: *Liocyma fluctuosa, Priapulus caudatus, Dendrodoa grossularia, Halicryptus spinulosus* and *Brada granulata.*

In the silty-sandy bottom 5 species were dominant (over 5%: *Liocyma fluctuosa, Dendrodoa grossularia, Halicryptus spinulosus, Priapulus caudatus* and *Chone duneri;* their total share amounted to 94.4%. In the sandy-silty bottom 4 species dominated: *Liocyma fluctuosa, Halicryptus spinulosus, Priapulus caudatus* and *Dendrodoa grossularia;* their total share was 90.5%.

Several dominant species on infauna decide on the picture of the biocenosis of the investigated Arctic estuary.

Liocyma fluctuosa (Bivalvia) (Fig. 2)

It was the most common and abundant species. In silty-sandy bottom its density on 1 m^{-2} ranged from 76 to 392 specimens (average 190), whereas in sandy-silty bottom — from 36 to 772 specimens (average 185.2). The average population density of *L. fluctuosa* was similar in both bottom types however this species was more regularly distributed in the silty-sandy bottom. In sandy-silty bottom a mosaic distribution of this species was observed. In general the main concentrations of this bivalve were noted in sandy-silty bottom; in 14 stations population density was over 201 specimens per squ. m (216 to 772). In silty-sandy bottom only in 9 stations the density of *L. fluctuosa* surpassed 201 specimens

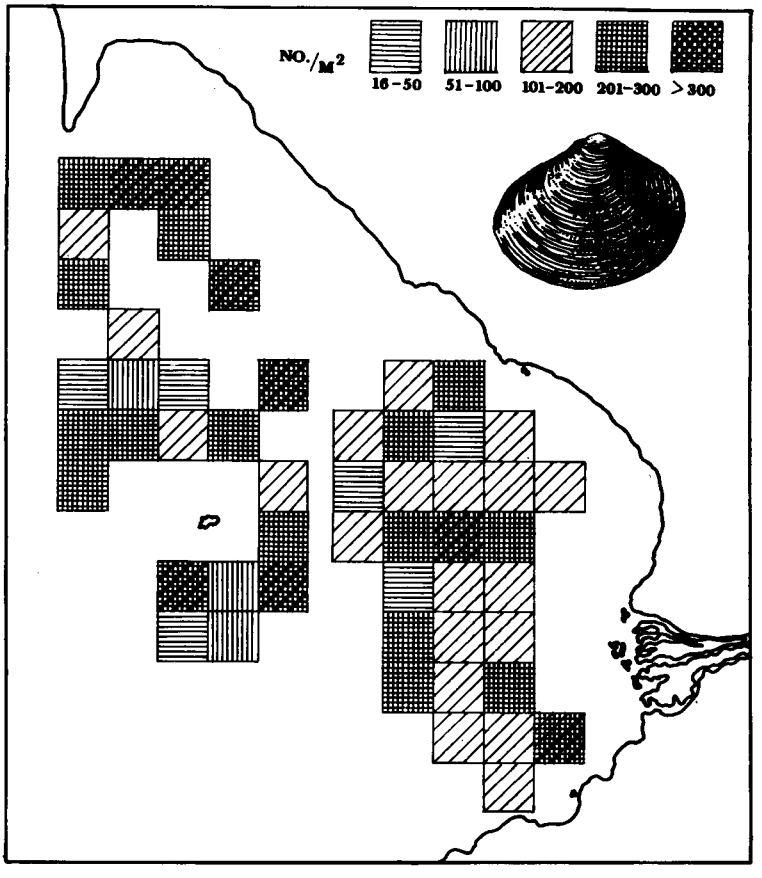

Fig. 2. Density distribution of *Liocyma fluctuosa* in the investigated area

per squ. m and in only two the density was in the highest class (348 and 392 ind. m^{-2}).

Dendrodoa grossularia (Ascidiacea) (Fig. 3)

Population density of this species was the highest in the silty-sandy bottom; 8 stations had the density over 71 specimens per squ. m (72 to 124). In this bottom type the distribution of *D. grossularia* was more regular (only in one station the species was lacking) than in the sandy-silty bottom, where this species was absent in 8 stations. In sandy-silty bottom the density over 71 specimens per squ.m was noted at 4 stations.

In silty-sandy bottom the density of *D. grossularia* ranged from 8 to 124 ind.$\cdot m^{-2}$ (average 41.4), whereas in sandy-silty bottom it was from 4 to 96 ind.$\cdot m^{-2}$ (average 21.2).

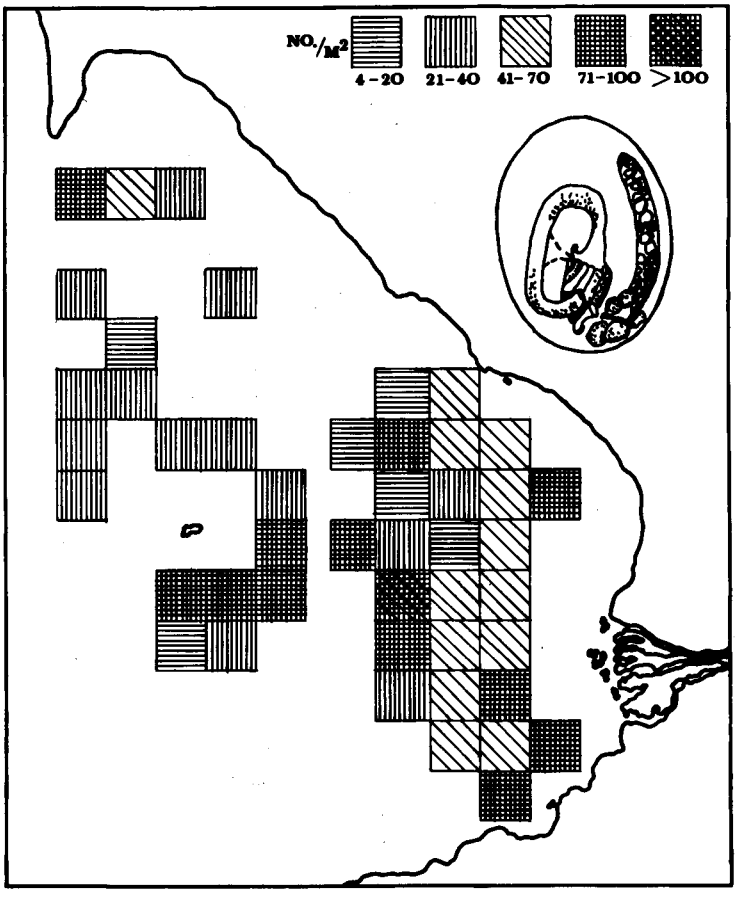

Fig. 3. Density distribution of *Dendrodoa grossularia* in the investigated area

Priapulus caudatus (Priapulida) (Fig. 4)

In silty-sandy bottom the density of this species was from 4 to 80 ind.·m^{-2} (average 23.6) and in sandy-silty bottom — from 4 to 208 ind.·m^{-2} (average 22.8). In silty-sandy bottom the distribution of *P. caudatus* was more regular than in sandy-silty one, where at 7 stations the species was lacking and at two stations this density was very high (124 and 208 ind.·m^{-2}).

Halicryptus spinulosus (Priapulida) (Fig. 5)

As in two above mentioned species the average population density of this species was similar — 32.0 and 31.2 ind.·m^{-2} in silty-sandy bottom and sandy--silty one respectively. However in silty-sandy bottom the distribution of *H. spinulosus* was more regular with densities from 8 to 72 ind.·m^{-2}. In sandy-silty

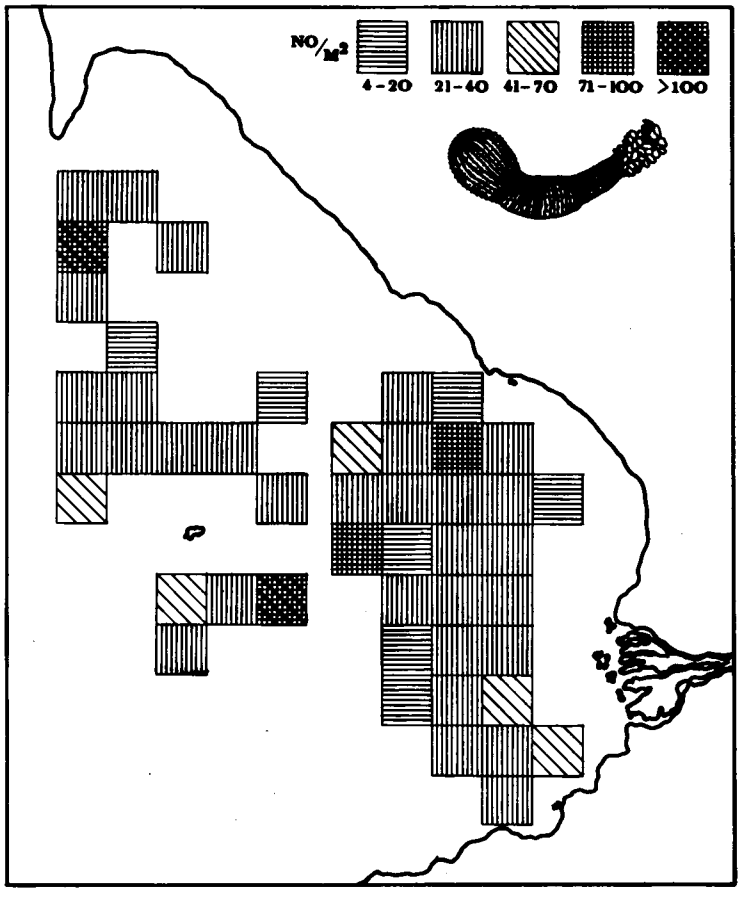

Fig. 4. Density distribution of *Priapulus caudatus* in the investigated area

bottom the densities ranged from 4 to 132 ind.·m^{-2} and in higher number of stations the densities attained comparatively high value.

Chone duneri (Polychaeta) (Fig. 6)

The least numerous species among the dominants. Its highest population densities were observed in silty-sandy bottom (4 to 92 ind.·m^{-2}, average 20 ind.·m^{-2}). In sandy-silty bottom population density of *Ch. duneri* ranged from 4 to 44 ind.·m^{-2} (average 5 ind.·m^{-2}).

Discussion

In contrast to the studies by Legeżyńska *et al.* (1984) who have investigated the whole area of Nottinghambukta the present quantitative studies of the

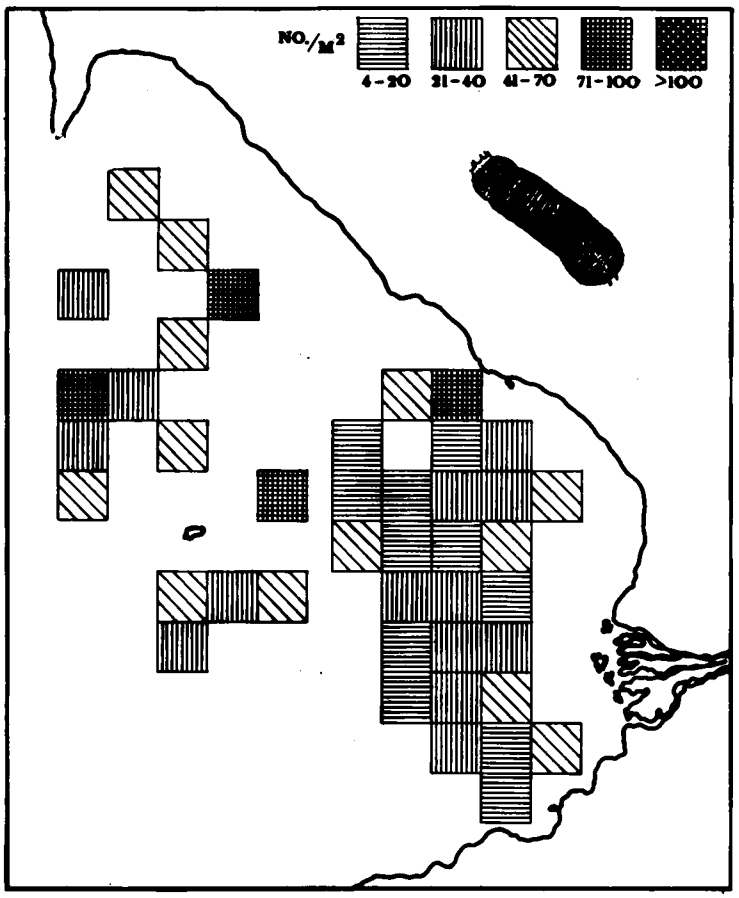

Fig. 5. Density distribution of *Halicryptus spinulosus* in the investigated area

infauna were carried out in the restricted part of the Bay characterized by very strong tidal currents and by strong temperature and salinity fluctuations, both in twenty-four hours and yearly cycles.

Out of 13 taxa determined in the present material 4 species: *Brada granulata, Cylichna alba, Mya truncata* and *Dendrodoa grossularia* were not recorded by Legeżyńska *et al.* (1984), so the former list of taxa is now extended by 4 species new for the area. Such a low diversity of macrofauna in the investigated part of Nottinghambukta is undobtedly due to the limiting influence of extreme environmental conditions.

The present studies were concentrated on poorly vagile representatives of infauna inhabiting the region of Nottinghambukta exposed to most intense environmental fluctuations. Methods adapted by the present authors allowed to collect the animals living in the sediment down to the depth of 20 cm. Collections of Legeżyńska *et al.* (1984) were performed using a dredge that have scratched

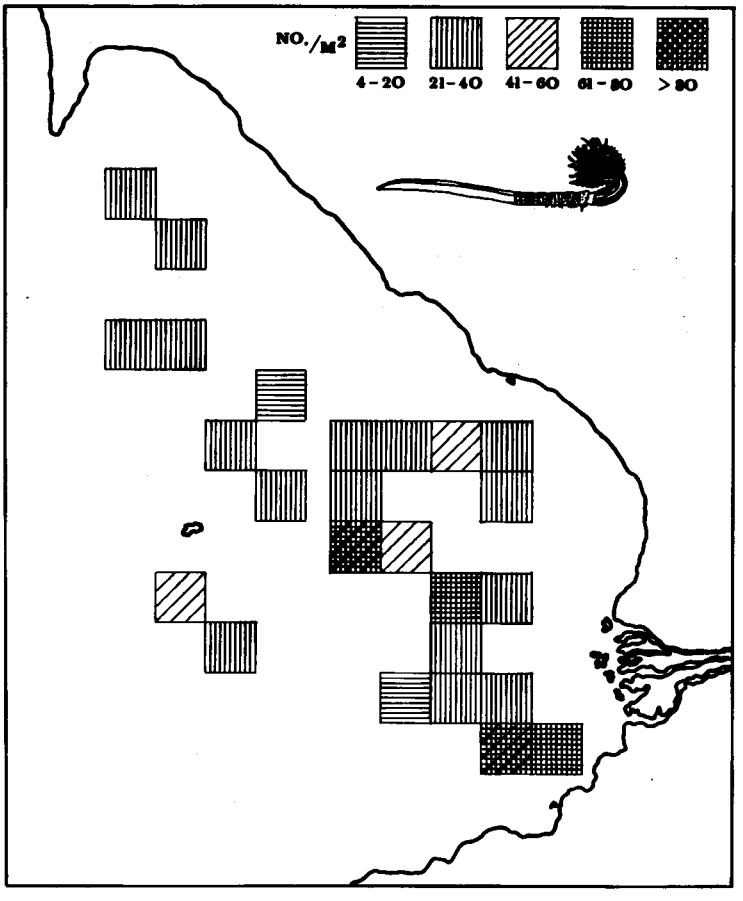

Fig. 6. Density distribution of *Chone duneri* in the investigated area

only 2–3 cm layer of sediment, therefore animals penetrating sediments deeper were lacking in the samples. On the other hand in our materials we have not found the polychaete *Fabricia sabella* (Ehrbg., 1836) that was found by the above authors to be very abundant in the investigated part of Nottinghambukta; Legeżyńska *et al.* (1984) recognized this species as a very resistant to environmental stresses.

Five dominant species — *Liocyma fluctuosa, Dendrodoa grossularia, Priapulus caudatus, Halicryptus spinolosus and Chone duneri* — characterize the infauna of shallow, estuarine part of Nottinghambukta. Comparatively high density of this animal assemblage undoubtedly results from rich food conditions and the resistance of these species to environmental stress. The role of leading, most abundant taxa in the biocenosis of this Arctic estuary is especially distinclty expresseed since these forms are comparatively large ones. Population structure studies on *Liocyma fluctuosa* revealed that in the silty-sandy bottom this species

attained the length of 19.3 mm and in the sandy-silty bottom — 17.8 mm. In both bottom types the dominant group (abt. 60%) consisted of specimens of the length up to 7 mm (Różycki, *unpubl).*

It is worth mentioning that Węsławski (1978), when collecting bottom samples in Nottinghambukta in June 1977 and in early July 1978, has not found any macrofauna there. According to Legeżyńska *et al.* (1984) the settling of the bottom of the Bay by macrofauna occurs in very short time, immediately after the ice cover retreat. This concerns mainly the representatives of nektobenthos, whereas the infauna representatives (Polychaeta, Priapulida, Bivalvia) probably overwinter deeply buried in the sediment. Therefore future studies on this ecological succession in Nottinghambukta during short Arctic summer would be highly interesting and desirable.

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Streszczenie

Materiał do badań zebrano latem 1980 r. w estuariowej części Zatoki Nottingham (Notthinghambukta), położonej około 20 km na północ od Hornsundu (rys. 1). Wyróżniono tutaj dwa rodzaje dna miękkiego: piaszczysto-muliste i mulisto-piaszczyste; strukturę osadów przedstawiono na Rys. 1. Wycinając kwadraty dna o boku 50 × 50 cm, na głębokość od 2 do 20 cm zebrano z dna Zatoki 54 próby (Rys. 1).

W badanym materiale oznaczono 13 gatunków makrobentosu (tab. 1), na które składają się niemal wyłącznie przedstawiciele infauny. Na dnie mulisto-piaszczystym występowało od 5 do 9 gatunków; dominowały próby zawierające 6–9 gatunków (78,6%). Na dnie piaszczysto-mulistym w poszczególnych próbach notowano od 1 do 9 gatunków; dominującymi (57,6%) były próby

zawierające 1–5 gatunków (tab. 2). W zat. 3 przedstawiono wskaźniki dominacji (D %) oraz frekwencji (F %) dla wszystkich gatunków.

Decydujący wpływ na obraz biocenozy badanego estuarium arktycznego mają gatunki najliczniejsze— *Liocyma fluctuosa* (Bivalvia), *Dendrodoa grossularia* (Ascidiacea), *Priapulus caudatus* i *Halicryptus spinulosus* (Priapulida) oraz *Chone duneri* (Polychaeta). Na kolejnych rysunkach (2–6) przedstawiono rozmieszczenie zagęszczenia tych gatunków na badanym obszarze Nottinghambukta.