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Distribution of *Euphausia crystallorophias, E. frigida, E. triancantha* and *Thysanoessa macrura* (*Crustacea, Euphausiacea*) in the southern Drake Passage and Bransfield Strait in February and March 1981*)

ABSTRACT: The distribution and some aspects of the ecology of *Euphausia crystallorophias, Euphausia frigida, Euphausia triacantha* and *Thysanoessa macrura* are presented. The investigations in the Polish Sector "A" show that *E. triacantha* is the northernmost and *E. crystallorophias* the southernmost species. These two species occurred least frequently. *T. macrura* was the most numerous and most regularly distributed species in the region under investigations.

Key words: Antarctica, *Euphausiacea*

1. Introduction

In the course of biological researches carried out by Polish BIOMASS-FIBEX 1981 expedition (Rakusa-Suszczewski 1982) besides *Euphausia superba* — the species which was the principal object of the studies — also other species of *Euphausiacea* were observed in the collected materials, namely: *Euphausia crystallorophias, E. frigida, E. triacantha* and *Thysanoessa macrura*.

The investigations lasted from 14th February till 12th March and covered the region from 60 S to 65 S and from 56°W to 66°W (Fig. 1). So practically, they covered the southern part of Drake Passage and nearly the whole area of Bransfield Strait.

*) The research was carried out within the MR-I-29 A Project during the Antarctic BIOMASS-FIBEX expedition headed by Prof. Dr. Stanisław Rakusa-Suszczewski.

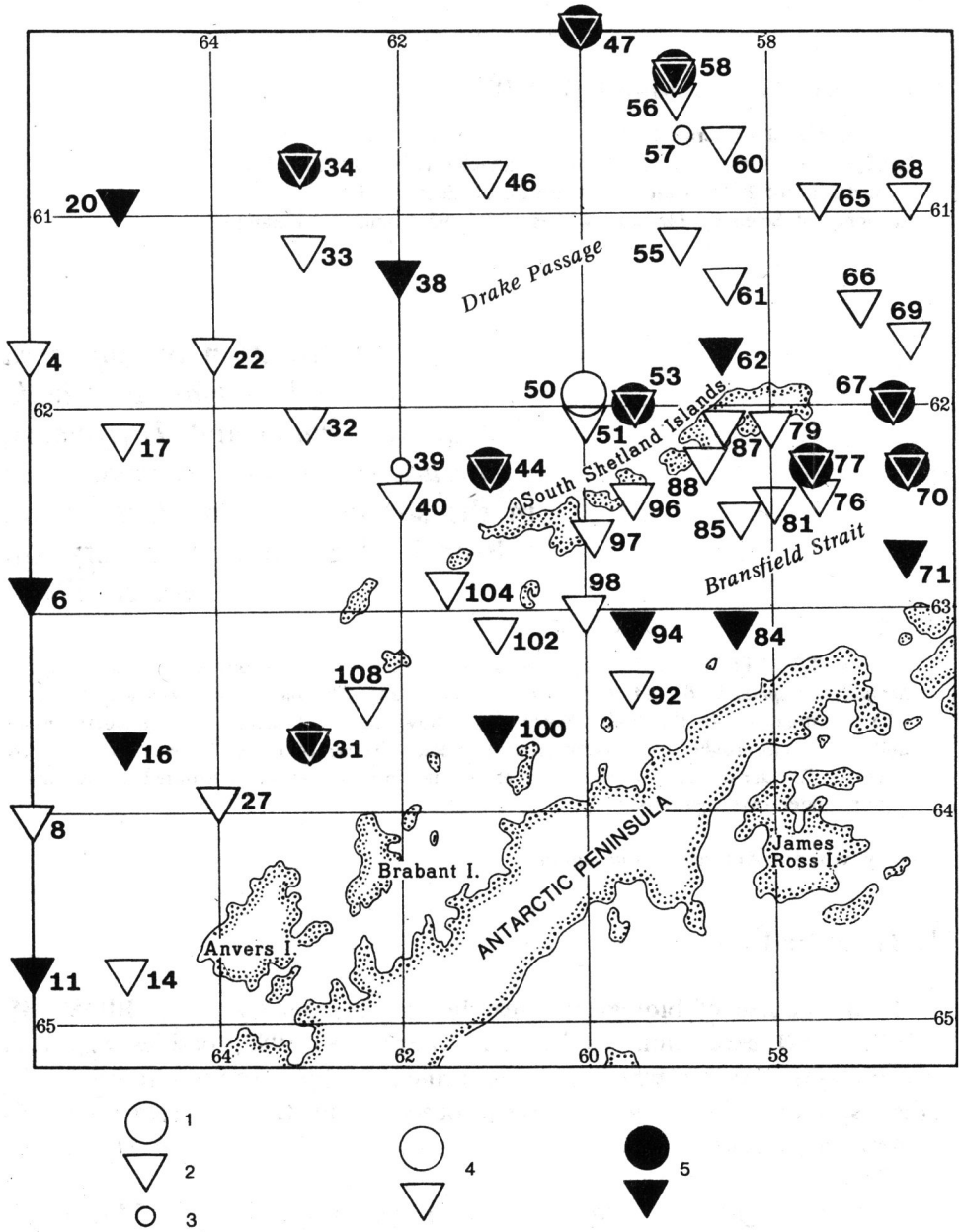

Fig. 1. Oceanic stations at which *Euphausia crystallorophias*, *Euphausia frigida*, *Euphausia triacantha* and *Thysanoessa macrura* samples were collected

1 — Bongo net, 2 — Nansen net, 3 — stern-trawl, 4 — day samples, 5 — night samples

The problem of horizontal and vertical distribution of the Antarctic *Euphausiacea* was dealt with by many authors, among others: John (1936), Baker (1959, 1965), Dzik, Jażdżewski (1978), Lomakina (1978), Makarov (1979), Fevolden (1979), Weigmann-Haass and Haass (1980).

Fairly comprehensive data on ecology, biology and morphology of *Euphausia crystallorophias* and *Thysanoessa macrura* of Admiralty Bay, King George Island, can be found in the papers by Kittel and Presler (1980), Rakusa-Suszczewski and Stępnik (1980), Jackowska (1980), Stępnik (1982).

The aim of this study is to present horizontal distribution of the above-metioned species.

2. Materials and methods

The material was collected on board of the r/v "Profesor Siedlecki" by means of three types of fishing gear: Nansen planktonic net with inlet 70 cm in diameter and 260 μm-mesh filtering screen, Bongo net with inlet 60 cm in diameter and 6 mm mesh and stern-trawl net with a 8×10 mm-mesh krill-net insertion.

Using Nansen net plankton was sampled from two water layers, i.e. 100—0 m and 300—100 m, whereas Bongo net was cast to the depth of 15—20 m and dragged through the water for about 20 minutes. Trawl hauls were made at various depths depending on the echosounding records.

Altogether 61 plankton samples were collected with Nansen net. The *Euphausiacea* (excl. *E. superba*) were found in 48 samples from the 100—0 m water layers and in 24 samples from 300—100 m water layers (Table I).

Bongo net was cast 16 times and *Euphausiacea*, other than *E. superba*, were found in 11 hauls (Table II).

In the material collected by means of stern-trawl species other than *E. superba* were found only twice. In one of the night-catches a comparatively large number of *E. triacantha* was found; in another *T. macrura* predominated decidedly. *Thysanoessa macrura* occurred probably much more frequently in krill hauls, but due to the large meshes of krill net this small species got away back into the water in great numbers, therefore in actual calculations only the samples collected with Nansen and Bongo nets were taken into account.

The animals caught with Nansen net were selected from the samples macroscopically. Smaller specimens, e.g. larvae of *T. macrura*, were counted in the Bogorov chamber. After appropriate calculations their density per 1000 m^3 of water was estimated (Table I). Yet, the obtained results should be treated with caution since Nansen net is a gear not quite satisfactory for catching *Euphausiacea*.

In the material collected with Bongo net or stern trawl only the total number of specimens caught was recorded (Table II).

Table I

Euphausiacea (excl. *E. superba*) caught with Nansen net

Species	No of station	Date	Water layer (m)		Individuals
			100—0	300—100	1000m³
Euphausia crystallorophias	22	19 Feb. 81		+	20
	27	20 Feb. 81		+	20
	31	20 Feb. 81	+		800
	67	28 Feb. 81		+	20
	84	6 Mar. 81	+		20
Euphausia frigida	6	15 Feb. 81	+		400
	38	22 Feb. 81	+		60
	70	4 Mar. 81	+		130
				+	20
	76	5 Mar. 81	+		100
	85	7 Mar. 81	+		30
Euphausia triacantha	20	18 Feb. 81	+		30
	68	4 Mar. 81		+	20
Thysanoessa macrura	4	15 Feb. 81	+		35000*)
	6	15 Feb. 81	+		400
	8	16 Feb. 81	+		4200
	11	16 Feb. 81	+		7500
	14	17 Feb. 81		+	300
	16	17 Feb. 81	+		150
				+	300
	17	18 Feb. 81	+		200
	20	18 Feb. 81		+	100
	27	20 Feb. 81	+		60
	31	20 Feb. 81	+		3000
				+	300
	32	21 Feb. 81	+		300
	34	21 Feb. 81		+	900
	38	22 Feb. 81	+		3700
	40	23 Feb. 81	+		60
	44	23 Feb. 81	+		180
				+	200
	46	24 Feb. 81	+		100
				+	2000
	51	25 Feb. 81	+		700
	53	25 Feb. 81	+		23000
	55	25 Feb. 81	+		1000
				+	40
	56	26 Feb. 81	+		1500
	58	26 Feb. 81	+		100
				+	1000
	60	27 Feb. 81	+		220
	61	27 Feb. 81	+		7000
	62	27 Feb. 81	+		1000
	65	28 Feb. 81	+		2000

1	2	3	4	5	6
	66	28 Feb. 81	+		300
	67	28 Feb. 81	+		12100
				+	100
	70	4 Mar. 81	+		720
				+	100
	71	5 Mar. 81	+		450
	77	5 Mar. 81	+		30
				+	500
	79	6 Mar. 81	+		400
				+	100
	81	6 Mar. 81	+		180
				+	40
	84	6 Mar. 81		+	200
	87	7 Mar. 81	+		1100
				+	20
	88	8 Mar. 81	+		750
	92	9 Mar. 81	+		30
	94	9 Mar. 81	+		330
				+	400
	96	10 Mar. 81	+		30
	97	10 Mar. 81	+		800
	98	10 Mar. 81	+		40
	100	10 Mar. 81	+		80
				+	400
	102	11 Mar. 81	+		70
	104	11 Mar. 81	+		2280
				+	300
	108	12 Mar. 81	+		200

*) *T. macrura* density/1000m^3 comprises the total number of individuals at all developmental stages i.e. furciliae, juveniles and adults.

A more detailed description of elaboration of plankton samples can be found in the paper by Jażdżewski et al. (1982).

Identification of *Euphausiacea* was made after John (1936), Percova (1976) and Lomakina (1978).

3. Results and discussion

Euphausia crystallorophias Holt et Tattersall, 1906

E. crystallorophias was collected at eight sampling stations (Tables I and II, Fig. 2). Six of these stations were located in Bransfield Strait and two in the region north of the South Shetland Islands. Three of these stations, i.e. Nos. 27, 31, 44 are located over the shelf and the remaining ones over the depths of 970—3500 m.

The density of *E. crystallorophias* is very low, ranging from 20 to 800 individuals per 1000 m^3.

The results from our investigations coincide almost completely with the

Table II

Euphausiacea (excl. *E. superba*) caught with Bongo haul and stern trawl

Species	No of station	Date	Bongo haul	Stern trawl	Individuals
Euphausia crystallorophias	31	20 Feb. 81	+		5
	44	23 Feb. 81	+		1
	70	4 Mar. 81	+		1
	77	5 Mar. 81	+		3
Euphausia frigida	44	23 Feb. 81	+		1
	47	24 Feb. 81	+		6
	50	25 Feb. 81	+		6
	58	26 Feb. 81	+		6
	67	28 Feb. 81	+		3
	70	4 Mar. 81	+		36
	77	5 Mar. 81	+		77
Euphausia triacantha	57	26 Feb. 81		+	> 50
Thysanoessa macrura	31	20 Feb. 81	+		69
	34	21 Feb. 81	+		5
	39	23 Feb. 81		+	> 200
	44	23 Feb. 81	+		5
	50	25 Feb. 81	+		42
	53	25 Feb. 81	+		4
	67	28 Feb. 81	+		9
	77	5 Mar. 81	+		1

observations by John (1936) and Weigmann-Haass and Haass (1980). Those authors, also, collected *E. crystallorophias* in the regions of the South Shetland Islands and likewise in very small quantities.

Our investigations show that *E. crystallorophias* occurs at the water temperatures ranging from −0.9° to +1.8°C (Wojewódzki-personal communication). This would make the range of thermic tolerance of this species slightly wider than that given hitherto (Lomakina 1978).

It is worthy to call attention to the fact that greater aggregations of *E. crystallorophias* were recorded at Admiralty Bay (Kittel 1980; Rakusa-Suszczewski and Stępnik 1980; Jackowska 1980; Stępnik 1980) whereas in relatively not very distant open waters investigated by our expedition the density of this species population was always very low. These findings corroborate earlier suggestions of many authors that this neritic species occurs in great numbers only in rather shallow waters, near the pack ice zone and above all south of the Antarctic Divergence zone.

Euphausia frigida Hansen, 1911

E. frigida was caught mainly in Drake Passage and in the eastern part of Bransfield Strait (Fig. 2). *E. frigida* was found at 11 stations in

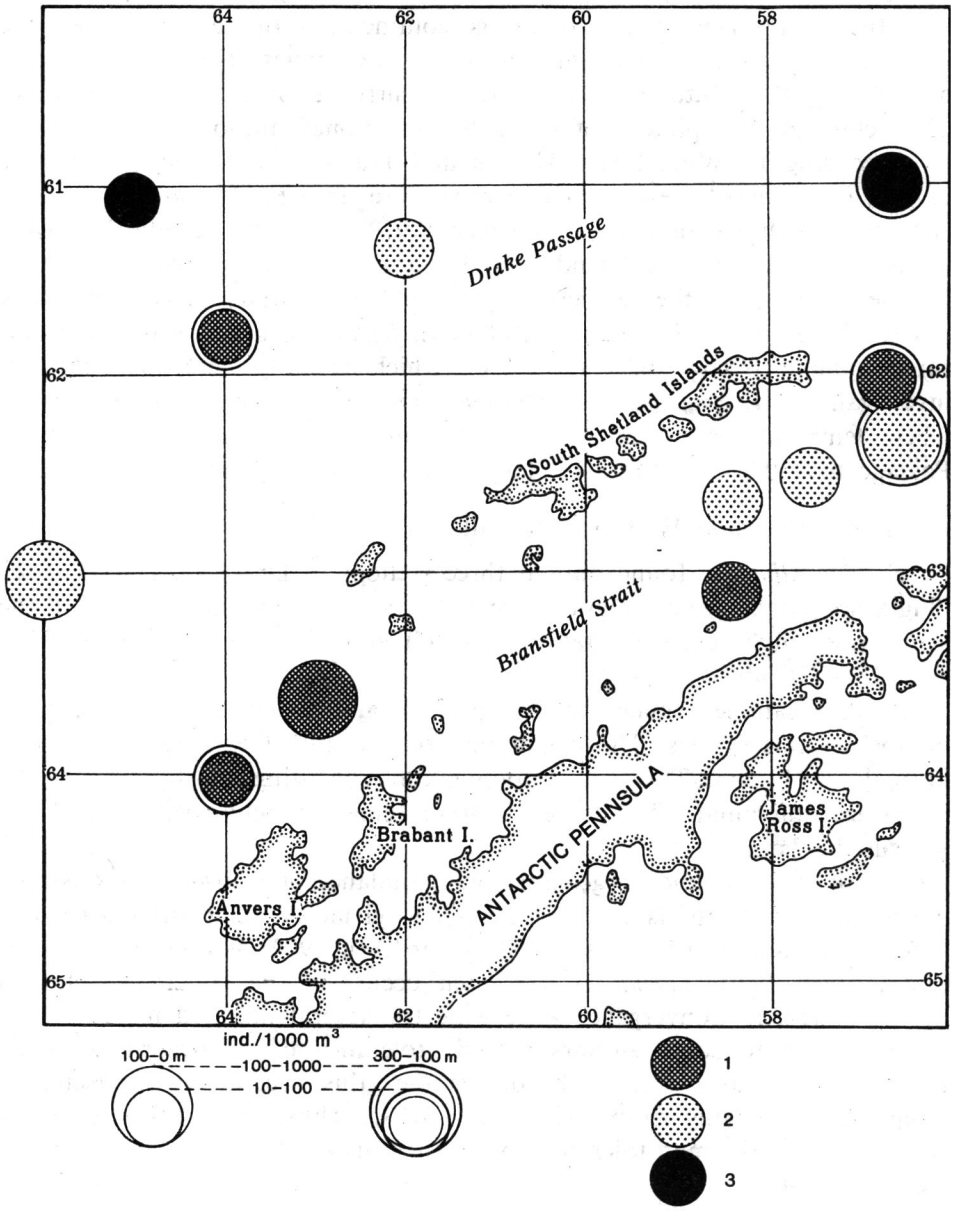

Fig. 2. Horizontal distribution of *E. crystallorophias*, *E. frigida* and *E. triacantha*

Only Nansen net samples. 1 — *Euphausia crystallorophias*, 2 — *E. frigida*, 3 — *E. triacantha*.

the material collected with Nansen net and Bongo net. The total number of this species was low, though slightly higher than the number of *E. crystallorophias* (Table I).

The data given by Baker (1965), Dzik and Jażdżewski (1978), Lomakina (1978) and Weigmann-Haass and Haass (1980) indicate

that the occurrence of *E. frigida* is confined to the area between the Antarctic Convergence and Antarctic Divergence zones. The present studies determining the southern limit of the occurrence of *E. frigida* at about 63°S, confirm the opinions of the above mentioned authors.

According to Weigmann-Haass and Haass (1980) the temperature of +2°C is the lowest critical temperature for *E. frigida*. This is in agreement with the data by Fevolden (1979), who has caught *E. frigida* in the region of Bouvet Island, but did not find this species in the cold Weddell Sea where the temperatures of the upper water layers are below +1°C. According to Lomakina (1978) *E. frigida* occurs at water temperatures ranging from −0.7 to +5°C, which is fully confirmed by our investigations. In our case, *Euphausia frigida* was collected in the waters where temperatures ranged from +2.3°C in the 100—0 m layer in Drake Passage to −0.9°C in the 300—100 m water layer in Bransfield Strait.

Euphausia triacantha Holt et Tattersall, 1906

E. triacantha was found only at three stations in Drake Passage (Fig. 2). Single specimens were caught twice with Nansen net and in one of the stern trawl night catches (station No. 57) several dozen of *E. triacantha* were found (Tables I and II).

In that sample females made up 72% and males 28% of the total number of this species. The maximum body length of females was 33 mm, of males — 30 mm. This was a population consisting mostly of sexually immature individuals. The largest mature female caught with Nansen net measured 47 mm.

The distribution and, in general, low abundance of *E. triacantha* observed during the investigations agree with the data given by other authors (Baker 1959; Dzik and Jażdżewski 1978; Fevolden 1979; Weigmann-Haass and Haass 1980). *Euphausia triacantha* occurs in the circumantarcticarea of the Antarctic Convergence zone wide for several hundred miles.

According to some authors thermic tolerance of *E. triacantha* ranges between +2°C and +12°C. In our studies this species was collected at temperatures ranging from −0.2° to +3.3°C. Thus, these findings extend the range of thermic tolerance of *E. triacantha* to temperatures below freezing-point.

Thysanoessa macrura G. O. Sars, 1885

T. macrura was, after *E. superba*, the species found most frequently and in greatest numbers in the investigated region. It was found at 51 sampling stations and was very numerous in one of the stern trawl catches (Tables I and II, Fig. 3).

Among the specimens caught three developmental forms were identified: furciliae, juvenile and adult. The lack of calyptopis stages in our investigations is quite natural. As results from the data by Makarov (1979)

and Fevolden (1979, 1980), concerning developmental cycle of this species, calyptopis of *T. macrura* appears already in October (Stępnik 1980) and its last stage may be observed but to the end of January.

T. macrura occurred throughout the investigated area, but was more numerous in the upper, 100—0 m water layer than in the 300—100 m layer (Fig. 3).

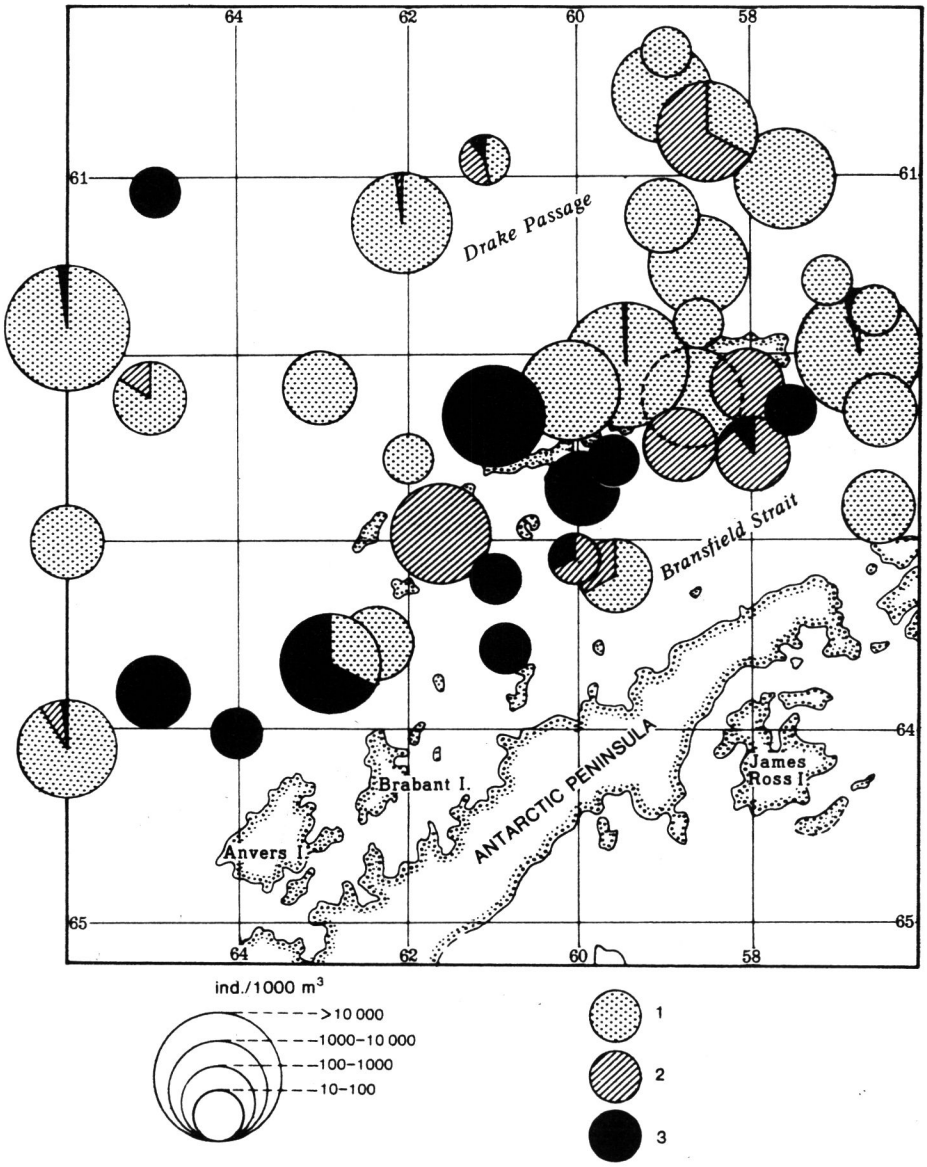

Fig. 3. Horizontal distribution of *T. macrura* in the 100—0 m water layer
1 — *furciliae*, 2 — *juvenes*, 3 — adult

Our studies show that the density of *T. macrura* population was much higher in the waters of the West Wind Drift and north of the South Shetland Islands than in the Bransfield Strait — at the confluence of the water currents from the Bellingshausen Sea and the Weddell Sea.

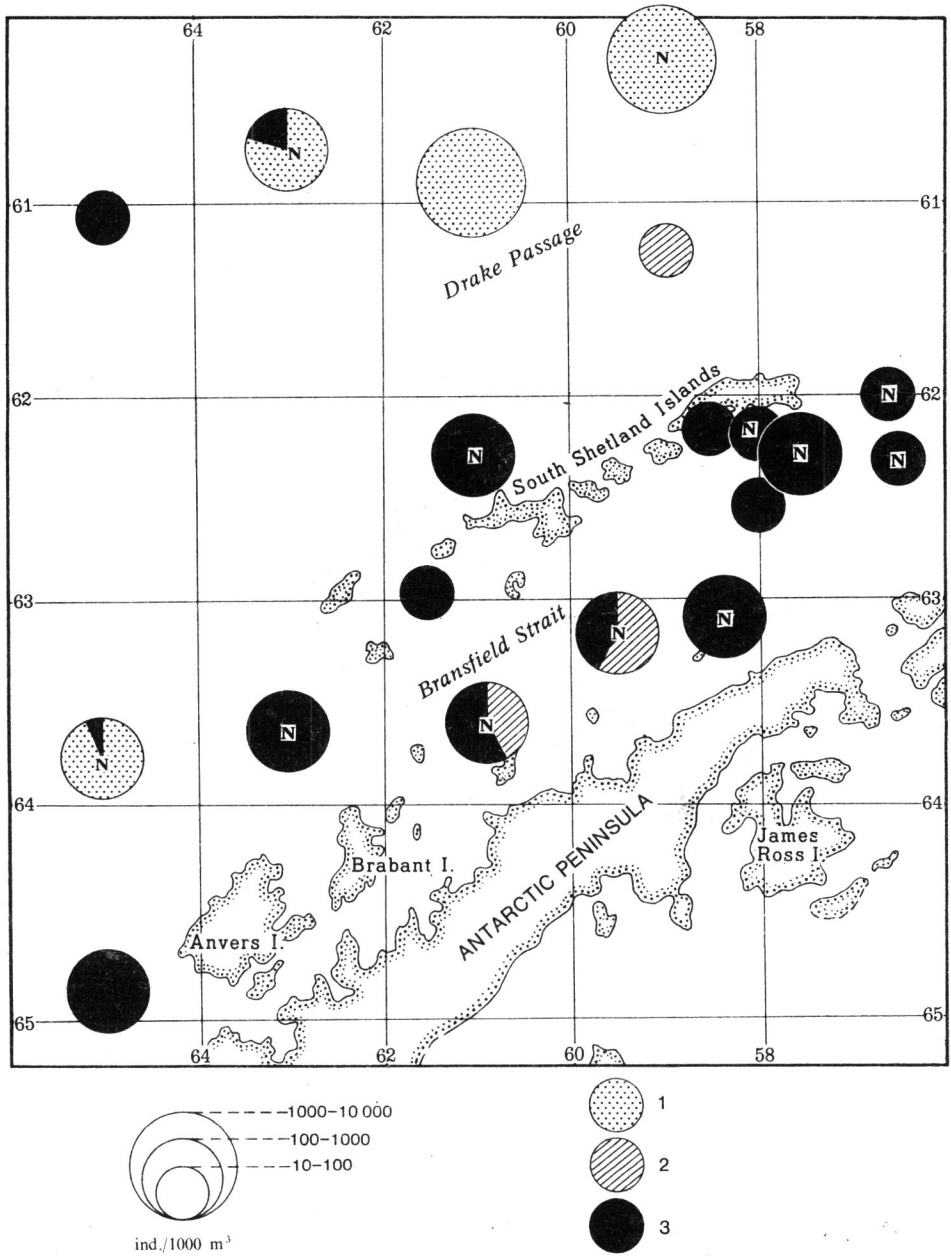

Fig. 4. Horizontal distribution of *T. macrura* in the 300—100 m water layer
N — night samples

Biological analyses of the populations from the Drake Passage and the Bransfield Strait were made.

The population of *T. macrura* from the Drake Passage (samples collected at the stations Nos. 39, 44, and 50, 23—25 February) was characterized by the mean body length of 22 mm (ranging from 16 to 27 mm). The females made up 86% and males 14% of the total number of individuals. The mean body length of the individuals of the population from the Bransfield Strait (stations Nos. 77 and 79, 5—6 March) was 19 mm (ranging from 17 to 23 mm). The percentage of females was 64% and of males 36%.

The results from the investigations concerning distribution of the body length of *T. macrura* agree with the data given by Rakusa-Suszczewski and Stępnik (1980) and Jackowska (1980), who have collected this species in the Admiralty Bay — the region belonging to the Polish Sector of the BIOMASS-FIBEX research.

In the 300—100 m water layer *T. macrura* occurred, as already mentioned above, less frequently and less numerously than in the 100—0 m layer (Fig. 4). The fact that the percentage share of adult forms in the 300—100 m water layer was higher is quite interesting. This may indicate vertical migration of *T. macrura*, since the greater part of the samples in which the adult forms were found had been collected at night.

It is also interesting that of the 24 stations, in which adult forms were observed, 11 were located over the shelf, 7 over the continental slope and only 6 over depths ranging from 1400 to 3600 m and more. Juvenile forms were observed at 11 stations. Three of them (Nos. 8, 79 and 104) were located over the shelf. Another three (Nos. 88, 94 and 100) over the continental slope. The remaining five stations were located over great depths ranging from 1800 to 3600 m and more. Juvenes were found in greatest numbers at Bransfield Strait. The occurrence of furciliae was observed at 28 stations, mostly in the waters of the western and northern part of the investigated regions. Twelve of those stations were located over the shelf and all the remaining ones over the depths ranging from 850 to 3600 m and more.

4. Резюме

Обсуждалось распределение и численность *E. crystallorophias*, *E. frigida*, *E. triacantha*, *T. macrura*, собранных в 300-метровом слое пелагиали Южного океана в секторе А международной программы БИОМАСС-ФИБЭКС, т.е. в южной части пролива Дрейка и в проливе Брансфилд в феврале и марте 1981 г (рис. 1).

На основании полученных результатов можно установить, что самым редким и при том найболее немногочисленным видом был *E. triacantha*, затем *E. crystallorophias* и *E. frigida* (таблицы I и II). Наблюдалась зональность их распределения. Найболее северным видом был *E. triacantha*, а найболее южным — *E. crystallorophias* (рис. 2).

Thysanoessa macrura была распределена в принципе равномерно во всем исследуемом секторе (рис. 3 и 4), но численность этого вида была выше в проливе Дрейка, чем в проливе Брансфилда.

5. Streszczenie

Omówiono rozmieszczenie i liczebność *Euphausia crystallorophias, E. frigida, E. triacantha* i *Tysanoessa macrura,* zebranych w 300-metrowej warstwie pelagialu Oceanu Południowego w sektorze „A" międzynarodowego programu BIOMASS-FIBEX, a mianowicie w południowej części Cieśniny Drake'a i w Cieśninie Bransfielda w lutym i marcu 1981 roku (rys. 1).

Uzyskane wyniki pozwoliły stwierdzić, że najrzadszym i najmniej licznie spotykanym gatunkiem były *E. triacantha,* następnie *E. crystallorophias* i *E. frigida* (tabela I i II). Zaznaczyła się strefowość w ich rozmieszczeniu. Najbardziej północnym gatunkiem był *E. triacantha,* najbardziej południowym zaś *E. crystallorophias* (rys. 2).

Thysanoessa macrura rozmieszczona była w zasadzie równomiernie w całym badanym sektorze (rys. 3 i 4), choć liczebność tego gatunku była wyższa w Cieśninie Drake'a niż w Cieśninie Bransfielda.

6. References

1. Baker A. C. 1959 — The distribution of *Euphausia triacantha* Holt and Tattersall — Discovery Rep., 29: 309—339.
2. Baker A. C. 1965 — The latitudinal distribution of *Euphausia* species in the surface waters of the Indian Ocean — Discovery Rep., 33: 309—334.
3. Dzik J., Jażdżewski K. 1978 — The euphausiid species of the Antarctic region — Pol. Arch. Hydrobiol., 25: 589—605.
4. Fevolden S. E. 1979 — Investigations on krill (*Euphausiacea*) sampled during the Norvegian Antarctic Research Expedition 1976/77 — Sarsia, 64: 189—198.
5. Fevolden S. E. 1980 — Krill off Bouvetöya and in the southern Weddell Sea with a description of larval stages of *Euphausia crystallorophias* — Sarsia, 65: 149—162.
6. Jackowska H. 1980 — Krill monitoring in Admiralty Bay (King George Island, South Shetland Islands) in summer 1979/1980 — Pol. Polar Res., 1(4): 117—125.
7. Jażdżewski K., Kittel W., Łotocki K. 1982 — Zooplankton studies in the southern Drake Passage and the Bransfield Strait in February-March 1981 during the BIOMASS-FIBEX expedition — Pol. Polar Res., 3: 203—242.
8. John D. D. 1936 — The southern species of the genus *Euphausia* — Discovery Rep., 14: 195—319.
9. Kittel W. 1980 — Populational studies on *Euphausia superba* Dana, 1852 (*Euphausiacea, Crustacea*) in waters of the Admiralty Bay during Antarctic summer of 1978 — Pol. Arch. Hydrobiol., 27 (2): 267—272.
10. Kittel W., Presler P. 1980 — Morphology of the postlarval developmental stages of *Euphausia crystallorophias* Holt et Tattersall, 1906 (*Euphausiacea, Crustacea*) — Pol. Arch. Hydrobiol., 27 (2): 259—265.
11. Lomakina N. B. 1978 — Eufausiidy mirovogo okeana (*Euphausiacea*) — "Nauka", Leningradskoe Otdielene, Leningrad, 222 pp.
12. Makarov R. R. 1979 — Larval distribution and reproductive ecology of *Thysanoëssa macrura (Crustacea: Euphausiacea)* in the Scotia Sea — Mar. Biol., 52: 377—386.
13. Percova K. N. 1976 — Ličinki evfaziid Antarktiki — Trudy Inst. Okeanol., 106: 147—170.
14. Rakusa-Suszczewski S. 1982 — Report on the r/v "Profesor Siedlecki" expedition to the Antarctic in 1981 during international BIOMASS-FIBEX programme — Pol. Polar Res. 3: (3—4): 137—141.
15. Rakusa-Suszczewski S., Stępnik R. 1980 — Three species of krill from Admiralty Bay (King George, South Shetlands), in summer 1978/79 — Pol. Arch. Hydrobiol., 27, (2): 273—284.
16. Stępnik R. 1982 — All-year populational studies of *Euphausiacea (Crustacea)* in the

Admiralty Bay (King George Island, South Shetlands Islands, Antarctic) — Pol. Polar Res. 3: 49—68.

17. Weigmann-Haass R., Haass G. 1980 — Geographische Verbreitung und vertikale Verteilung der *Euphausiacea (Crustacea)* während der Antarktis-Expedition 1975/76 — Meeresforsch, 28: 19—31.

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