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Henryk CZYKIETA ¹⁾, Wojciech KITTEL ²⁾, Zbigniew WITEK ³⁾,
Norbert WOLNOMIEJSKI ¹⁾

¹⁾ Sea Fisheries Institute, Świnoujście Branch, Pl. Słowiański 11,
76-600 Świnoujście, POLAND

²⁾ Laboratory of Polar Biology, Department of General Zoology,
University of Łódź, ul. Banacha 12/16, 90-237 Łódź, POLAND

³⁾ Sea Fisheries Institute, Al. Zjednoczenia 1, 81-345 Gdynia, POLAND

Biological characteristics of the population of *Euphausia superba* Dana from the southern part of the Drake Passage and the Bransfield Strait carried out during the BIOMASS-SIBEX expedition (December 1983 — January 1984)*

ABSTRACT: In the investigated area krill occurred in low abundance. It was recorded mainly above the shelf and above the continental slope close to the Palmer Archipelago and near the northern shores of Elephant Island. In the central part of the Bransfield Strait *E. superba* was caught in especially small quantities. In general krill of small size occurred, the size decreasing from the west to the east. Mature krill was dominant in the western part of the investigated area, whereas juveniles in the eastern part. Gravid females were caught very rarely.

Key words: Antarctica, SIBEX, *Euphausiacea*, krill biology.

1. Introduction

Hitherto published data indicate that the distribution, abundance and krill population structure in the Drake Passage and in the Bransfield Strait fluctuate considerably from year to year (Jażdżewski et al. 1978, Witek et al. 1981, Kalinowski 1982, Nast 1982, Wolnomiejski et al.

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1982, Brinton and Antezana 1984, Kalinowski and Witek 1985, Siegel 1985). To explain the causes of these fluctuations one should follow their course in long time periods as well as investigate simultaneously various environmental factors. Such tasks constitute the basis of the BIOMASS Project.

The present paper describes the composition of the krill population during the Polish part of the BIOMASS-SIBEX Project. It was a continuation of Polish research carried out in this area since 1976, however, in contrast to the former expeditions working usually in second half of Antarctic summer, this one was held in the beginning of that period.

2. Material and methods

Krill was caught since 19 December 1983 to 8 January 1984 by the R/V "Profesor Siedlecki". The general description of the research stations is given in a paper by Rakusa-Suszczewski and Lipski (1985), while the position of trawl hauls and the Bongo net hauls are presented in Fig. 1.

Commercial trawl hauls were carried out in the water layer ranging from 5 to 158 m, mainly in a layer from 10 to 100 m. A haul lasted 20 to 100 minutes, usually 30 to 60 minutes. The mesh size of the codend of the trawl was 6×6 mm. The trawl was hauled at a speed of 3-4 knots. The catches were carried out either after the echosounder indications or at haphazard.

The Bongo net had rings 60 cm in diameter; one of the rings had gauze with a 0.333 mm mesh, the other with a 0.505 mm mesh.

Trawlings were double oblique, from the surface down to about 200 m and then hauled up, at a speed of about 3 knots. Maximal depth was measured with a depth gauge. The amount of filtrated water

Table I

Comparison of krill maturity scales

Dzik, Jażdżewski (1978) Wolnomiejski et al. (1982)*	Makarov, Denys (1981)
1 — juvenes	I
2 — subadult males	II A1, II A2, II A3
3 — adult males	III A, III B
4 — subadult females	II B
5 — adult females	III A, III B, III C
6 — gravid females	III D
7* — spent females	III E

* only in Wolnomiejski et al. (1982)

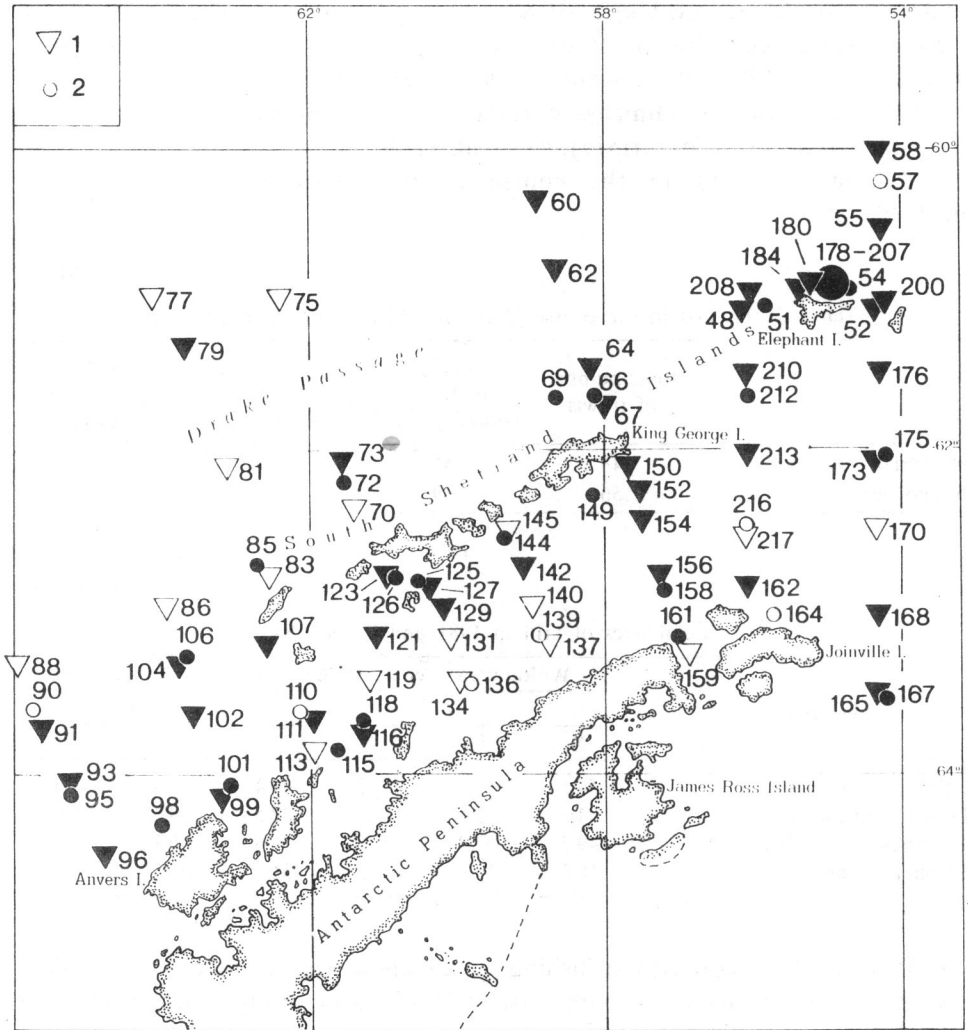


Fig. 1. Distribution of sampling localities during the Polish part of the BIOMASS-SIBEX investigations. 1—Bongo net, 2—trawl. Empty symbols — lack of krill in the catch

was calculated using a flow-meter. Bongo net catches were usually carried out without previous echosounder indication.

Random samples containing more or less 100 krill individuals (98–168) were taken from the commercial catch of krill. The analysis of the Bongo net catches of krill were carried out only in such cases when the number of individuals caught exceeded 30.

Krill body length was measured from the tip of the rostrum to the end of the uropod. Stages of sexual maturity were estimated according to scale of Makarov and Denys (1981). For comparison with the

materials of the BIOMASS/FIBEX expedition and of earlier ones which were analysed according to other scale (Dzik, Jażdżewski 1978, Wolnomiejski et al. 1982), both scales are compared (Tab. I).

The filling of the alimentary tract was determined according to the 5 — stage scale of Wolnomiejski et al. (1980).

Material obtained in the course of the investigations is presented in Table II.

Table II

Material obtained in the course of the BIOMASS-SIBEX investigations

	total number of trawls	number of trawls containing krill	number of analysed samples	number of analysed individuals
industrial trawl	48	41	38	4384
Bongo net	56	39	10	952

Table III

Mean sizes of krill in 1981 and in 1983/84

Study area	Wolnomiejski et al. (1982)			present investigations		
	\bar{X}	♂♂	♀♀	\bar{X}	♂♂	♀♀
	Palmer Archipelago	54.8	56.2	54.5	44.4	47.9
Drake — Shetlands	51.3	55.5	52.8	37.5	44.4	37.0
Bransfield — Shetlands	49.3	53.7	49.7	36.9	46.1	39.6
Elephant Island	50.3	53.4	50.2	31.7	45.3	38.3

Detailed data concerning fishing parameters and results of biological analysis of krill from particular trawl hauls and Bongo net hauls are included in appendix I.

3. Results

The analysis of the results allows us to distinguish five regions (Fig. 2).

Region I. Western Bransfield Strait

The krill captured there was represented by two distinctive size groups. One of them had on the average a length of 40 mm. The major part of this group constituted immature krill (50–70%) with a dominance of females. The other group, of a mean body length of about 45 mm

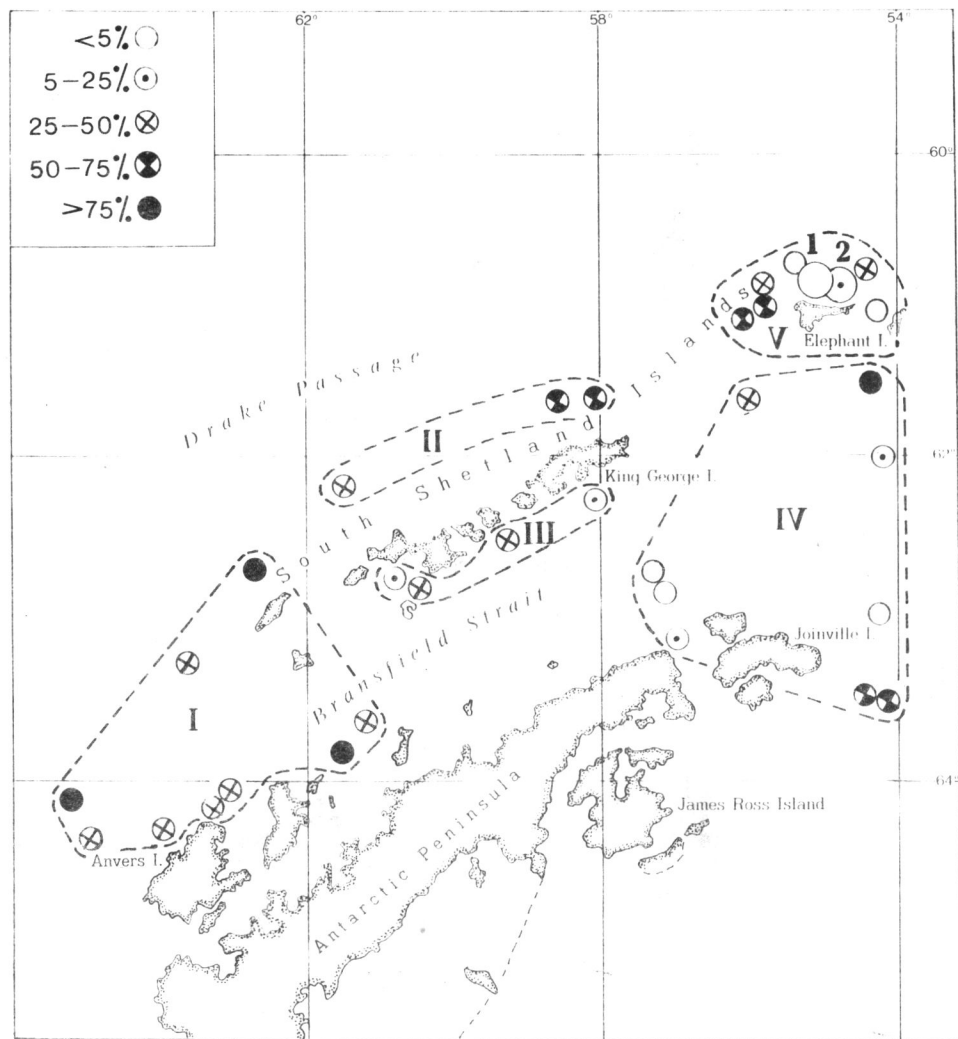


Fig. 2. The share of mature krill in the population in particular regions. 1—group of 11 hauls, 2—group of 6 hauls. A legend in the top left corner describes the percentage of mature individuals. Roman numerals denote study regions

consisted of mature krill (80%) with a dominance of males. Both in the trawl hauls and in the Bongo net hauls the share of juveniles was low (App. 1, Fig. 3).

Region II. Drake Passage off South Shetland Islands

The mean length of krill caught in this region ranged from 36 to 38 mm. The population was characterized by equal share of mature and immature

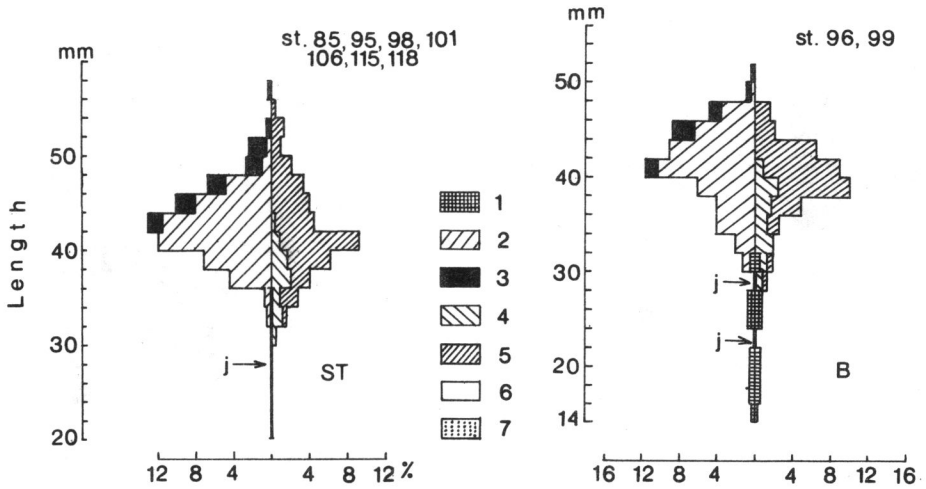


Fig. 3. Population structure of krill in the region of Western Bransfield Strait. ST—stern trawl, B—Bongo net. 1—juvenes, 2—subadult males, 3—adult males, 4—subadult females, 5—adult females, 6—females with eggs, 7—spent females

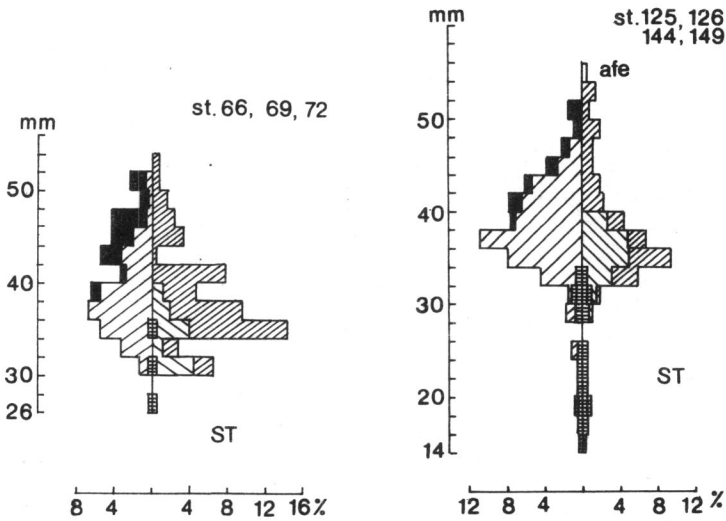


Fig. 4. Population structure of krill in the region of Drake Passage off South Shetland Islands

krill and equal proportions of sexes. The abundance of juveniles was low (App. 1, Fig. 4).

Region III. Bransfield Strait off South Shetland Islands

This region was characterized by krill of body length ranging from 35 to 40 mm. Immature krill constituted about 60%, with a slight dominance

of males. Juveniles (lengths from 14 to 34 mm) were also recorded, but their abundance was low (App. 1, Fig. 5).

Region IV. Eastern Bransfield Strait

In the southern part of this region, mature krill occurred. Its share amounted to above 50%, the mean body length was about 40 mm and males dominated (Fig. 2 and 6). In the middle part of this region

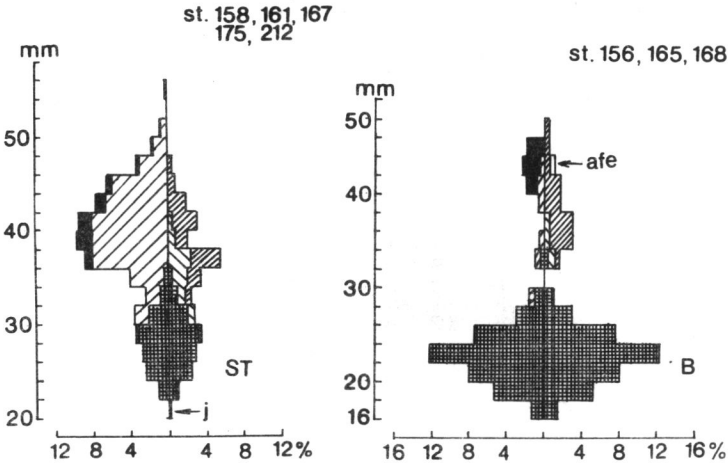


Fig. 5. Population structure of krill in the region of Bransfield Strait off South Shetland Islands

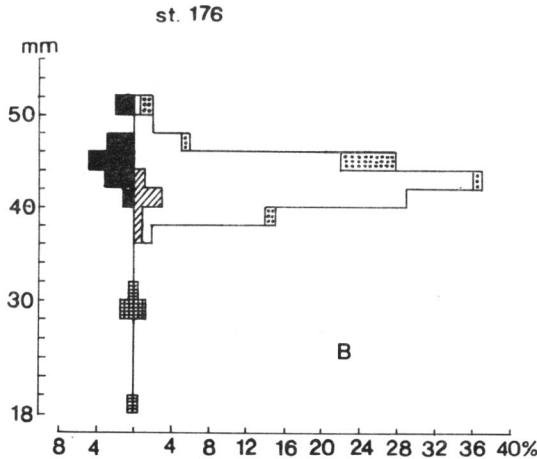


Fig. 6. Population structure of krill in the region of Eastern Bransfield Strait

the juvenile krill dominated, and its share in the trawls ranged from 50% to above 90%; the mean body length was 22–27 mm. In some trawls of this region there occurred a slight dominance (about 60%) of immature

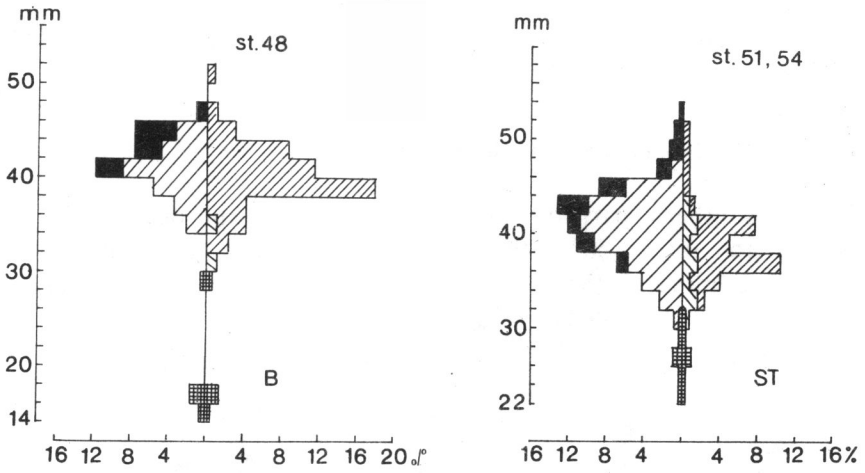


Fig. 7. Population structure of krill in the region of Elephant Island, December 1983

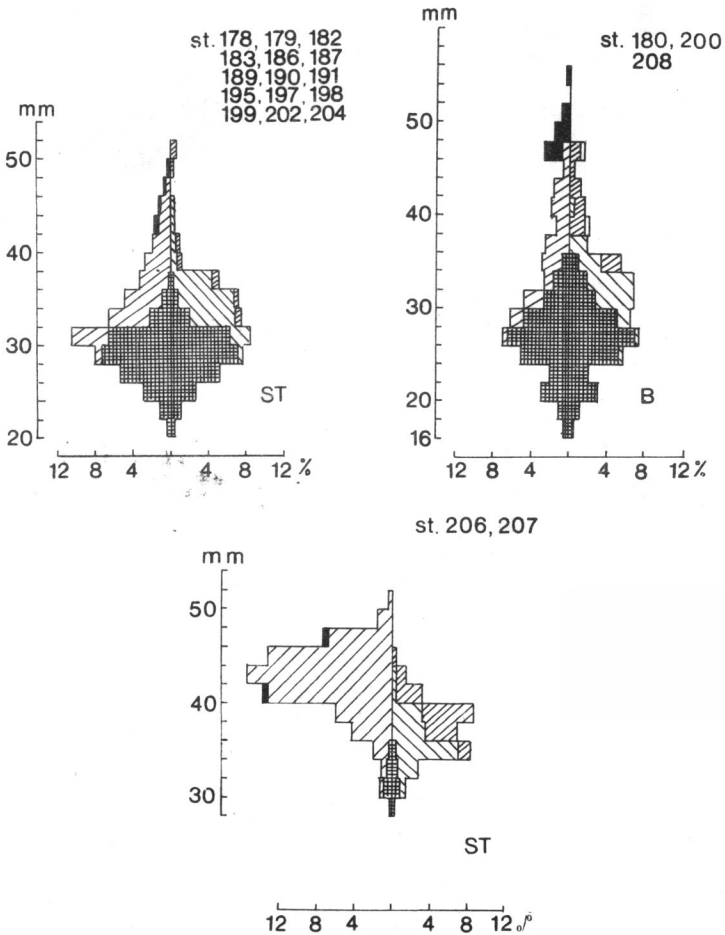


Fig. 8. Population structure of krill in the region of Elephant Island, January 1984

krill of mean body length 39–40 mm. In the northern part (station 176) of this region a distinct dominance of the mature krill was recorded. Its share was 96%, and mean body length was 42 mm. Females with eggs dominated here (App. 1, Fig. 6).

Region V. Elephant Island

This region was investigated twice at an interval of 2 weeks. In the first phase of the investigations the mature and immature krill occurred in equal percentages. Males dominated in mature, and females in immature

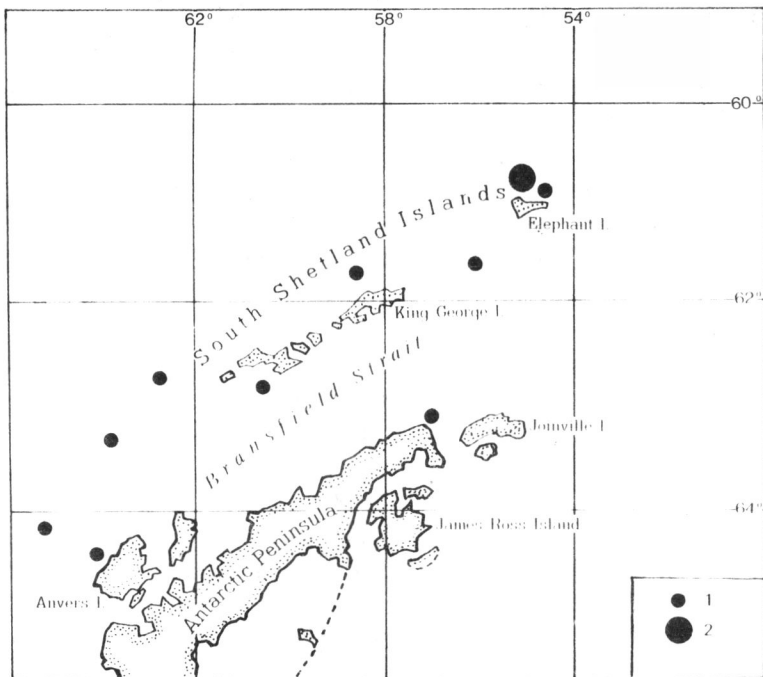


Fig. 9. Distribution of the commercial krill trawlings of the efficiency exceeding $0.5 \text{ t} \cdot \text{h}^{-1}$

krill. The percentage of juveniles was low. The mean body length of krill captured in this phase was about 40 mm (Fig. 7).

Two weeks later, the juvenile and immature krill of the mean length of 30 mm dominated here (App. 1, Fig. 8). In hauls taken at stations 206 and 207, which were carried out at the very end of the second phase, the immature krill distinctly dominated (80%) with a dominance of males (App. 1, Fig. 8).

Excepting the waters above the Elephant Island shelf krill caught during present investigations was characterized by high indexes of gut

filling. Only in single cases the mean gut filling was lower than 4.0 (App. 1).

In general, from the commercial point of view, the amounts of krill caught were low. Of the total number of 48 trawl hauls only in 24 the efficiency amounted to 0.5 ton per hour of fishing (Fig. 9).

4. Discussion

The results presented above allow to conclude that the amounts of captured krill its size and degree of development distinctly differed from those of previous investigations carried out in the same waters (Nast 1982, Wolnomiejski et al. 1982, Kalinowski 1982, Siegel 1985).

An analysis of the trawl hauls indicates that higher catch efficiencies were obtained only in waters above the shelf and above continental slope close to the Palmer Archipelago, to the north of King George Island and at the northern coast of Elephant Island. Hydroacoustic investigations carried out at the same time (Kalinowski et al. 1985) complement the results of our investigations. These authors noted that only in the above mentioned areas the concentrations of krill exceeded 1000 indiv. m^{-2} and about 100 $t \cdot nM^{-2}$.

In the middle part of the Bransfield Strait krill was not caught at all, or in very small quantities. A similar situation was recorded in the Drake Passage. According to Kalinowski et al. (1985) in these waters the density amounted only to about 0.26 $t \cdot nM^{-2}$ in the Bransfield Strait, and to 0.34 $t \cdot nM^{-2}$ in the Drake Passage. In 1981 during the BIOMASS-FIBEX Expedition extremely dense krill concentrations occupying large areas were found in the Bransfield Strait close to the Trinity and Astrolabe Islands (Kalinowski 1982, Wolnomiejski et al. 1982). Kalinowski (1982) recorded 346 $t \cdot nM^{-2}$ in the Bransfield Strait and 28.9 $t \cdot nM^{-2}$ in the Drake Passage.

This decrease of the amount of krill is noteworthy. In the Bransfield Strait in February 1982 Siegel (1985) recorded much lower amount of krill (14.82 $t \cdot nM^{-2}$) than Kalinowski (1982) although still much higher than the amount found by the present authors.

Krill caught in the period of present investigations was usually of small size, differing in this respect from krill caught in the period of the BIOMASS-FIBEX Expedition (Wolnomiejski et al. 1982). The mean body size of krill decreased in the west-east direction. A similar relationship was observed in former years of investigations including 1981, although in that year krill was of a particularly large size (Wolnomiejski et al. 1982). Table III presenting mean body length of krill and the mean length of mature males and females illustrates well this phenomenon.

A similar variability occurred in the degree of krill maturity. In region I (West Bransfield Strait), sexually mature individuals constituted 61.8% of the total amount of krill. The abundance of juveniles, on the other hand, was very low. Their percentage share amounted to only 7.7% (App. 1). Over the northern shelf of the Elephant Island (region V) mature individuals constituted only 4% of the population while juvenile and immature krill dominated there. The population composition of krill inhabiting the eastern part of the Bransfield Strait varied widely, depending upon the position of the haul (App. 1, Fig. 6). The trawling efficiency was very low there.

A comparison of data obtained on the basis of the Bongo net hauls with results based on trawl catching in respective regions (Figs. 3, 6, 7, 8) confirms previous suggestions of Wolnomiejski et al. (1982), concerning the selective catching of krill by the Bongo net. However, from the present results it follows that catching with the Bongo net should be considered a supplementary method in the population study of krill. The reason is that the Bongo net catches the fraction of smallest individuals, which go through the trawl meshes, or which are heavily damaged.

5. Резюме

Исследования проводились в декабре — январе 1983/84 гг. в районе южной части пролива Дрейка и в проливе Брансфилда на станциях программы исследований BIOMASS-SIBEX (рис. 1). Криль ловили тралом или сетью Бонго. Пробы, собранные сетью Бонго, считали дополнительным материалом, основываясь, главным образом, на ловле тралом. В работе проведено также сравнение результатов настоящих исследований и исследований экспедиции BIOMASS-FIBEX.

На исследуемой поверхности находилось в общем небольшое количество кривля. Немного большее скопление было обнаружено лишь над шельфом и континентальным склоном вблизи архипелага Палмера и около северного берега острова Элефант (рис. 9). В средней части пролива Брансфилда *Euphausia superba* вообще не ловился или только случайно и в небольших количествах. Подробные результаты анализа кривля со всей поверхности исследования представлены в приложении 1, а характеристика популяции кривля в некоторых выделенных районах — рис. 3—8. Кривль обычно имел небольшие размеры. В западной части исследуемой поверхности преобладали особи половозрелые, а в восточной — ювенильные (рис. 2). Самки, готовые к нересту попадались редко и также в небольшом количестве.

Средние размеры кривля уменьшались в направлении с запада на восток исследуемых районов (табл. III). Аналогичное явление наблюдалось во время экспедиции BIOMASS-FIBEX.

6. Streszczenie

Badania prowadzono w okresie grudzień–styczeń 1983/84 w rejonie południowej części Cieśniny Drake'a i w Cieśninie Bransfielda na stanowiskach wyznaczonych programem badań BIOMASS-SIBEX (rys. 1). Kryla poławiano włokiem przemysłowym oraz siatką Bongo. Z uwagi na to, że połowy siatką Bongo dawały przeważnie nikle rezultaty, uzyskane wyniki potraktowano jako uzupełniający element badań, a oparto się głównie na wynikach połowów włokowych. W pracy dokonano porównania wyników badań niniejszych oraz ekspedycji BIOMASS-FIBEX.

Na badanym obszarze występowały ogólnie niewielkie ilości kryla. Nieco większe jego skupienia spotkano jedynie nad szelfem i skłonem szelfu w pobliżu Archipelagu Palmera i przy północnym brzegu Wyspy Elephant (rys. 9). W środkowej części Cieśniny Bransfielda *Euphausia superba* nie poławiano wogóle, lub tylko sporadycznie i w niewielkich ilościach. Szczegółowe wyniki analiz biologicznych kryla z całego obszaru przedstawia appendix 1, a charakterystykę populacji *E. superba* w wyróżnionych rejonach badań — rysunki 3–8. Kryl generalnie odznaczał się niewielkimi rozmiarami. W zachodniej części badanego obszaru dominowały osobniki dojrzałe płciowo natomiast we wschodniej juwenilne (rys. 2). Samice „tarłowe” poławiane były sporadycznie. Średnie rozmiary kryla malały w układzie zachód-wschód badanych rejonów (tab. III). Podobne zróżnicowanie obserwowano podczas badań ekspedycji BIOMASS-FIBEX.

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