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Distribution of *Euphausia frigida*, *Euphausia crystallorophias*, *Euphausia triacantha* and *Thysanoessa macrura* in the southern part of Drake Passage and in the Bransfield Strait during the 1983—1984 austral summer (BIOMASS-SIBEX)*)

ABSTRACT: In the plankton samples collected with a Bongo net besides *Euphausia superba* the following species of the *Euphausiacea* were found: *E. frigida*, *crystallorophias*, *E. triacantha* and *T. macrura*. The most aboundant and most frequently caught species was *T. macrura* equally distributed throughout the research area. The species *E. frigida* also occurred regularly though in much smaller numbers. *E. triacantha* occurred sporadically, mainly in the western part of the research region, and *E. crystallorophias* only at two stations in the Bransfield Strait. Some aspects of the biology and ecology of the mentioned above species are presented in this study.

Key words: Antarctica, *Euphausiacea*, distribution

1. Introduction

During biological studies conducted within the international programme BIOMASS-SIBEX, besides the species *Euphausia superba* — which was the main object of the investigations in the course of this experiment — also other species of the order *Euphausiacea* were observed, namely: *Euphausia frigida*, *Euphausia crystallorophias*, *Euphausia triacantha* and *Thysanoessa macrura*.

*) The research was carried out within the MR-I-29 A Project during the Antarctic BIOMASS-SIBEX Expedition headed by Prof. Rakusa-Suszczewski and Dr. Bykowski

A great number of authors, among others: John (1936), Baker (1959, 1965), Marr (1962), Mauchline and Fischer (1969), Lomakina (1964), Dzik and Jażdżewski (1978), Fevolden (1979, 1980), Weigmann-Haas and Hass (1980) were interested in the problem of the horizontal and vertical distribution of the above-mentioned species.

This study is a continuation of the earlier investigations of Polish reserchers (Dzik and Jażdżewski 1978, Rakusa-Suszczewski and Stępnik 1980, Kittel and Stępnik 1983) and also an attempt to supplement and exted the information on the subject of the horizontal distribution of the above-mentioned species with regard to some elements of their biology and ecology.

2. Material and methods

The investigations were carried out from December 10th, 1983 till January 8th, 1984. They covered the area between longitudes 42°W and 66°W and latitudes 60°S and 65°S (Fig. 1).

The materials were collected at 68 sampling stations from the board of the vessel r/v "Profesor Siedlecki" (Fig. 1). The detailed data on the stations location was given by Rakusa-Suszczewski and Lipski (1985). A Bongo-net was used for sample collecting. The mouth openings of that net were 60 cm in diameter; one of them was provided with gauze of 333 μm mesh, another with gauze of 505 μm mesh. The net was hauled obliquely twice, from the sea surface downwards to about 200 m depth and back. The measurements of the maximum depth were made by means of a time-sounder echo-sounder and of the quantity of filtered water by means of the flowemeters attached to both nets. In this paper materials from the 505 μm-mesh-net were used.

The *Euphausiacea* were selected macroscopically, then identified and measured. Biological analyses were made only then, when the number of the animals of a given species was more than 25 individuals in the sample. Altogether 7 analyses of *E. frigida* and 38 of *T. macrura* were made. The analyses included the measurements of the body length with accuracy to 1 mm and determination of sex. The identification of the *Euphausiacea* were made after: John (1936), Dzik and Jażdżewski (1978), Mauchline (1980), Kirkwood (1982).

3. Results and discussion

Euphasia frigida Hansen, 1911

This species was caught at 32 stations in the research region. Thus, it belongs to the species occurring frequently (Table I, Fig. 1). However,

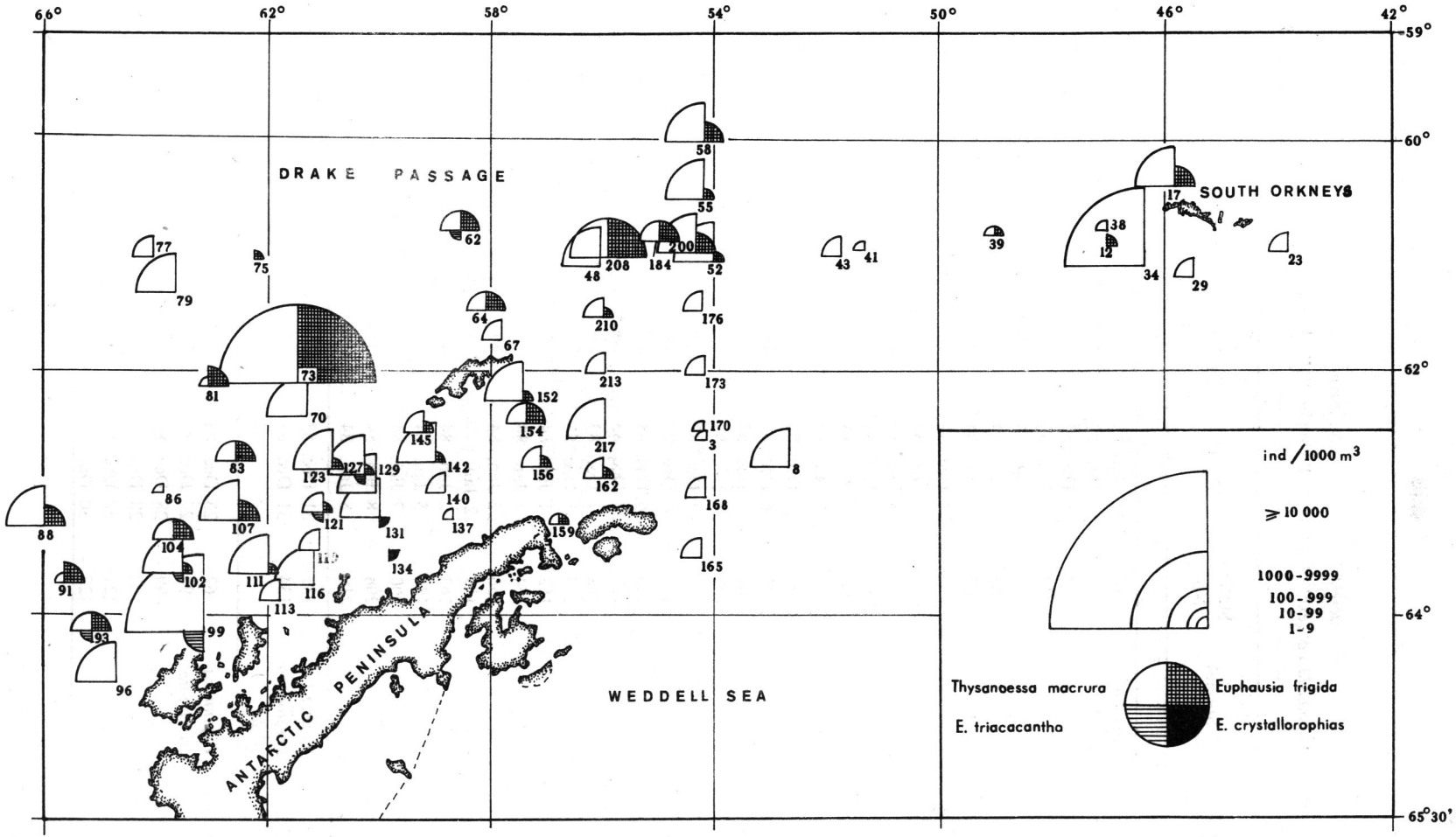

Fig. 1. Distribution and abundance of *Euphausia frigida*, *Euphausia crys stallorophias*, *Euphausia triacantha*, and *Thysanoessa macrura* populations

Table I.

Euphausiacea (excl. E. superba) caught with Bongo net 505 μm

Species	Station No.	Date	Maximum haul depth (m)	Ind./1000 m³
1	2	3	4	5
Euphausia	17	13 Dec. 83	185	76
frigida	39	17 Dec. 83	193	8
	52	21 Dec. 83	190	1
	55	21 Dec. 83	223	1
	58	22 Dec. 83	210	43
	62	23 Dec. 83	170	17
	64	23 Dec. 83	235	14
	73	24 Dec. 83	180	1295
	75	25 Dec. 83	180	7
	81	26 Dec. 83	170	26
	83	26 Dec. 83	163	76
	88	27 Dec. 83	215	20
	91	27 Dec. 83	–	10
	93	27 Dec. 83	222	19
	102	28 Dec. 83	180	9
	104	28 Dec. 83	245	13
	107	29 Dec. 83	150	10
	111	29 Dec. 83	180	2
	121	30 Dec. 83	195	3
	123	30 Dec. 83	117	2
	127	30 Dec. 83	200	9
	142	31 Dec. 83	180	1
	145	31 Dec. 83	210	9
	152	1 Jan. 84	185	2
	154	1 Jan. 84	195	19
	156	2 Jan. 84	192	2
	159	2 Jan. 84	75	6
	162	2 Jan. 84	165	2
	184	5 Jan. 84	180	22
	200	7 Jan. 84	200	63
	208	8 Jan. 84	155	538
	210	8 Jan. 84	148	4
Euphausia	131	31 Dec. 83	210	3
crystalloro-	134	31 Dec. 83	175	9
phias				
Euphausia	62	23 Dec. 83	170	1
triacantha	93	27 Dec. 83	222	1
	99	28 Dec. 83	197	11
	102	28 Dec. 83	180	8
	121	30 Dec. 83	195	3
	127	30 Dec. 83	200	2

Thysanoessa	3	10 Dec. 83	180	5
macrura	8	11 Dec. 83	180	513
	12	12 Dec. 83	200	2
	17	13 Dec. 83	185	127
	23	14 Dec. 83	180	16
	29	15 Dec. 83	210	15
	34	17 Dec. 83	45	1430
	38	17 Dec. 83	120	7
	39	17 Dec. 83	193	1
	41	18 Dec. 83	205	3
	43	18 Dec. 83	60	95
	48	19 Dec. 83	95	460
	52	21 Dec. 83	190	206
	55	21 Dec. 83	223	441
	58	22 Dec. 83	210	135
	62	23 Dec. 83	170	21
	64	23 Dec. 83	235	10
	67	23 Dec. 83	193	59
	70	24 Dec. 83	–	763
	73	24 Dec. 83	180	1794
	77	25 Dec. 83	180	12
	79	25 Dec. 83	145	190
	81	26 Dec. 83	170	4
	83	26 Dec. 83	163	15
	86	26 Dec. 83	160	5
	88	27 Dec. 83	215	401
	91	27 Dec. 83	–	2
	93	27 Dec. 83	222	53
	96	27 Dec. 83	195	447
	99	28 Dec. 83	197	3063
	102	28 Dec. 83	180	463
	104	28 Dec. 83	245	10
	107	29 Dec. 83	150	451
	111	29 Dec. 83	180	411
	113	29 Dec. 83	120	77
	116	29 Dec. 83	205	174
	119	29 Dec. 83	175	31
	121	30 Dec. 83	195	20
	123	30 Dec. 83	117	427
	127	30 Dec. 83	200	325
	129	30 Dec. 83	220	563
	131	31 Dec. 83	210	347
	137	31 Dec. 83	110	3
	140	31 Dec. 83	167	44
	142	31 Dec. 83	180	210
	145	31 Dec. 83	210	58
	152	1 Jan. 84	185	231
	154	1 Jan. 84	195	44
	156	2 Jan. 84	192	63

Thysanoessa	159	2 Jan. 84	75	9
macrura	162	2 Jan. 84	165	69
	165	3 Jan. 84	180	12
	168	3 Jan. 84	145	13
	170	3 Jan. 84	195	3
	173	3 Jan. 84	160	70
	176	4 Jan. 84	160	75
	184	5 Jan. 84	180	96
	200	7 Jan. 84	200	209
	208	8 Jan. 84	155	540
	210	8 Jan. 84	148	27
	213	8 Jan. 84	197	40
	217	8 Jan. 84	193	558

it prefers evidently the waters of Drake Passage, north of the South Shetlands and in the region of Elephant Island, where it occurred most aboundantly and most frequently. It was observed also fairly often though in smaller numbers in the shelf waters of the Polmer Archipelago and in the northern part of Bransfield Strait and the South Orkneys. *E. frigida* was not found in the waters remaining under the influence of the cold masses of water from the Weddell Sea.

Biological characteristic of the seven largest hauls of *E. frigida* is shown in Figs. 2 and 3. A low percentage (0—11%) of the juvenile stages is a very characteristic feature. There was a high percentage of males and females with spermatophores. In a sample collected at the station No. 88 — males with spermatophores made up 77% and females 14%. In a sample collected at the station No 200 the percentages of males and females with spermatophores were still higher —54% and 11% respectively. This surely evidences that this species is in the reproduction season. The body length of the males was in the range of 11—21 mm and of females 12—24 mm.

Euphausia frigida is a circumpolar species (Łomakina 1978, Kirkwood 1982), though it keeps resolutely away from very cold waters (Weigmann-Haass and Haass 1980, Fevolden 1980). This fact is confirmed by our investigations as well. The temperature of the waters in which this species is present ranges from -0.7 — $+0.5$°C (Łomakina 1978). *E. frigida* makes daily vertical migration for feeding, moving from the depth of 50 m under the water surface (at night) downwards to 300 m depth (in the daytime). Since the majority of the samples were collected in the daylight and this species goes deeper downwards at that time might have been the decisive cause of a not too high abundance of *E. frigida* in the hauls.

Euphausia crystallorophias Holt and Tattersall, 1906

This was the least often noticed species during our investigations. It was observed only at two stations (131 and 134) in the Bransfield Strait (Table I, Fig. 1).

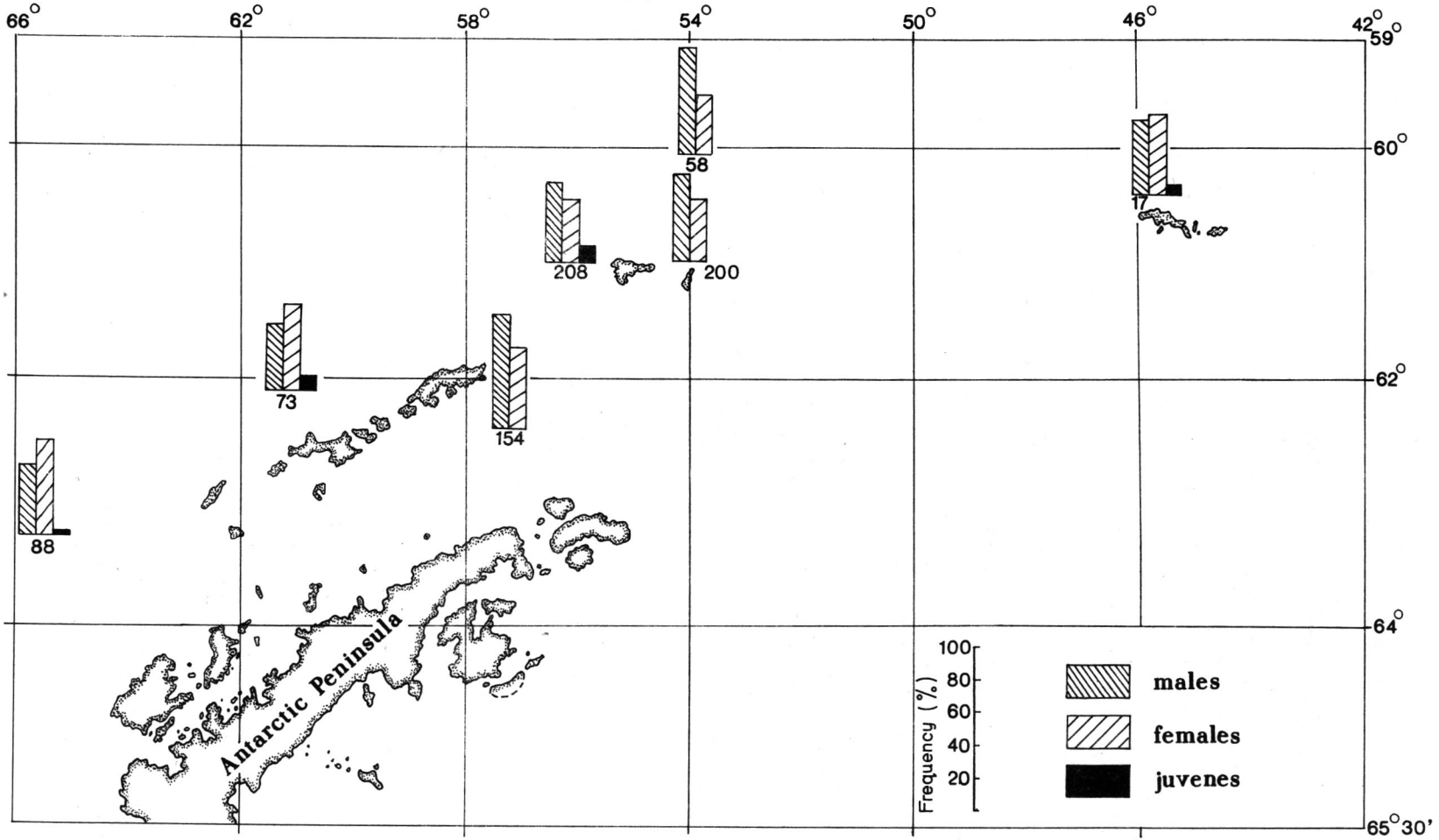

Fig. 2. Frequency distribution of various sex groups of *Euphausia frigid a* in the analysed saples
Only the samples containing more than 25 specimens are represented.

The fact of such a rare occurrence of *E. crystallorophias* in the research region is very intriguing. The earlier data from the literature (John 1936, Łomakina 1978, Weigmann-Haass and Haass 1980) indicate that this particular sector of our investigations and Bransfield Strait especially are the areas of the mass-occurrence of this species. Also, in the waters of Admiralty Bay, King George Island, *E. crystallorophias* was recorded freqently and in large numbers (Kittel 1980, Rakusa-Suszczewski and Stępnik 1980).

The reasons of such a rare and sparse occurrence of this species may be attributed surely to its biology. *Euphausia crystallorophias* breeds in the

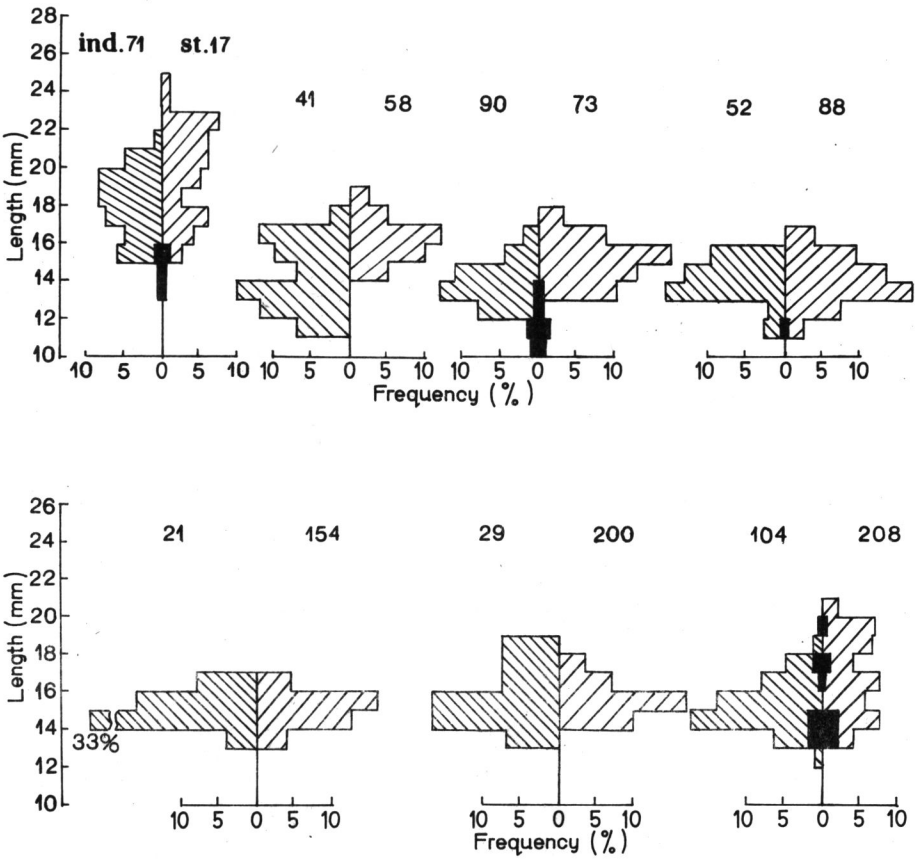

Fig. 3. Frequency distribution and length distribution of the developme ntal stages of *E. frigida* in the research area

early period of the Antarctic summer, beneath the ice, far away in the south (Lomakina 1978, Mackintosh 1934) and hence, to be sure, its absence in the open waters of the region under investigations.

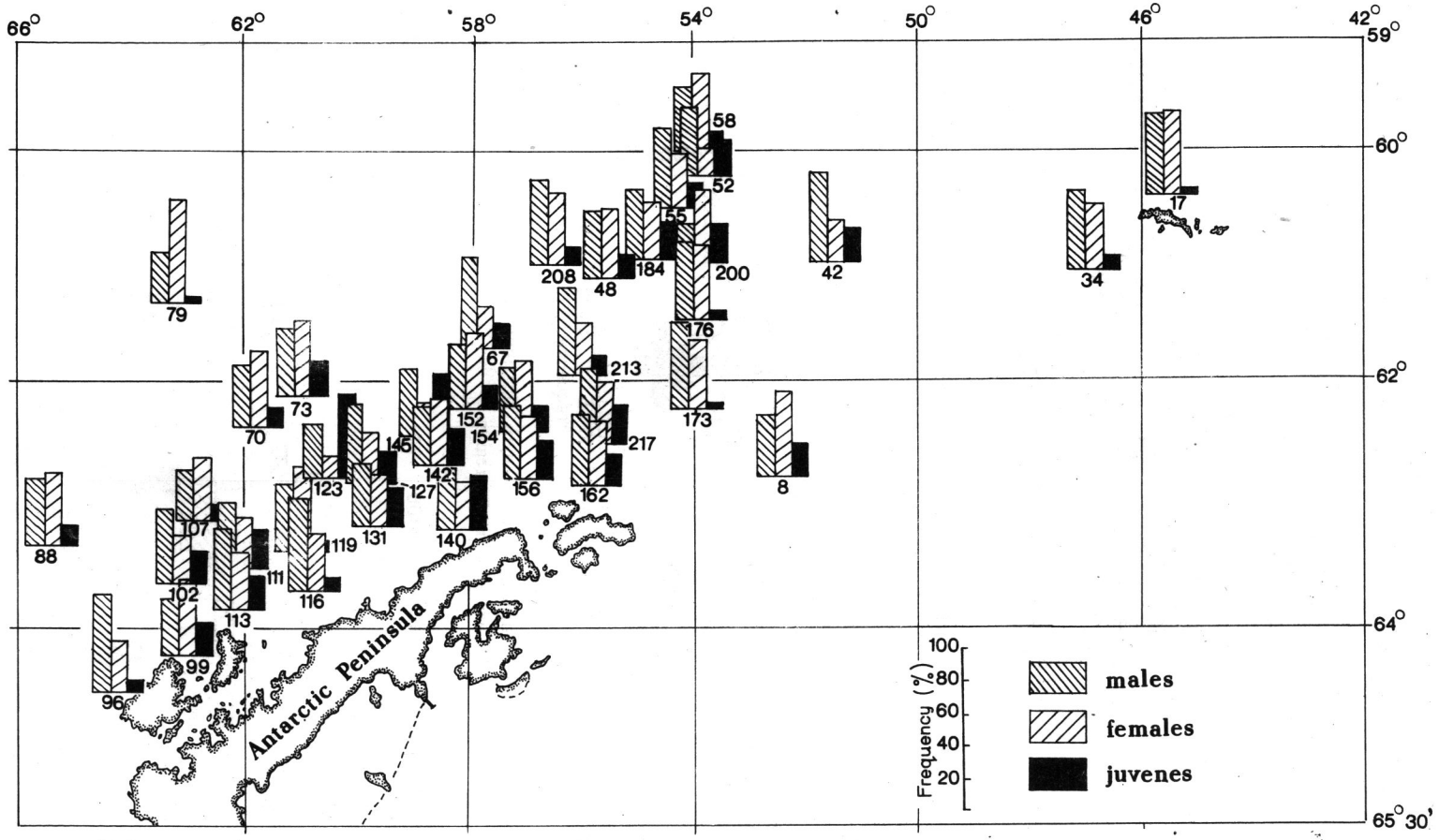

Fig. 4. Frequency distribution of various sex groups of *Thysanoessa macrura* in the analysed samples (more than 25 specimens in the sample)

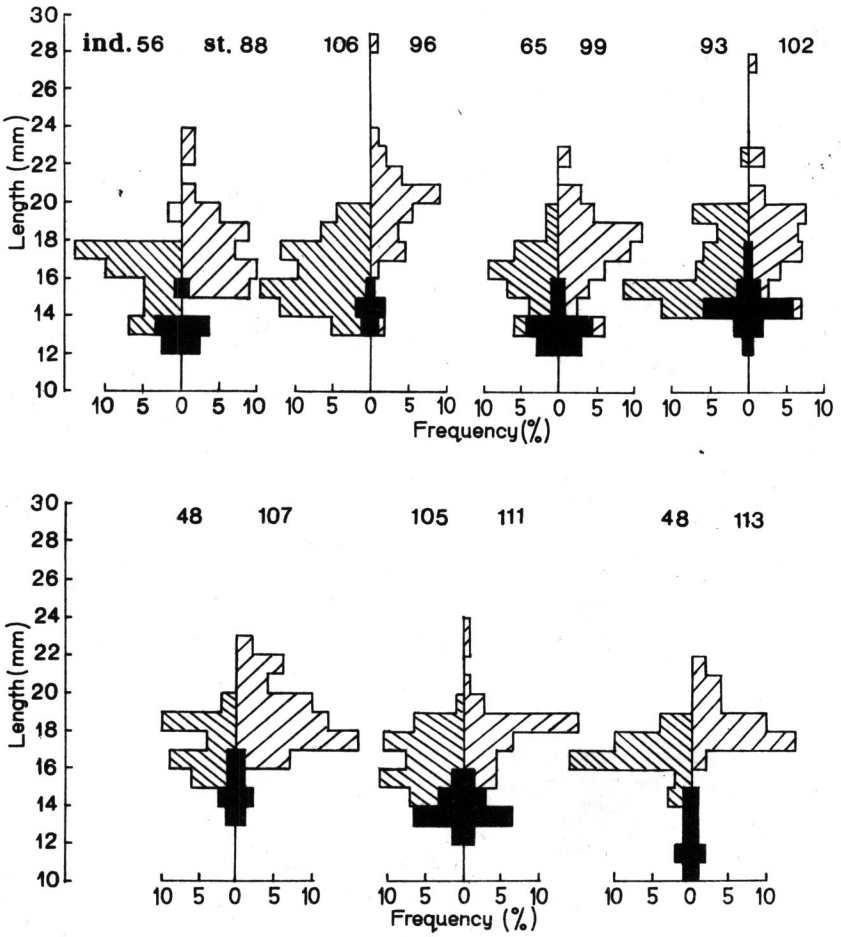

Fig. 5. Frequency distribution and length distribution of the developmental stages of *T. macrura* in the region of the Palmer Archipelago

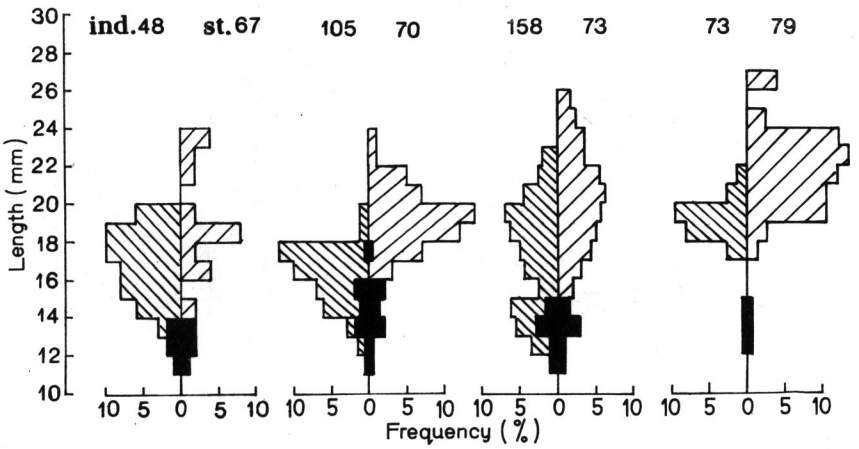

Fig. 6. Frequency distribution and length distribution of the developmental stages of *T. macrura* in Drake Passage

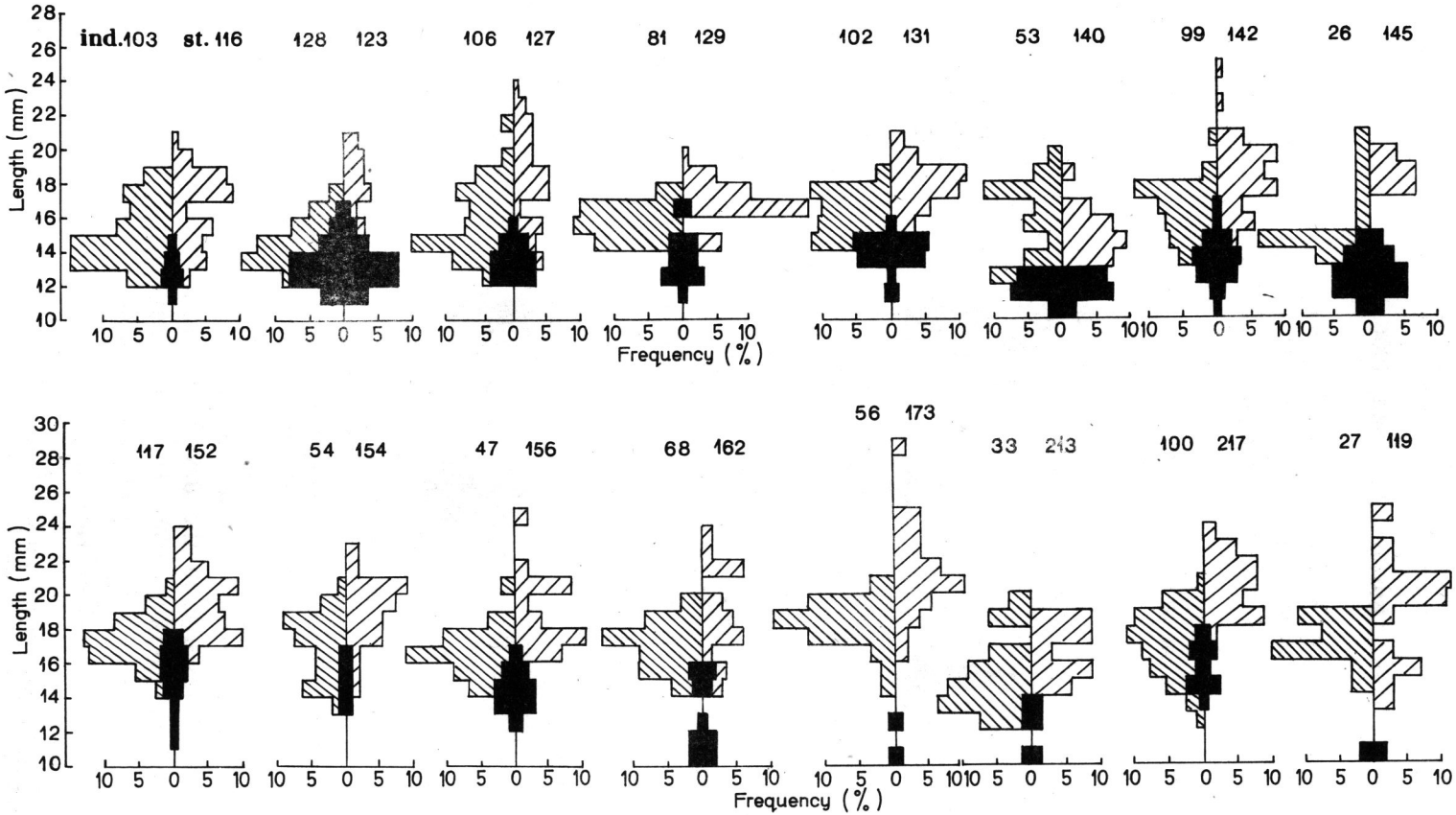

Fig. 7. Frequency distribution and length distribution of the developmental stages of *T. macrura* in Bransfield Strait

Euphausia triacantha Holt and Tattersall, 1906

This species also was observed infrequently and in scant numbers. It was present only at six stations (Nos. 62, 93, 99, 102, 121 and 127) mainly, in the western part of the research region (Table I, Fig. 1).

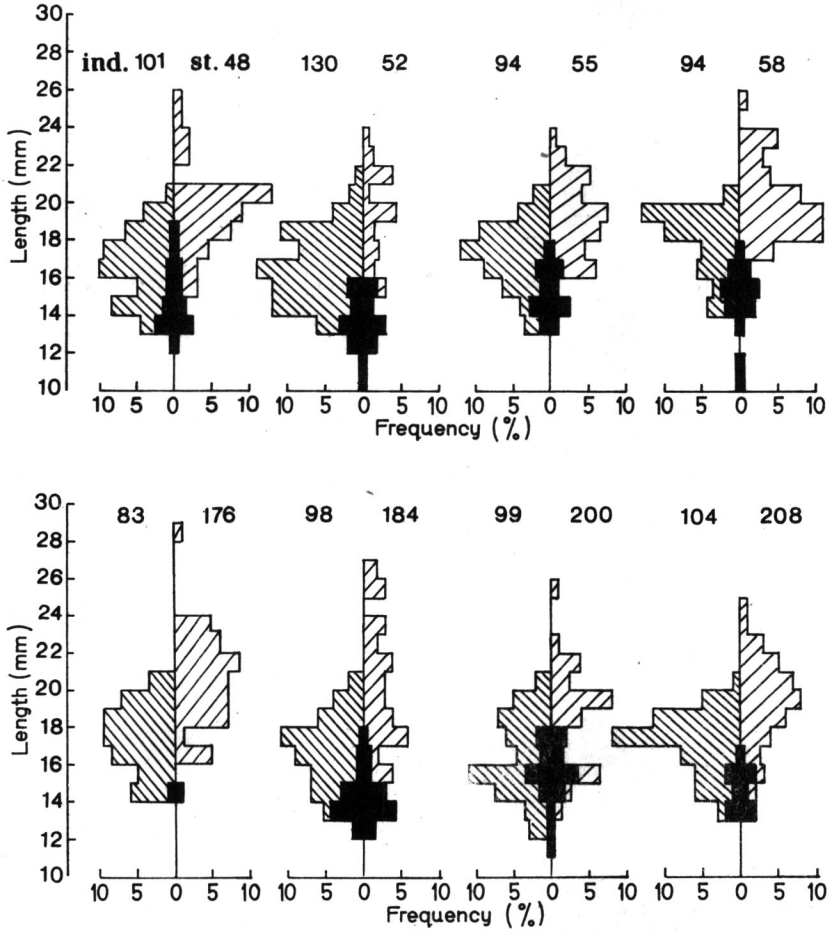

Fig. 8. Frequency distribution and length distribution of the developmental stages of *T. macrura* in the waters around Elephant Island

Euphausia triacantha does not aggregate into swarms (Baker 1959, Lomakina 1978) and in the daytime it moves downwards to a depth of about 700 m (Baker 1959). These are, certainly, the main causes of such a low frequency of this species in the course of our investigations.

Thysanoessa macrura G. O. Sars, 1885

This species occurred most often and in greatest numbers during the period of our investigations. It was recorded at 62 stations of the research

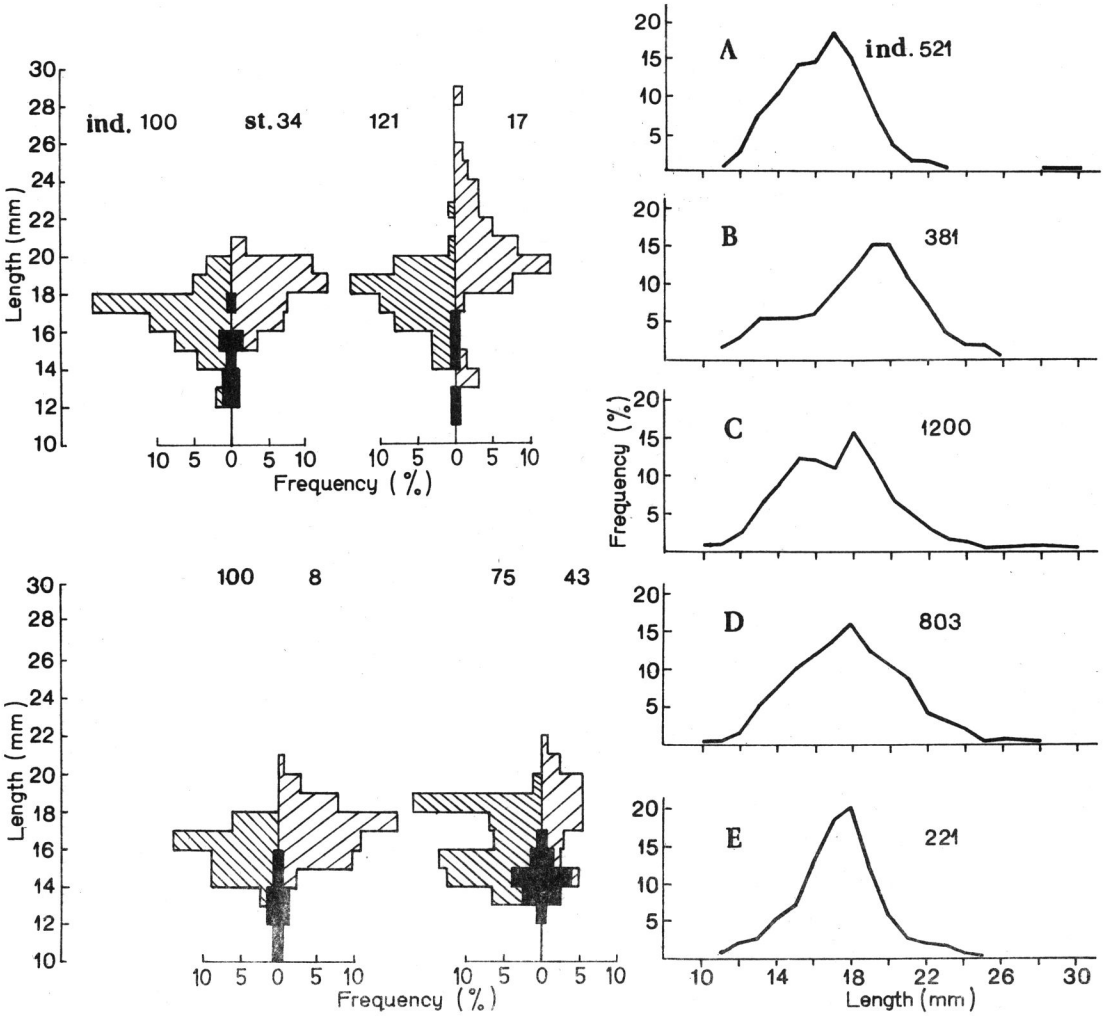

Fig. 9. Frequency distribution and length distribution of the developmental stages of *T. macrura* in the region of the South Orkney Islands and at stations 8 and 43

Fig. 10. Length distribution and frequency distribution of *T. macrura* in different research regions

A — the Palmer Archipelago, B — Drake Passage, C — Bransfield Strait, D — Elephant Island, E — South Orkneys

area (Table I, Fig. 1). The distribution of this species is, in principle, equal throughout the investigated region.

Having collected very rich material 38 biological analyses of this species were made.

Figure 4 illustrates the freguency distribution of three developmental stages of *T. macrura* — males, females and juveniles at various stations. Figures: 5, 6, 7, 8, 9 — show digrams of the frequency distribution

Table II.

Characteristic of the *Thysanoessa macrura* population in different research regions

Research area	Palmer Archipelago		Drake Passage		Bransfield Strait		Elephant Island		South Orkneys	
Station No.	88, 96, 99, 102 107, 111, 113		67, 70, 73, 79		116, 119, 123 127, 129, 131 140, 142, 145 152, 154, 156 162, 173, 217		48, 52, 55, 58 176, 184, 200 208		17, 34	
Average length (mm)	15.9		18.7		15.9		18.5		17.6	
Percent and average length of different developmental stages										
	%	mm	%	mm	%	mm	%	mm	%	mm
1 — males	47	16.2	36	16.9	43	15.8	45	19.4	48	16.9
2 — females	37	18.2	54	20.2	34	18.7	38	19.2	45	18.8
3 — juveniles	16	13.5	10	14.6	23	13.2	17	16.4	6	14.5

and length distribution of three developmenth stages in the singled out regions of the investigations, i.e. in the waters of the Palmer Archipelago Drake Passage, Bransfield Strait, around Elephant Island and the South Orkneys.

After integration of the samples from various regions (Table II, Fig. 10) it turned out that the largest specimens of *T. macrura* (mean-body-length — 18.7 mm) occur in Drake Passage, whereas the smallest (15.9 mm) in the waters of the Palmer Archipelago and in Bransfield Strait. The highest percentage of juvenile forms (juvenes) — 23% was noted in Bransfield Strait, the lowest — 6% and 10% in the vicinity of the South Orkneys and in Bransfield Strait respectively. The ratio of males and females was approximate, but as a rule to a slight advantage of males. Only in Drake Passage the situation was reversed: males made up 36% and females 54% of the total number of specimens (Table II).

Thysanoessa macrura is the only species, among those described above, which does not daily such extensive vertical migration as the others (Lomakina 1978) and thereof its high abundance in the analysed samples. Occurring at the upper water layers in large swarms *T. macrura* plays an important role in the biology of the Antarctic ecosytem, as it is an easily accessible food for birds and seals. Moreover, *T. macrura* was also found in the stomachs of whales (Nemoto and Nasu 1958).

4. Резюме

Представлено распределение, численность и некоторые аспекты биологии *Euphausia frigida*, *E. crystallorphias*, *E. triacantha*, *Thysanoessa macrura*.

Пробы брались сетью Бонго со слоя воды от поверхности до около 200 м. Исследования проводились с 10 декабря по 8 января 1984.

Полученные результаты показали, что наиболее редки и малочисленным видом был *E. crystallorophias* (таблица 1, рис. 1). Он был найден только на двух станциях в проливе Брансфилда. На шести станциях, в основном в западной части сектора исследований был обнаружен *E. triacantha* (таблица 1, рис. 1). Вид *E. frigida* был распределён равномерно, хотя его численность была наибольшая в проливе Дрейка. Не обнаружено его только в водах находящихся под влиянием холодных вод с моря Уэдделла (таблица I, рис. 1). Биологические анализы *E. frigida* показали малое количество молодьи (рис. 2 и рис. 3). Наиболее частым и многочисленным был вид *T. macrura* (таблица II, рис. 1). Он встречался во всём исследуемом секторе. На основе районизации ловов и биологических анализов установлено, что наибольшие особьи этого вида обитают в проливе Дрейка, а наименьшие в водах архипелага Пальмера и в проливе Брансфилда. Процентные соотношения самцов и самиц обычно были в пользу самцов. Наибольшее количество молодьи было в проливе Брансфилда, наименьшее в проливе Дрейка и водах Южных Оркенейских островов.

5. Streszczenie

Omówiono rozmieszczenie, liczebność i niektóre aspekty biologii *Euphausia frigida*, *E. crystallorophias*, *E. triacantha* i *Thysanoessa macrura*.

Próby pobierano siatką Bongo z warstwy O m do około 200 m. Badania trwały od 10 grudnia 1983 r. do 8 stycznia 1984 r.

Uzyskane wyniki pozwoliły stwierdzić, że najrzadszym i najmniej licznie spotykanym gatunkiem był *E. crystallorophias* (tabela I, rys. 1). Występował tylko na dwóch stacjach w Cieśninie Bransfielda. W sześciu stacjach i to przede wszystkim w zachodniej części sektora badań, stwierdzono *E. tricantha* (tabela I, rys. 1). Gatunek *E. frigida* rozmieszczony był w zasadzie równomiernie, choć liczebność jego była największa w Cieśninie Drake'a. Nie stwierdzono go natomiast w wodach będących pod wpływem zimnych wód z Morza Weddella (tabela I, rys. 1). Analizy biologiczne *E. frigida* wykazały małą ilość juvenes (rys. 2 i 3). Najczęściej i najliczniej stwierdzono gatunek *T. macrura* (tabela II, rys. 1). Występuje on w całym badanym sektorze. Wykonane analizy biologiczne oraz rejonizacja zaciągów (tabela II, rys. 4—10), pozwoliły stwierdzić, że największe osobniki tego gatunku występują w Cieśninie Drake'a najmniejsze zaś w wodach Archipelagu Palmera i Cieśninie Bransfielda. Udziały procentowe samców i samic były z reguły na korzyść samców. Najwięcej form młodocianych stwierdzono w Cieśninie Bransfielda, najmniej w Cieśninie Drake'a i wodach Orkadów Południowych.

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