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About *Pandalus borealis* (Kroyer, 1848) nutrition on Flemish Cap

by

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Abstract

Results from spring and autumn 1996 survey on Flemish Cap are discussed related to a broad information base from published literature. Information about *Pandalus borealis* nutrition in the Barents Sea suggest it feeds on detritus accumulating on the top layers of the substratum. Mixture of bottom and planktic organisms as well as detritus, *Polychaeta, Spongia , Copepoda, Foraminifera, Peridinea, Diatomea* were found in stomachs.

Introduction

The first information about *P. borealis* nutrition in the Barents Sea was given by Z.G.Palenichko (1941) (by Turpaeva, 1953). According to her data *P.borealis* feeds on detritus accumulating on the top layers of the bottom. Mixture of bottom and planktic organisms as well as detritus *Polychaeta, Spongia, Copepoda, Foraminifera, Peridinea, Diatomea* were found in stomachs.

Turpaeva (1948, 1953) pointed out that flakeslikes detritus (on the average 60 %) dominated in *P.borealis*'s food lump. The chaetes of *Polychaeta,* fragments *of Crustacean's* chitin, the shells of *Foraminifera, Peridinea, Diatomea and Tintinoide* were presented in detritus. The food lump consisted of planktic copepods (mainly *Calanus finmarchicus* and *Harpacticidae*) about 30% as average .The sand was found in small quantities (10%). Turpaeva marked the significant difference of food content in organisms collected in day time and night hours. In 35 foreguts of organisms collected in day time detritus predominated. The large fragments of the planktic Crustacean with tissue and drops of fat were found mainly in 10 foreguts, collected during the night. Turpaeva (1953) explained that planktic organisms were caught during night migration of *P.borealis* and stated that the given species were concerned to filter feeders.

The Berenboim (1981, 1992) examined 483 stomachs (material was collected in April-June, December, 1978 and June, 1979) and concluded that *Polychaeta* (more often *Spiochaetopterus typicus* — 10,3%) and *Euphausiacea* (frequency of occurrence was 38,9 and 27,8% relatively) were the main food resource of *P.borealis* in the Barents Sea. From other bottom organisms *Foraminifera* (11,8%) and early adults *Bivalvia* (9,7%) were found. copepods as planktic organisms were met (6,3 %, among them *Metridia longa* and *Pareuchaeta norvegica*). Shrimp showed cannibalism often (probably, it occurred in trawl and was artifact — the comment of author). The Berenboim believed that junior age groups were more active in feeding. Young organisms fed on plankton, females – benthos.

The most complete research work on feeding of *P.borealis* was undertaken by Wienberg (Wienberg, 1980). Material (more than thousand stomachs) was collected by him between October and December, March, 1973 and February, 1975 in Northern Sea in areas of trade Fladen Graund and Farn Deeps and in strait Skagerrak. Investigated shrimps were at different stages of ontogenesis: juvenile, male, transitive stages from male to female, female without eggs and female with eggs on the pleopods..

Polychaeta *Paramphinome jeffreysii*, representatives of *Harpacticida, Nematoda* were revealed in stomachs. The detritus predominated in 70% of stomachs, sand was found in 2/3 of stomachs. To Wienberg's mind the function of sand is substitution of gastric mill elements. Food lump of 2/3 specimens collected in Skagerrak contained shell fragments of mollusks. Besides benthic *Amphipoda*, squids, *Chaetognata, Isopoda, Echinodermata* were found in stomachs. The fish scale belonged to *Boreogadus esmarkii (*Gadidae).

There were the typical representatives of macroplankton as *Euphausiacea, Mysida, Copepoda* and decapods larva in food lump.

Juveniles devoured less mollusks than mature males. Mollusks and shells remains were met rarely in females than in males stomachs. Females with eggs fed on *Polychaeta* less than other shrimps. Males fed on plankton more actively than females. The maximum consumption of mollusks was observed during the day, the *Polychaeta* more were often met in foreguts (up to 30%) in the morning (9.00-12.00 a.m.). Early in the morning *Euphausiacea* was the main food component of shrimps (Wienberg, 1980).

It can be concluded that *P. borealis* feeds actively 24 hours in Barents and in Northern seas. Moreover it prefers plankton at night and benthos during the day.

At western coast of Kamchatka (Ohotsk Sea) and in bay Alaska (Bering Sea) (Belogrudov, 1971) the most preferable food components of *P. borealis* were *Crustacea* (in Alaska Bay — *Decapoda*, in Anadir Bay — *Amphipoda* and *Isopoda*). The *Polychaeta* and mollusks were less attractive for *P. borealis. Foraminifera* were marked in food lump of Anadir Bay shrimps.

Material and Methods

The material was taken by the experts of Rybprognos company (trade vessel "Maltsevo") during the spring-autumn period, 1996, in northern, western and southwest slopes of Flemish-Cap (fig.1). Materials were collected in day hours (between 6.25 a.m. and 6.25 p.m.). 209 stomachs were examined (there were 106 males, 71females). The carapace length of shrimps varied from 15 to 30 mm.

To determine the biological state of examined shrimps the technique of invertebrates laboratory of AtlantNIRO was used (Burukovsky, 1992). The characteristic peculiarities of *P.borealis* were taken into account.
To research the food content and separate components correlation in food lump the visual registration technique (frequency of occurrence of various food objects and percentage in food volume) (Burukovsky, 1985). The share of given component in volume of food lump was determined visually accurate to 10% (Burukovsky, 1985).

Results

The food contained in all investigated stomachs, however full stomachs formed 20%. Friable gray, flaky gruel without any structure, which was determined as detritus was found in each second stomach. Other food remains were contained in detritus mass of full or nearly full stomachs. Fine sand with an impurity spicule of glass sponges in stomachs was presented. It indicates that main biotope of food extraction for the investigated shrimps the bottom is.

Among *Foraminifera* founded in stomachs *Globigerina sp*. (0.075-0.25 mm) predominated. In most cases species were presented by whole organisms. But bottom *Foraminifera* were broken off. Probably, *Foraminifera* is consumed by shrimps as the source of $CaCO_2$.

Among *Crustacea Amphipoda* predominated. Its fragments varied between 4,3 and 15,5 mm.

Rather common component of food lump was chitin remains, which could be fragments of *Crustacea* shells. We assume that shrimps feed on carrion.

Found *Polychaeta* (*Aphrodittidae)* were sedentary and errantia. Its separate fragments were up to 6,7 mm in length. *Chaetognathae*'s chaetes were common content of a food lump. Its length varied between 0,2 mm and 1,5

mm. Some stomachs up to half of its volume filled with large fragments of *Euphausiidae (*mandibles). Embryonic shells of *Gastropod* were whole. *Copepoda* in food lump of *P borealis* were whole (1,3 – 2,4 mm in length).

Spicule of glass sponges and skeletal rests of echinoderms (0,07 – 0,2 mm in length) were found in stomachs.

In some examined stomachs we found fish fragments (bones and scales). Scale was presented as whole fragments as particles. We consider that bone and scales belonged to dead fish.

Antennas, pieces of appendages of *P. borealis* were met. In our opinion, it is not cannibalism. This is the result of long staying shrimps in trawl.

The frequency of occurrence of *Foraminifera, Amphipoda* and detritus were 54,1%, 41,6%, 40,2% respectively. It is possible to consider them as main food objects. *Gastropod*'s postlarvaes presented by embryonic shells (27,3%), *Polychaeta* (23,4%) and echinoderms (19,8%) were the secondary food objects. The rest (*Chaetognata, Euphausiidae*, scale and other) can be regarded as casual victims.

The main components of *P. borealis* food lump were *Amphipoda* and detritus. These components occurred in the proportions 36.3% and 20.9% of the food lump respectively. *Polychaeta* (8,1%), unindefied *Crustacea* (3,2%), occurrence in food lump is 87.7 % and 66.0% relatively. *Amphipoda* (43,4%), *Crustacea* (41,5%), fish scale (41,5%), Copepod's spermatophores (32,05%) and *Euphausiidae* (24,5%) were characteristic food objects. Mollusks, shrimps, *Mysida*, spicules of sponges, echinoderms were casual victims. The average victims number in one stomach was 4,48.

Amphipoda (39,4%) and *Foraminifera* (35,2%) predominated in food content of females. But they cannot be regarded as background objects because its frequency of occurrence is not significant. Detritus (19,7%), *Euphausiidae* (16,9%) and *Polychaeta* (11,2%) were secondary food objects. The rests of *Crustacea* (4,2%), fish scale (1,4%), shrimps (4,2%), etc. were referred to casual objects (Table. 2). The average quantity of victims in one stomach was 1,56.

Correlation of different food objects in average reconstructed food lump differed significantly in both sexes: the main food object of males was detritus (34.1%), then *Amphipoda* (27.2%), for females – *Amphipoda* (39.4%), then detritus (16.8%) Secondary food objects for males were Crustacea remains (10.2%) and Polychaeta (5.5%), for females were shrimps (8.4%), *Euphausiacea* (6.8%), *Polychaeta* (3.1%). As casual victims for males were shrimps (1.7%), echinoderms (1.4%), *Foraminifera* (0.8%). *Foraminifera, Crustacea* remains, fish scale, mollusks, etc were echinoderms (1,5%) and *Gastropod*'s embryonic shells (1,5 %) were secondary food components. *Mysida* (0,7%), *Chaetognata* (0,5%), *Foraminifera* (0, 2%) and mollusks (0,2%) were casual objects.

The inhabitants of pelagial were found very seldom.

The reason of the dominance of bottom organisms in food lump was that material was taken during the day while *P.borealis* kept at the bottom. Poorly digested skeletal rests of pelagic victims, probably, remained since the previous peak of feeding, which might occur at night.

The average quantity of food objects was 2,47. Food content of males differed significantly from females. It is possible to consider that *Foraminifera* and detritus are background objects in the males nutrition as its frequency of not met in great quantities in females stomachs (Table. 2.).

Discussion

Pandalus borealis fed on benthos during the day but meso- and macroplankton remains met frequently in food lump. Probably, these remains were eaten at night.

Food composition was the same for *P.borealis* as in Northern and Barents seas as in seas of Far East. Detritus played key role in *P.borealis* nutrition of Flemish Cap (Turpaeva, 1948, 1953; Wienberg, 1980). The main food objects of shrimps were not the same as *Polychaeta* in Barents and Northern seas (Turpaeva, 1948, 1953; Wienberg, 1980; Berenboim, 1981, 1992) or mollusks and *Decapoda* in Ohotsk sea (Belogrudov, 1971) but as Amphipoda

(Gammaridae) in Bering Sea. Berenboim (1981, 1992) and Belogrudov (1971) didn't report about detritus in shrimps stomachs. Probably, these authors didn't take into account detritus as food objects.

Alive *Crustacea* and *Crustacea* carrion were in the shrimps diet. Hence, *P. borealis* of Flemish Cap is carnivorous animal combining predatoreance with necrophagous and detritophagous. Therefore, it can be hardly referred to filter feeders (Turpaeva, 1948, 1953).

The average quantity of components in food lump is the indirect characteristic of food catching (Burukovsky, Froerman, 1974; Burukovsky, 1985). In food lump of attacking predators there are, as a rule, one-two of food objects, while collecting predators have more then 3. From this point of view of *P. borealis* of Flemish Cap takes medium position between attacking predator and predator-collector.

The given species is characterized by well identified sexual dimorphism in feeding (mainly in day time). Detritus and *Crustacea* remains predominated in males nutrition the average number of food components was 4,48. It is possible to consider them detritophagous, necrophagous and predators-collectors mainly. In females diet Amphipoda took the first place. As a secondary food source females used detritus but its share in food lump was twice less than in males. Rests of dead *Crustacea* were met rarely. The role of *Polychaeta, Euphausiidae* and shrimps increases. The average quantity of components in food lump was 1,56. It leads to the conclusion that *P. borealis* females of Flemish Cap are attacking predators, which can also feed on detritus.

Pandalus borealis is protandrous that passes the first stage of ontogenesis as a male on Flemish Cap (about 100%) (Parsons et all, 1998; Sudnik, 2000). The sexual dimorphism of *P. borealis* nutrition is a consequence of age variability in feeding. We didn't have an opportunity to make this statement more clearly due to lack of material.

Pandalus borealis of Flemish Cap feeds on benthic and planctic organisms, detritus and carrion *Crustacea* also. It has an ability to combine detritophagous, necrophagous and attacking. It allows to consider it as predators-opportunists (Burukovsky, 1985).

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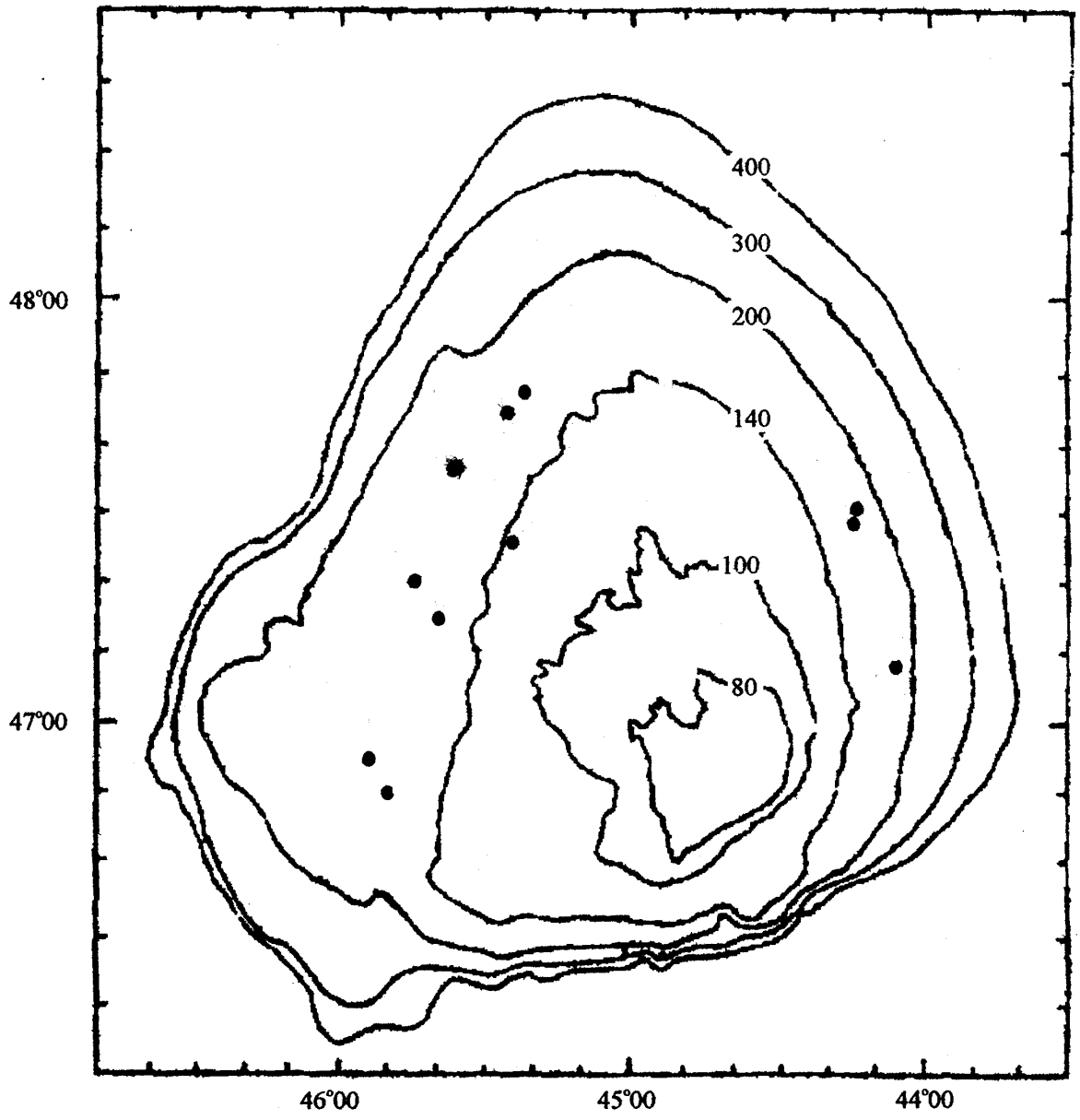

Fig.1. Shrimps collection on the Flemish Cap

Table 1. *Pandalus borealis* food composition of Flemish Cap.

Food objects	Frequency of occurrence, %	Percentage in food volume, %
Foraminifera	83,0	0,5
Detritus	76,0	40,0
Echinodermata	64,0	3,7
Gastropod's embryonic shells	55,3	3,1
Amphipoda	48,5	12,6
Polychaeta	38,8	6,8
Chaetognata	27,8	1,8
Indefinite Crustacea	15,5	6,8
Shrimps	9,7	2,6
Euphausiacea	9,7	0,5
Mollusks	7,8	0,5
Mysidacea	2,9	1,6
Sand	97,9	19,5
Number of dissected stomachs	113	20

Table 2. Male and female diet of *P. borealis*.

Food objects	Males		Females	
	Frequency of occurrence, %	Percentage in food volume, %	Frequency of occurrence, %	Percentage in food volume, %
Foraminifera	87.7	0.8	35.2	—
Detritus	66.0	34.1	19.7	16.8
Amphipoda	43.4	27.2	39.4	38.9
Indefinite Crustacea	41.5	10.2	4.2	—
Fish scale	41.5	1.2	1.4	—
Spermatophores of Crustacea	33.9	—	2.8	—
Polychaeta	32.0	5.5	11.2	3.1
Copepoda	30.2	—	1.4	—
Euphausiacea	24.5	—	16.9	6.8
Mollusks	16.9	—	1.4	—
Shrimps	16.9	1.7	4.2	8.4
Cnidarians	13.2	—	—	—
Mysidacea	6.6	—	—	—
Chaetognata	3.8	—	1.4	—
Sponge	54.7	0.3	2.8	—
Skeleton remains of Echinodermata	48.1	1.4	12.7	—
Sand	87.7	19.8	56.3	23.1