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Biological characteristics of *Euphausia superba* Dana (BIOMASS III, November 1986 — January 1987)

ABSTRACT: Krill population structure was studied in Western Antarctic in austral spring and summer 1986/87. At the end of October and the beginning of November in the waters around Elephant Island the mean krill length was 44 mm and sexually mature specimens dominated. Juveniles were absent. In the Bransfield Strait the mean *E. superba* length was 43 mm, and males slightly overdominated females. The share of females with spermatophores and of immature females was higher than in the Elephant Island area. Juveniles were also not recorded. Krill was most diversified around Elephant Island in January; juveniles and females with ovaries filled with eggs were recorded. It was found that 84% of krill population was infested by ciliate protozoans (Apostomatida).

Key words: Antarctica, Euphausiacea, krill biology, epibiontic protozoa, BIOMASS III.

1. Introduction

Krill populations in the waters of the Bransfield Strait and the area around Elephant Island were frequently investigated. From the so far obtained data it follows that the distribution and structure of developmental stages of investigated krill populations in both areas varies greatly from year to year (Jazdzewski et al. 1978; Wolnomiejski et al. 1982; Brinton and Antezana 1984; Czykieta et al. 1985; Nast 1986; Siegel 1986; Brinton et al. 1987).

Most of the above mentioned authors conducted their research in Antarctic summer. Few data on krill population structure in Antarctic spring are available. The present results concern among others this very period.

2. Material and methods

Krill were collected from board of r/v "Profesor Siedlecki" in two terms. One of them, BIOMASS III-1, lasted from 26 Oct. till 19 Nov. 1986 when the area at Elephant Island (stations 14, 50, 52) and the Bransfield Strait (stations 65, 67, 94) were investigated while other, BIOMASS III-2, lasted from 08 Jan. till 18 Jan. 1987, when again the area around the Elephant Island (stations 38, 42, 56, 73, 82, h2, h3, h5, h7) was studied (Fig.1).

General characteristics of the investigated stations is given by Rakusa-Suszczewski (1988).

Material was obtained with a commercial trawl, a Bongo net and RMT-8 trawl. The commercial trawl was usually hauled in the water layer 0—100 m. The trawl was hauled by 85 to 220 min. The trawl was supplied with an inlet of 6×6 mm meshes and was towed at speed of 3 to 4 knots.

The Bongo net had circular frames 60 cm in diameter and a gauze of 0.505 mm meshes; double oblique tows were made at the ship's speed of about 3 knots.

The RMT-8 trawl had a net of 4.5×4.5 mm meshes. It was lowered at the ship's beam and hauled at a speed of 3 knots. Depths of the hauls varied, depending frequently on the echosounder records.

Krill samples were taken at random from the catches, and 100 individuals of each sample were analysed. The krill body length was measured from the tip of rostrum to the end of telson. Sexual maturity stages were determined on the basis of external sex characteristics. A slightly modified version of a classification proposed by Wolnomiejski, Witek and Czykieta (1980) was used. To their scale a group of spermatophore bearing females was added. Following stages were therefore distinguished: 1 — juveniles, 2 — immature males, 3 — mature males, 4 — immature females, 5 — mature females, 6 — mature females with spermatophores, 7 — mature females with ovaries filled with eggs. The stages belonged to three phases of sexual maturity: juvenile krill — stage 1, immature krill — stages 2 and 4, mature krill — stages 3, 5, 6 and 7 (Table 1).

Alimentary tract fullness was determined according to a 5-grade scale after Wolnomiejski, Witek and Czykieta (1980).

During the analysis the presence of epibionts on krill thoracic appendages was recorded. In several samples some 25 individuals were controlled in this respect.

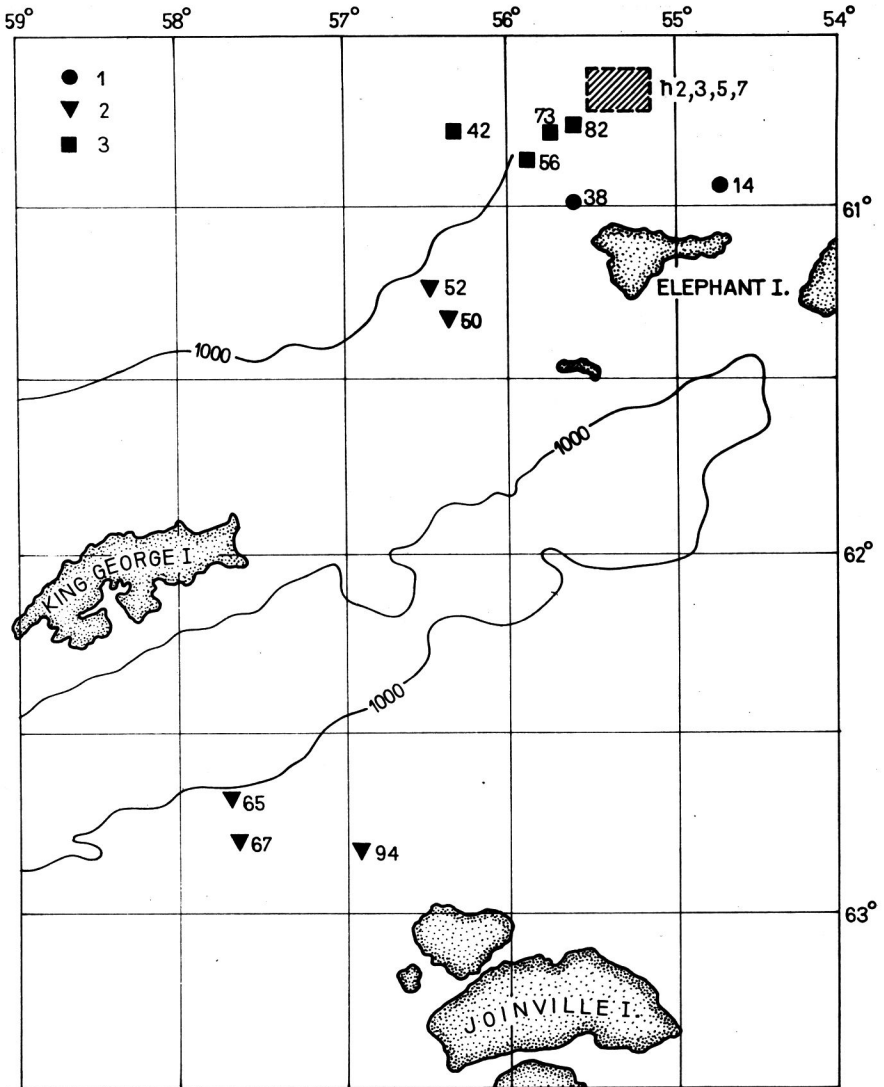


Fig. 1. Research area and stations for which biological analysis of krill was made
 1 — pelagic trawl hauls (ST); 2 — Bongo-net; 3 — RMT 8.

3. Results and discussion

Population structure

In the region of Elephant Island (BIOMASS III-1) the *E. superba* population structure was characterized by the percentage share of males approaching 50% in every haul (Table 1, Fig. 2). On the whole, mature

Table 1

Biological characteristics of krill catches during BIOMASS III

RESEARCH AREA	ELEPHANT I (26 October — 19 November 1986)					ELEPHANT II (8 — 18 January 1987)													
	14*	50*	52*	65*	94*	B	MTH	MTH	MTH	B	RMT	RMT	RMT	RMT	h2	h3	h5	h7	
Station No	14*	50*	52*	65*	94*	B	MTH	MTH	MTH	B	RMT	RMT	RMT	RMT	h2	h3	h5	h7	
Fishing gear	MTH	MTH	MTH	MTH	MTH	MTH	MTH	MTH	MTH	MTH	RMT	RMT	RMT	RMT	MTH	MTH	MTH	MTH	
Depth of bottom (m)	—	450	440	750	530	270	37	3500	537	3100	3200	—	—	—	—	—	—	—	
Depth of trawling (m)	20	20—45	40—130	20—30	25—90	40—50	20	—	—	—	—	—	—	—	60—90	30—100	25—70	45—120	
Time of trawling (min)	—	220	85	125	165	120	—	—	—	—	—	—	—	—	85	135	145	180	
Average length (mm)	41.9	43.1	46.8	42.4	43.1	42.9	36.1	49.3	33.7	41.9	41.6	47.7	46.8	45.5	48.8	—	—	—	
Alimentary tract filling	4.2	3.4	4.0	3.1	3.6	4.3	4.2	4.2	4.2	4.2	4.2	3.8	3.7	3.8	3.8	3.8	3.9	3.9	
Number of analyzed specimens	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
Percent contribution of developmental stages and mean size of krill																			
1. juveniles	%	—	—	—	—	—	29	2	33	17	17	—	—	—	—	—	6	—	
2. subadult males	mm	10	3	2	16	11	15	34	4	36	23	21	31	28	29	35	29	35	
3. adult males	%	35.6	42.0	41.0	37.2	41.9	40.0	44.5	49.5	36.1	46.8	43.9	49.0	49.1	47.3	50.8	47.3	50.8	
4. subadult females	mm	42	45	47	40	19	39	3	37	3	7	8	6	5	10	7	10	7	
5. adult females	%	46.8	45.1	49.1	45.7	49.1	44.7	47.3	52.6	47.0	49.4	49.7	50.7	51.2	49.6	49.0	49.6	49.0	
6. adult females with spermatophores	mm	16	1	—	4	5	—	29	2	19	6	14	3	6	2	1	2	1	
7. adult females with eggs	%	34.9	38.0	—	36.0	42.4	—	34.2	31.0	33.9	34.2	34.6	45.3	37.2	33.0	33.0	33.0	33.0	
Immature krill total	mm	26	42	48	30	42	30	2	—	2	8	—	1	—	5	—	2	7	
Mature krill total	%	39.5	40.1	44.7	41.7	40.5	41.0	38.5	—	37.0	46.2	—	44.0	42.4	43.0	44.8	43.0	44.8	
	mm	6	9	3	10	23	16	1	56	7	39	40	59	56	51	50	51	50	
	%	46.3	45.1	46.3	41.4	43.6	44.9	46.0	48.0	44.9	44.6	47.6	46.9	46.7	46.1	48.1	46.1	48.1	
	mm	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	
	%	—	—	—	—	—	—	—	53.5	—	—	—	—	—	—	—	—	—	
	mm	26	4	2	20	16	15	63	6	55	29	35	34	32	31	36	31	36	
	%	35.2	40.0	41.0	36.6	42.1	40.0	39.3	40.2	35.9	40.5	39.2	47.2	43.1	40.1	41.9	40.1	41.9	
	mm	74	96	98	80	84	85	6	42	12	54	48	66	66	63	64	63	64	
	%	44.2	43.4	46.7	43.1	44.4	43.5	43.9	51.4	42.9	47.6	49.6	47.2	46.8	46.2	47.3	46.2	47.3	

MTH — Midwater trawl haul, B — Bongo-net, RMT — Rectangular midwater trawl.

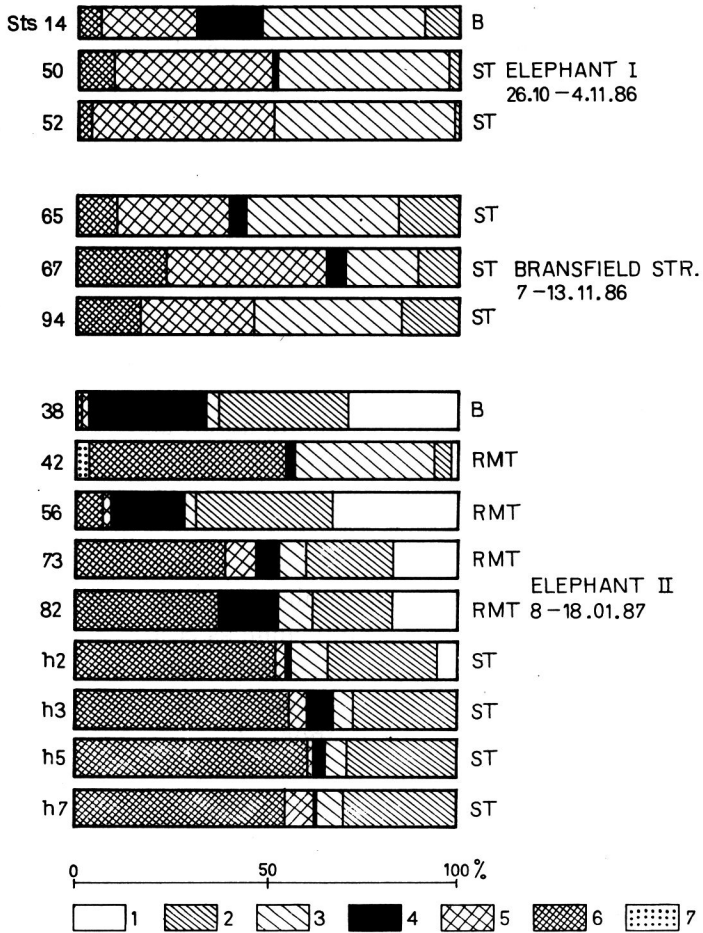


Fig. 2. The share of particular postlarval krill stages in individual hauls
 1 — juvenes; 2 — subadult males; 3 — adult males; 4 — subadult females; 5 — adult females;
 6 — adult females with spermatophores; 7 — adult females with ovaries filled with eggs.

krill dominated. The percentages of immature males and immature females were low and amounted to about 10% each only in station 14. Females with spermatophores were most abundant in station 50, but they constituted only 9% of the analysed sample. Juveniles were absent. The mean krill body length was 44 mm, maximal krill body length was 57 mm for males and 53 mm for females. Different percentage shares of particular krill stages were observed by Nast (1986) in the same area in the beginning of November 1983. This author has recorded a high share of juvenile krill (41%) and a low share of females with spermatophores. The mean krill body length was about 40 mm. However, the population structure of krill caught in the same region and in the same period of 1984 (Nast 1986) was very similar to the

population structure found in the course of our investigations; juvenile krill in Nast's studies of 1984 occurred very rarely and the sex ratio was about 1:1. The results obtained in same region at the end of November and the beginning of December 1984 by Endo, Imaseki and Komaki (1986) are fully concordant with our results. Krill body length recorded by these authors was 44–45 mm, percentage shares of males and females were 40% and 60%, respectively, while the share of juveniles amounted to only 3%.

In the first stage of the expedition (BIOMASS III-1) investigations were also carried out between the Antarctic Peninsula and King George Island (Fig. 1). The shares of particular *E. superba* stages were not much different from those found in the Elephant Island region (Fig. 2). Males constituted 46% of the population, 15% of them being immature. The share of females was 54%; 18% of females bore spermatophores and 3% were immature ones. Juveniles were absent. The mean krill body length was 43 mm, the maximal body length of males was 57 mm, and of females — 51 mm (Fig. 3).

Siegel (1986) investigated krill in the same region in November 1984; he has obtained somewhat different results. The ratio of males to females was similar (1.17:1.0), but sexually mature animals clearly dominated. Females with spermatophores were much less abundant than in our studies. Siegel (1986) did not record any immature females at all, whereas the percentage of immature males was very low — about 2%. Juveniles comprised only 7% of the analysed population. The mean krill body length was 46 mm and was higher than that obtained in our study.

In the second part of the expedition (BIOMASS III-2) investigations were carried out again around the Elephant Island (08—18 Jan. 1987) (Fig. 1). That time results much differ from those obtained two months earlier in the first part of the expedition. The population composition of particular hauls varied widely. Juveniles were recorded in six hauls (Tab. 1, Fig. 2). Their shares were diversified and ranged from 2% to 33% of the analysed sample. The share of immature males was also high (from 4% to 36%) and that of mature males was usually low, amounting to 37% only once in station 42.

Females with spermatophores were very abundant (maximally up to 60%). In station 42 females with ovaries filled with eggs were also recorded. The mean body length of krill of this region was 43.5 mm. The maximal body length of males was 59 mm and of females — 58 mm (Fig. 3).

Quetin and Ross (1984) recorded similar results in the Elephant Island region in January 1982. They pointed out to the very high diversity of the krill population in comparison to other regions studied in the same month by these authors.

According to Czykieta et al. (1986) juvenile and immature krill dominated in the Elephant Island region in January 1984. The situation was

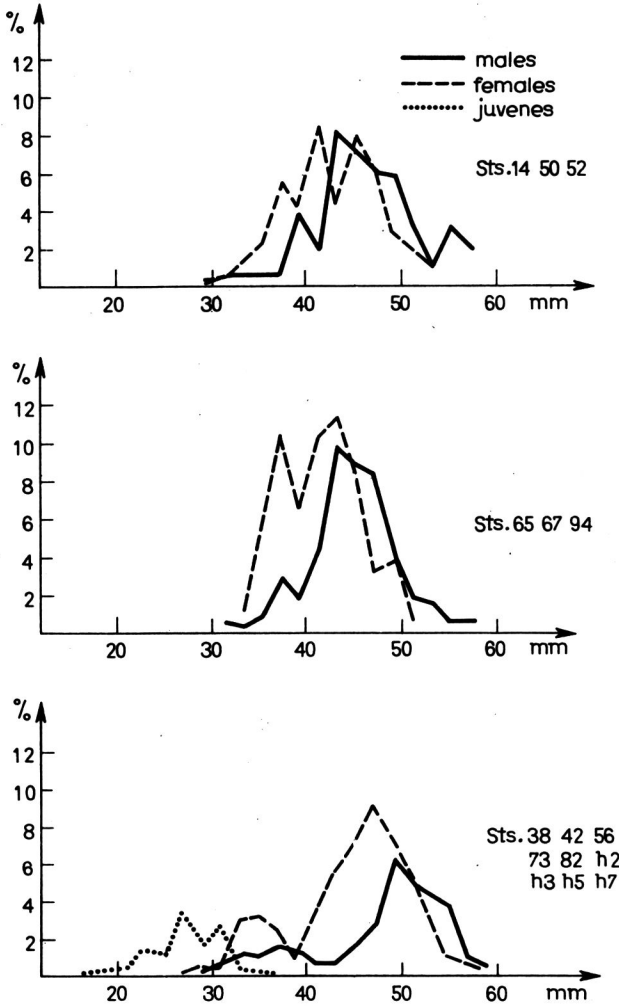


Fig. 3. Size-frequency distribution of juvenes, males and females of *Euphausia superba* in particular research areas

reversed in the course of the present studies. Mature krill generally dominated (see Table 1).

Krill population structure summarized for whole investigated areas (Elephant I and II, Bransfield Strait) is presented in Fig. 4.

Epibiontic Protozoa on *Euphausia superba* Dana

Krill collected with the commercial trawl in the regions of King George Island, Elephant Island and in the Bransfield Strait was infested by epibiontic ciliate Protozoa (Tab. 1, Fig. 1). Three different resting stages were dis-

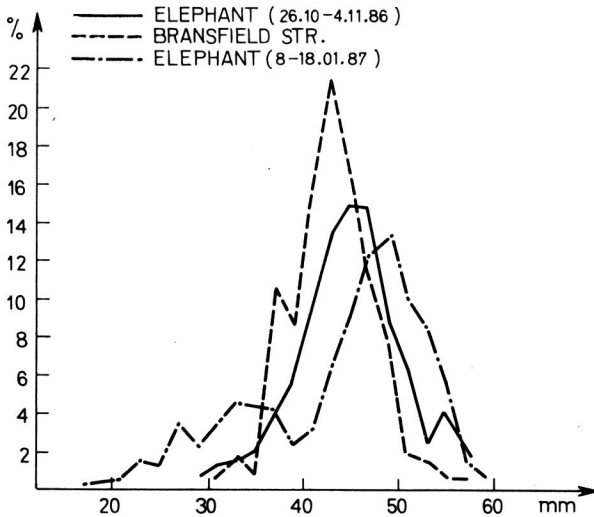


Fig. 4. Size-frequency distribution of *Euphausia superba* for particular research area

tinguished (Pl. 1, 2, 3), which probably belonged to three species of the family Foettingeriidae, order Apostomatida, classis Hymenostomea (De Puytorac et al. 1984). These forms were described in detail by Rakusa-Suszczewski and Nemoto (in preparation) and Rakusa-Suszczewski and Filcek (in press).

Form 1 (Pl. 1, a) occurred most frequently on the endopodite distal segments of thoracic appendages, among setae. Form 2 (Pl. 1, b) was larger and occurred on plumose setae of exopodites of the thoracic appendages. Form 3 (Pl. 1, c) adhered to the segments of thoracic appendages and was the most abundant one.

Out of randomly chosen 127 specimens of the size ranging from 36 to 54 mm 107 were infested by protozoans (forms 1, 2 and 3) which constituted 84% of the investigated *E. superba* specimens. The abundance of Protozoa on particular krill specimens varied widely and was not sex dependent in the studied *E. superba* length range. The high infestation level of the krill population is probably due to the krill swarming habits.

The same forms of Protozoa were recorded on *E. superba* collected south of Australia (Rakusa-Suszczewski and Nemoto, in preparation), in the Admiralty Bay in an annual cycle (Rakusa-Suszczewski and Filcek, in press) and in the Weddell Sea region. These data evidence for the circumantarctic distribution of the Protozoa in question.

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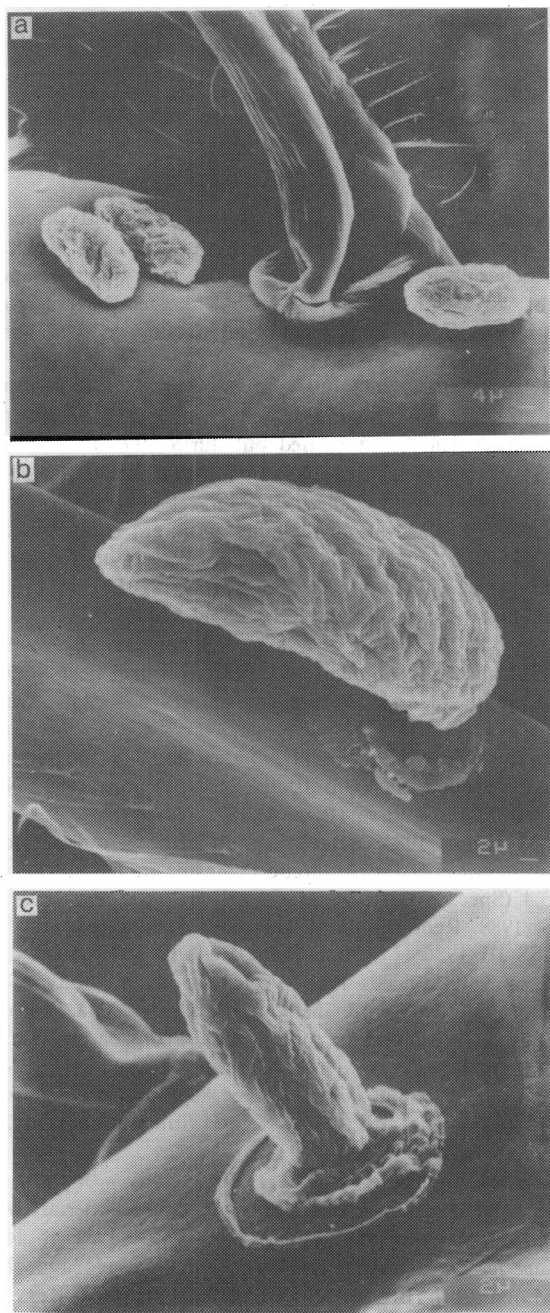


Plate 1. Aprostomatid ciliates from krill:
a — form 1; b — form 2; c — form 3.

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5. Streszczenie

Badania prowadzono w rejonie wyspy Elephant (w dwóch różnych terminach) i w Cieśninie Bransfielda, w ramach programu BIOMASS III (rys. 1). W pracy przedstawiono wyniki analiz biologicznych kryla z tych rejonów (tab. 1). W rejonie wyspy Elephant (przełom października i listopada) średnia długość kryla wynosiła 44 mm i przeważały osobniki dojrzałe płciowo. Juvenes nie stwierdzono (tab. 1, rys. 2 i 3). W Cieśninie Bransfielda (w listopadzie) średnia długość *E. superba* wynosiła 43 mm i również przeważały osobniki dojrzałe płciowo. Form juvenilnych ponownie nie stwierdzono (tab. 1, rys. 2 i 3). Zaznaczyła się niewielka przewaga procentowa samic nad samcami. Najbardziej zróżnicowane populacje kryla stwierdzono w rejonie wyspy Elephant w styczniu 1987. Średnia długość wynosiła 43.5 mm. Przeważały osobniki dojrzałe płciowo, lecz juvenes były obecne w większości prób. W jednym z zaciągów złowiono także samice z jajnikami wypełnionymi jajami (tab. 1, rys. 2 i 3).

Na *Euphausia superba* stwierdzono trzy formy Protozoa Apostomatida (fot. 1, 2, 3), należące prawdopodobnie do trzech różnych gatunków Foettingeriidae (Ciliophora). Około 84% badanych osobników było infestowanych przez te pierwotniaki.