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Biological characteristics of *Euphausia superba* Dana in the southern Drake Passage and the Bransfield Strait in February-March, 1981 (BIOMASS-FIBEX) *)

ABSTRACT: In the investigated area, mass occurence of krill was observed in the vicinity of islands and the Antarctic Peninsula, in the waters above the shelf and shelf's slope. Small quantities of krill were found in the open oceanic waters. Immature individuals dominated close to the Antarctic Peninsula. Large, sexually mature krill dominated farther from the continent. Gravid females contributed little to the total populations. Krill of the largest size occured near the Palmer's Archipelago, and of the smallest size at the Antarctic Peninsula and the Elephant Island. It is likely that krill observed west and north of the Palmer Archipelago had been brought by currents from the Bellingshausen Sea. Krill in the Bransfield Strait originated probably from the mixing of populations carried by currents from the Weddell Sea and the Bellingshausen Sea.

Key words: Antarctic, FIBEX, krill biology, *Euphausiacea*

1. Introduction

The Bransfield Strait and the southern part of the Drake Passage (area "A") have been investigated by the Polish expedition of the r/v "Profesor Siedlecki", within the international BIOMASS-FIBEX programme of 1981. This area had been earlier researched by four Polish Marine Antarctic Expeditions in the years 1976—1979. Krill biology observations had been made during each of the expeditions (Wolnomiejski et al. 1977[1]), Czykieta

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[1]) Wolnomiejski N., Witek Z., Czykieta H., Chłapowski K., Sitek S. 1977 — Biological characteristics of krill and of other elements of the Antarctic marine biocenosis —

and Koronkiewicz 1978[2]), Jażdżewski et al. 1978, Witek 1979[3]), Wolnomiejski and Boberski 1979[4]), Witek et al. 1980, Witek 1981[5]). Population studies of *E. superba* in the Admiralty Bay have been also done; they were based at the scientific Arctowski station on the King George Island (Jackowska 1980, Kittel 1980, Rakusa-Suszczewski and Stępnik 1980, Stępnik 1982).

The purpose of the present paper is to give biological characteristics of *E. superba* catches, in the Polish investigations of the FIBEX "A" area.

2. Materials and Methods

Krill trawls were made with a stern-trawl-net, and with an open net of the Bongo type. The stern net's catching bag was supplied with a small-meshed (mesh size 10 × 12 mm) sack. The Bongo net had a mesh size of 6 mm. Fishing with the two nets was done at the average ship's velocity of three knots. Catches within the FIBEX programme, that is up to 12 March when station 111 was reached, had been done at locations scheduled according to the distribution of the oceanographic sampling stations (Fig. 1). After 12 March till 20 March, "krill patch" studies were done, and trawls were made according to echosounder readings indicating large krill concentrations. Most often industrial trawls were made within the 15—50 m water layer (max. to 205 m). The time of trawling varied from 5 to 85 minutes; usually it was 20 to 60 minutes. Table I gives the detailed descriptions of every catch. Bongo-net fishing always lasted ca. 20 minutes.

In general, krill samples obtained in 58 stern — trawls and eight Bongo-net catches have been analysed (six stern trawls and ten Bongo nets gave a zero results). In addition, krill analyses were made on materials obtained in six stern-trawl and one Bongo trawls, on the shelf and shelf's slope of the Elephant Island, outside the "A" area (Fig. 1.). Location of stations, exact time and depths of trawling are given in a report of Rakusa-Suszczewski (1982).

Biological analyses of krill were done on fresh material, immediately after fishing. Random krill samples were used in the analyses: from every sample 100 individuals were measured. The measurement included:

— body length with the accuracy of 1 mm,

(In: Sprawozdanie z Badań II Polskiej Morskiej Ekspedycji Antarktycznej, MIR, Gdynia), 1: 20–63.. In Polish.

[2]) Czykieta H., Koronkiewicz A. 1978 — Studies on krill biology made on the r/v "Profesor Bogucki". (In: Sprawozdanie III Polskiej Morskiej Ekspedycji Antarktycznej) MIR, Gdynia 1: 5–28 In Polish.

[3]) Witek Z. 1979 — Phytoplankton distribution and some aspects of the biology of Antarctic krill, *Euphausia superba* Dana — Pap. ICES C. M. 1979/L: 14, 10 pp.

[4]) Wolnomiejski N., Boberski E. 1979 — Biological characteristics of the Antarctic krill — (In: Sprawozdanie z Badań IV Polskiej Morskiej Ekspedycji Antarktycznej) MIR, Gdynia, 2: 220–258. In Polish.

[5]) Witek Z. 1981 — On the life cycle of Antarctic krill, *Euphausia superba* Dana — Pap. ICES C. M. 1981 L: 20. 10 pp.

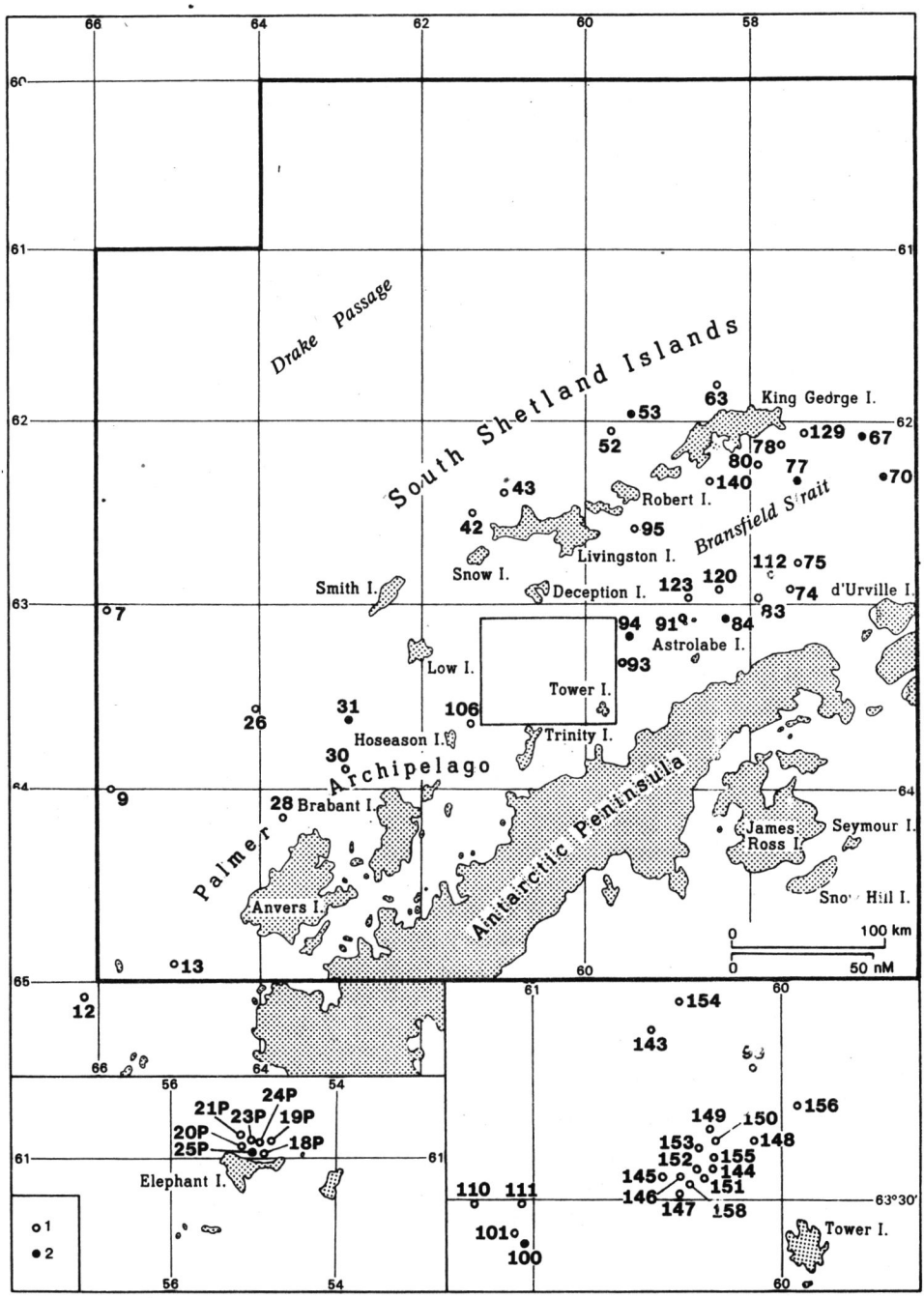

Fig. 1. Polish research region of the BIOMASS-FIBEX programme 1981
Numbers of krill fisheries stations: 1 — Stern trawl, 2 — open Bongo net, P- industrial trawl.

— sex and maturity stage,
— degree of gut filling.

Length of krill was measured from the anterior edge of rostrum to the end of uropods (Standard 1)[6]). The following maturity stages have been distinguished:

1. juvenile stage
2. immature males
3. mature males
4. immature females
5. mature females
6. gravid females
7. spent females

The above stages formed three maturity groups:
juvenile krill — stage 1
immature krill — stages 1 and 4
mature krill — stages: 3, 5, 6 and 7

Degree of gut filling was defined according to a five-step scale (Wolnomiejski, Witek and Czykieta 1980):

1° empty stomach, stomach and hepatopancreas discoloured,
2° only stomach filled with food,
3° food filling stomach and the part of gut in cephalothorax,
4° food fills the stomach and the part of gut reaching half of the abdomen length,
5° food in the gut reaches beyond the half of the abdomen length.

In stages 2 to 5, stomach and hepatopancreas are coloured green or dark green.

The arithmetical average of the different degrees of gut filling in 100 individuals representing a sample, was used as the indicator of the degree of gut filling of krill obtained in various trawls.

Group characteristics of krill in the research area was found by applying the method of "weighing" the results of individual analysis in relation to the corresponding hourly efficiency of trawling, the latter being used as the quantity unit in the calculations (computer programme Problem; Wolnomiejski et al. 1980). No data obtained from the analysis of krill fished by the Bongo net were included in the group characteristics calculations.

Conclusions on the origin of krill caught in a given area were based on calculations made according to the method given by Florek et al. (1951). Differences between catch areas were defined on the basis of the different contributions of various development stages.

3. Results

Data showing some of the krill fishing parameters, and also the characteristics of analysed krill are presented in Table I. This table does not include catches which gave a zero results: at stations 3, 24, 35, 39,

[6]) "Antarctic krill biology" 1979, BIOMASS Report Series, 10: 31–33.

Station No.		100	101	106	110	111	112	120	123	129	140	143	144	145	146	147	148	149	150	151	152	153	154	155	156	18P	19P	20P	21P	23P	24P	25P
Month, day		11 Mar.	11 Mar.	12 Mar.	12 Mar.	12 Mar.	14 Mar.	15 Mar.	15 Mar.	16 Mar.	17 Mar.	17 Mar.	17 Mar.	18 Mar.	18 Mar.	18 Mar.	18 Mar.	19 Mar.	19 Mar.	19 Mar.	19 Mar.	19 Mar.	20 Mar.	20 Mar.	20 Mar.	1 Mar.	2 Mar.	2 Mar.	2 Mar.	3 Mar.	3 Mar.	4 Mar.
Fishing gear — ST*), B**)		B	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	B
Depth of trawling (m)		35–15	30–15	39–24	40–12	50–20	40–25	40–25	30–8	38–12	22–5	90–45	30–15	40–15	40–15	40–15	30–10	27–12	35–20	25–6	30–10	30–15	60–45	40–15	95–35	20–5	40–25	55–35	55–35	70–55	40–25	50–40
Time of trawling (min)		20	15	10	50	60	40	15	45	45	65	50	50	40	50	50	30	5	10	20	40	10	40	50	20	60	25	20	10	15	20	20
Krill catch — ST (kg), B (gram)		4700	8000	14000	200	4000	5000	2000	15000	3500	2500	7000	7000	5000	5000	3000	8000	4500	5000	8000	5000	3000	2000	10000	1000	700	1500	2500	4000	7000	7500	200
Average length (mm)		39.3	47.0	48.9	43.8	42.7	47.8	49.2	49.8	51.2	48.4	47.6	48.7	42.9	46.8	45.8	51.3	38.8	44.4	44.1	47.3	47.8	47.8	49.5	43.5	51.2	50.7	52.7	50.8	49.4	50.2	44.2
Alimentary tract fullness		2.6	2.3	3.0	4.0	2.9	3.8	3.5	3.6	4.2	4.1	3.9	3.7	3.4	3.2	3.3	3.3	3.2	3.0	3.7	3.4	3.1	4.0	3.5	3.0	4.5	4.8	4.4	4.5	4.6	4.6	3.9
	juvenes	6	1		1	3								3											1					1	1	1
	adolescent males	29	33	48	36	52	32	32	46	24	28	36	29	35	35	48	41	45	36	38	38	37	37	38	43	18	11	2	18	21	11	23
Percent contribution	adult males	3	12	4	3	3	8	8	10	49	21	18	10	3	9	3	12		3	3	5	4	19	4	4	43	27	53	19	48	40	19
of development	adolescent females	53	25	23	33	31	21	19	10	11	19	26	36	42	27	30	16	54	42	45	27	30	22	32	37	2	4	4	4	9	8	30
stages of	adult females	9	29	25	27	11	39	40	34	16	32	20	25	17	29	19	31	1	19	14	30	29	22	26	15	37	58	41	58	21	4	27
Euphausia superba	gravid females																												1			
	spent females																															
	22													1																		
	23																															
	24																															
	25																															
	26																															
	27																															
	28	1												1																	1	
	29	2				1									1										2							2
	30	2			1	1																										
	31	3		1	1	3												1							1							4
	32	5	2			1		1				1		3	1			1		2					3					2		1
	33	5				1					1	1		2	2	1		2	1	1		1	1		2					2		5
	34	5	1		1	3					2			1		1		1				2	1									3
	35	8			4	5	2	1				2		6		1		9	2	5	2			1	8							2
	36	6	2	2	5	11		1		1		2		4	1	1		10	1	7	1	1	3		6							
	37	7	4	2	3	7	1	3		1	3	2	3	5	2	3		16	8	3		1	2		6		1				2	8
	38	12	3	2	9	7	5	1	1		2	5	6		3	6	1	15	9	12	5	4	3		5	1						3
Length frequency distribution (%)	39	6	3	1	10	2	2	4	2	1	2	3		6	5	9	2	8	7	6		2	2	2	6	1	2			1	2	3
	40	7	2	4	5	3	5	1	3	1	6	3	3	4	4	4	1	10	3	2	6	2	2	1	5	1	1	1		4	1	4
	41	2	3	3	2	6	7	3	3	1	3	7	4	5	9	5	1	11	8	6	5	5	4	1	3	2			1		2	3
	42	2	8	3	7	2	5	4	4	1		1	3	4	5	5	1	4	2	5	4	2	2	7	6		2		2	3	2	8
	43	4		1	7	6	3	2	3	1	2	4	2	4	1	4	1	5	4	6	9	10	9	2			2	1	2	4	3	3
	44	1	8	4	3	2	1	1	5	1	5	5	6	6	2	4	1	1	4			2	3	4	1	1			2	2	1	2
	45	2	5	2	5	2	2	1	1	3	7	6	3	5	2	5	4	2	7	1	4	3	4	4	1	5	4	1	2	2	2	4
	46	2	4	5	1	1	2	2	4	5	2	4	5	5	3	4	1	1	7	4	7	2		5	2	1	5		1	1	1	2
	47	3	7	7	6	4	5	4	4	3	10	4	3	3	5	2	2		7	1	4	4	5	2	4	1	5	4	1		2	1
	48	3	5	3	4	1	5	2	4	1	7		1	5	7	4	9		6	3	4	7	9	10	3	6	2	6	6	2	6	3
	49	1	6	7	3	5	5	4	9	2	1	6	2	5	6	4	8		2	2	4	4	3	5	7	5	8	1	4	2	5	2
	50	4	6	12	4	4	6	12	6	9	4	4	9	3	7	6	8		3	9	7	6	7	8	8	6	10	10	9	5	3	3
	51	2	3	8	3	6	11	10	10	7	4	11	11	3	6	8	7	2	4	8	8	8	3	7	4	12	11	6	9	12	10	2
	52	1	4	5	3	7	10	9	6	19	7	8	9	6	6	10	10	1	7	6	12	10	10	12	4	16	13	10	10	14	5	1
	53	2	3	4	4	4	7	12	6	13	13	2	15	2	6	6	10		2	3	5	6	10	8	3	12	7	18	15	14	13	5
	54	1	9	4	5		7	9	9	8	7	4	5	2	6	1	9		1	4	6	4	4	3	4	14	4	13	13	12	10	5
	55	1	4	6	1	2	4	4	7	13	5	7	7	1	3	3	4		2	2	4	8	4	10	1	8	10	10	8	7	3	6
	56		3	3		2	3	3	8	6	7	4		1	5	2	7		1	1	3	3	2	4		7	8	7	7	6	7	4
	57		2	3	1	1	1	3	2	2	1	4	4	1	1		7			1		1	6	2	4		4	8	5	3	12	5
	58		2	5	1		1	1	1			2					2		1			1	1	2	1	1		2	3	2	4	3
	59			2	1			1	1		1	1			1	1	2		1			1					1	1			3	2
	60		1	1					1	1							2											1				1
	61							1																								
	62																															
	63																															
	64																															
	65																															

Biological characteristic of krill catchment during BIOMASS-FIBEX, 1981

Table I.

Station No.		7	9	12	13	26	28	30	31	42	43	52	53	63	67	70	74	75	77	78	80	83	84	91	93	94	95	99
Month, day		16 Feb.	16 Feb.	17 Feb.	17 Feb.	20 Feb.	20 Feb.	20 Feb.	21 Feb.	23 Feb.	23 Feb.	25 Feb.	26 Feb.	28 Feb.	28 Feb.	5 Mar.	5 Mar.	5 Mar.	6 Mar.	6 Mar.	6 Mar.	6 Mar.	7 Mar.	9 Mar.	9 Mar.	10 Mar.	10 Mar.	10 Mar.
Fishing gear — ST*), B**)		ST	ST	ST	ST	ST	ST	ST	B	ST	ST	ST	B	ST	B	B	ST	ST	B	ST	ST	ST	B	ST	ST	B	ST	ST
Depth of trawling (m)		20—0	80–50	35–20	35–5	65–45	40–20	40–25	10–0	45–20	40–25	50–35	25–15	30–15	15–0	15–0	50–35	60–17	20–5	20–5	40–25	50–35	15–10	40–20	38–10	15–0	130–15	50–15
Time of trawling (min)		60	85	20	15	75	15	5	20	30	20	20	20	50	20	20	40	10	20	30	60	10	20	20	20	20	65	20
Krill catch — ST (kg), B (gram)		0.5	0.5	5000	25000	60	4000	500	600	400	3000	4000	200	4000	100	900	2500	5000	100	200	200	10000	1200	10000	6500	1000	12000	4000
Average length (mm)		54.3	54.8	54.9	54.8	55.3	48.4	43.7	42.8	48.5	52.9	50.5	40.5	51.0	39.9	47.6	46.4	49.9	42.4	48.1	49.4	45.8	39.6	50.0	48.3	42.7	48.2	48.9
Alimentary tract fullness		3.4	3.2	4.7	4.8	4.2	4.1	4.5	4.0	4.3	3.7	3.8	4.9	4.5	2.2	2.9	4.0	4.1	2.8	4.5	4.0	4.2	2.5	3.5	3.3	3.7	3.9	4.1
Percent contribution of development stages of *Euphausia superba*	juvenes					1	9	2	4	3		1	13		7	3			6	1			1			2		
	adolescent males	2	8	12	9	2	34	41	40	45	23	45	40	34	45	30	45	26	38	34	25	30	34	35	42	35	28	41
	adult males	78	56	31	28	79	12	5	11	19	38	20	10	27	6	28	3	5	9	41	55	13	3	10	19	10	23	9
	adolescent females			1	2		7	35	37	13	4	18	32	15	33	9	16	12	25	10	10	27	52	15	16	17	29	12
	adult females	20	36	56	60	17	38	17	8	20	35	16	5	24	9	30	36	57	22	14	10	30	10	40	23	36	20	38
	gravid females				1	1																						
	spent females																											
Length frequency distribution (%)	22								1						1													
	23																											
	24																											
	25																											
	26								1						1													
	27									1																		
	28								1						2													
	29												1		2	1										1		
	30						1						2						1	1			1					
	31							1	1				4		3				3			1				1		
	32					1	2		1				3		6				4						2	2		
	33	2					1	2	6		1				3		1		1			1	6			2		
	34						2	3	11	1			7		8		1	1	3			1	3		2	2	1	
	35						2	1	7	3			6		13		1	2	10	1		4	12			3	3	1
	36			1			3	5	5	2			8	1	7	3	3	1	4	2	2	2	6		4	4	1	2
	37						2	5	10	5	1		7		8	4	2		5	2		5	16		3	8	6	
	38						2	4	6			6	8		3	2			3	2			5	11	1	1	10	3	
	39				1		1	5	6	3	1	1	9	3	2	4	7	1	8	1	2	7	9	3	2	11	8	1
	40						5	8	3	5		1	11	3	4	7	4		2	3	6	11	8	1	4	4	1	5
	41						3	5	3	5	1	3	2	3	3	2	3	3	3	7		3	6	6	3	6	1	2
	42						1	11	3	6	2	3	1	3	2	4	7	6	3	4	6	7	3	4	4	5		4
	43						2	7	1	2	2	4	5	1	3	3	4		2	1	3	1	2	1	3	4	2	3
	44				1		2	4	1	4	3	4	2	2		5	3	2	8	1	1	4	2	4	1	1	3	6
	45							4	1	2	1	4	1	4	6	2	9	4	9	6	3	1	1	4	4	3	2	2
	46						1	6		1	1	2		5		6	3	3	1	4	6	2		4	1	4	5	4
	47						3	3		1			1	3	3	1		3	2	2	4	1	2	4	2	2	5	4
	48			3	2		2	5	1	2	2			2	2	2	12	4	3	5	3	1	2	4	5	2	2	5
	49		2	2		1	5	2		1		3	1	8	1	1	6	3	4	4	1	1		2	3	2	3	7
	50		6		6	2	9	2	1	1	4	4		1	3	7	5	7	4	10	10	5	1	7	9	5	5	7
	51	2	10	5	4	2	7	1	2	8	7	4		6	5	3	6	9	2	5	8	1	1	6	7	5	4	3
	52	6	6	5	6	4	4	3	2	4	2	15	2	8	4	8	9	17	6	12	9	3	1	4	5		11	13
	53	14	4	16	5	8	13	2	3	7	16	3	3	10	1	5	6	13	5	13	11	6	2	14	8	2	6	16
	54	22	12	12	11	14	8		1	1	8	13	1	5	1	12	1	6	1	5	10	9		11	4	4	10	4
	55	26	24	10	26	17	5	6	6	11	16	13	3	7	1	6	2	7	2	5	9	7	4	6	9	3	6	6
	56	10	8	13	17	16	4	2	2	13	10	7		4	1	6	1	3	1	4	5	7		4	7	1	6	4
	57	18	10	9	5	15	6	2	6	6	8	7	3	8		4	2	1		1	1	2	1	4	4	2	3	
	58		8	13	2	11	1		2		10	2	2	4	2		1	3				2		4	3	1	1	
	59		2	7	3	6	1	1	6	3	3	1	1	2			1											1
	60		6	3	8	3	2		1	1	1		2	5				1						2			2	
	61				2					1				2														
	62		2																									
	63				1																							
	64																											
	65			1																								

*) ST — stern trawl
**) B — Bongo open net

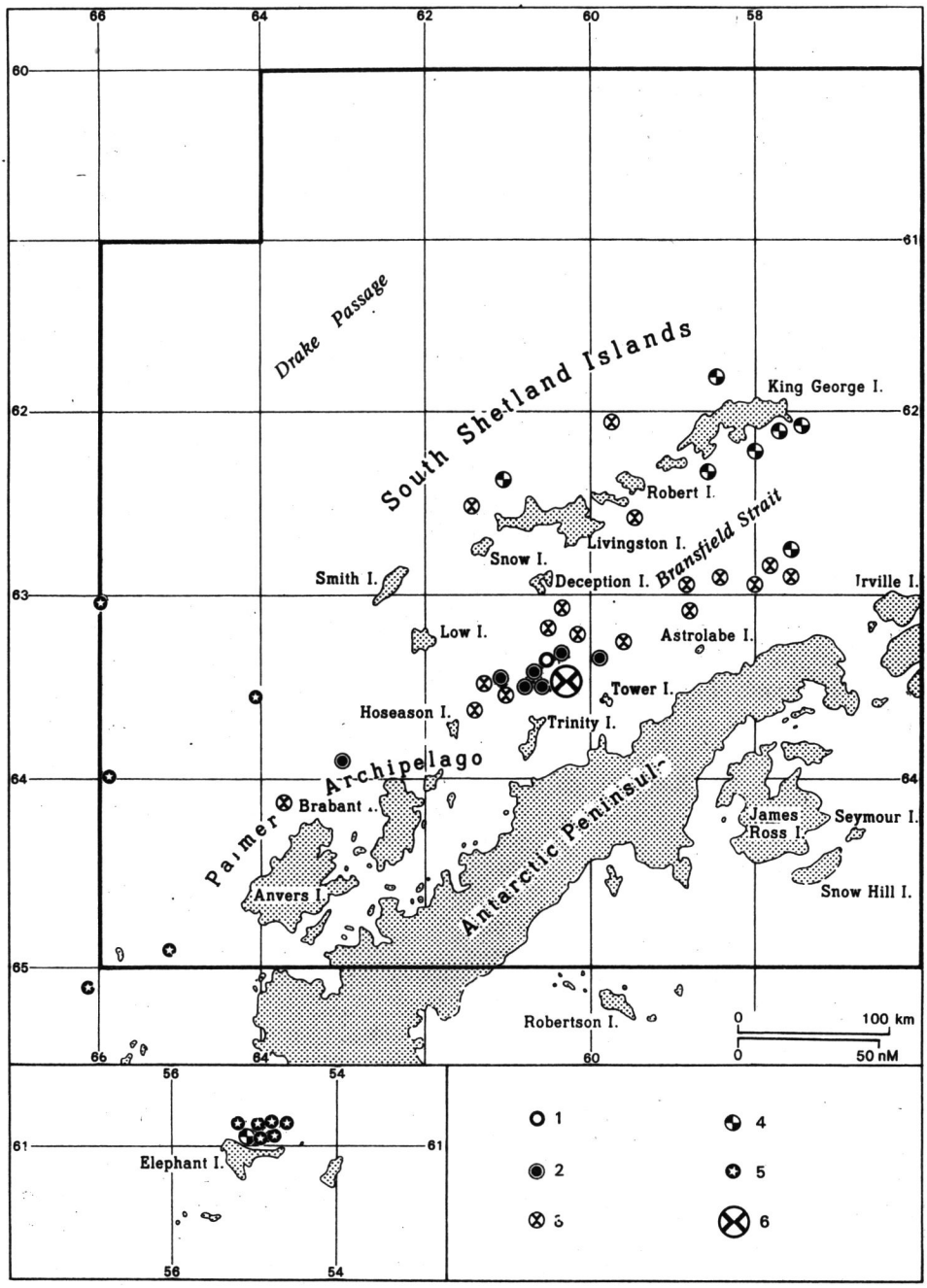

Fig. 2. Distribution of krill with varying contribution of mature forms
1- up to 5% of the total catch, 2- 6 to 25%, 3- 26 to 50% 4- 51 to 75%, 5- more than 75% mature forms, 6- a group of six catches containing 26 to 50% mature forms.

54, 57 by a stern-trawl-net; and at stations 19, 21, 25, 34, 38, 44, 47, 50, 58, 98 by a Bongo net. At three of the above stations (st. 47, 57, 98) only several specimens of *E. superba* were caught.

Sexually immature krill was dominant in 31 of the 49 analysed catches (Fig. 2). Mature krill was predominant in the remaining 20 catches. Juvenile forms and gravid females occurred only sporadically and in small amounts. Spent females were not found. Krill with the predominance of sexually mature individuals was mainly found in the region of the Palmer's Archipelago, and of the Elephant Island. Krill with the highest percentage of sexually immature forms occurred near the Antarctic Peninsula.

When the geographical distribution of stations was considered, five different subareas have been distinguished within the research area. They were:

1. NW of Palmer Archipelago, with stations 7, 9, 12, 13, 26, situated north and west from the Palmer Islands. The results of catches at stations 28 and 30 have not been included in the subsequent biological analysis of krill. Composition of developmental stages differs substantially from the population structure and length distribution of krill in this area.
2. South Shetland Islands — Drake Passage, with stations 42, 43, 52 and 63 located in the Drake Passage, north of the South Shetlands.
3. South Shetland Islands — Bransfield Strait, with stations 78, 80, 95, 129 and 140 located in the Bransfield Strait, south of the South Shetlands.

Table II.

Krill characteristics in different research areas

Research area	NW of Palmer Archipelago		South Shetland Islands-Drake Passage		South Shetland Islads-Bransfield Strait		Antarctic Peninsula		Elephant Island	
Average length (mm)	54.8		51.3		49.3		46.0		50.3	
Average filling of alimentary tract	4.8		3.9		4.0		3.4		4.6	
Percent and average length of different development stages and maturity groups:	%	mm	%	mm	%	mm	%	mm	%	mm
1 — juvenes	<0.1	32.0	0.6	40.3	<0.1	30.0	0.2	31.4	0.6	30.3
2 — subadult males	9.4	53.6	36.2	50.1	27.3	49.8	38.9	45.4	15.7	48.5
3 — adult males	28.4	56.2	26.8	55.5	28.9	53.7	6.8	55.5	37.5	53.4
4 — subadult females	1.9	48.1	13.0	43.4	23.3	41.0	31.5	40.5	6.7	39.5
5 — adult females	59.5	54.5	23.5	52.8	20.5	49.7	22.7	50.5	39.2	50.2
6 — gravid females	0.9	56.0	–	–	–	–	–	–	0.3	52.0
7 — spent females	–	–	–	–	–	–	–	–	–	–
Total immature krill	11.3	52.7	49.2	48.3	50.6	45.8	70.3	43.2	22.4	45.8
Total mature krill	88.7	55.1	50.2	54.2	49.4	52.0	29.5	51.7	77.0	51.8

4. Antarctic Peninsula, with stations 74, 75, 83, 91, 93, 99, 101, 106, 110, 111, 112, 120, 123, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 155, 156 in the Bransfield Strait, north of the Antarctic Peninsula.
5. Elephant Island; six trawls (not included with the FIBEX stations, and designated by a letter P in Table I) were made north of the island.

Table II illustrates the general variations of krill in each of the five subareas. Most uniform krill populations, with regard to maturity and length, occurred in the north-west region of the Palmer Archipelago (Figs. 2 and 3). In the remaining areas, particularly in the vicinity of the Antarctic Peninsula, the frequency curves for length distribution are two-peaked (Fig. 3).

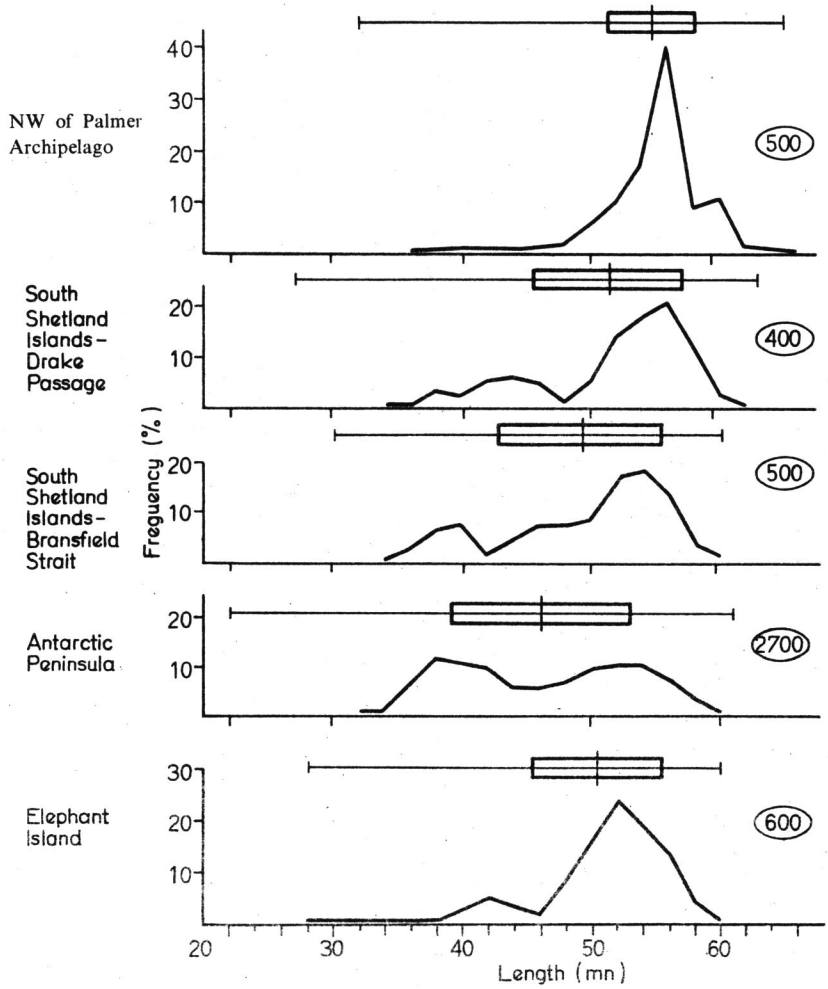

Fig. 3. Mean value and length distribution of *Euphausia superba* in different research regions Numbers in the circles show the quantity of investigated specimens.

Two subregions have been distinguished which differed from one another by the percent contribution of developmental stages (Fig. 4). The first subregion included the north-west area of the Palmer's Archipelago and the waters near the Elephant Island; here mature stages of krill contributed more than 75%. The second subregion included: the South Shetland Islands — Drake Pasage area, and the South Shetlands — Bransfield Strait area; mature krill stages made up 51 to 75%. The area of the Antarctic Peninsula, where adult forms gave 26 to 50% of the total krill populations, could also be included in this subregion.

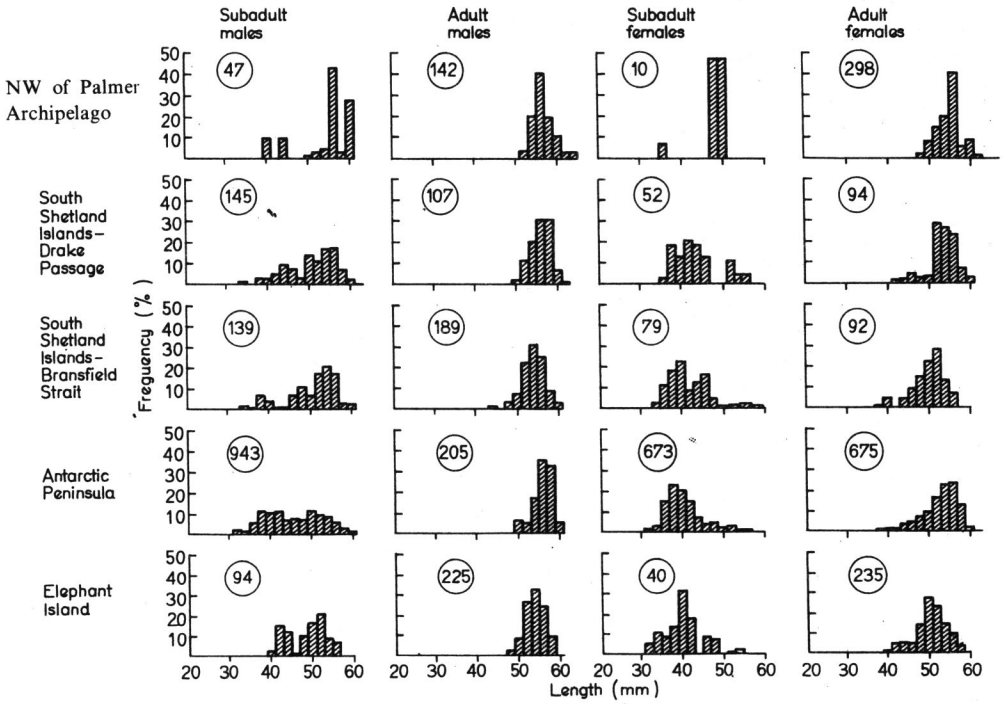

Fig. 4. Percent contribution of chosen developmental stages of *Euphausia superba* in different research regions
Numbers in the circles show the quantity of investigated specimens.

4. Discussion

Detailed data from the analyses of krill catches (Table I) pertain both to krill fished by a stern-trawl-net, and by a Bongo net. Speculations on the character of variations in krill are based only on the results of trawling. As observed previously (Wolnomiejski, Witek and Czykieta 1980; Wolnomiejski in prep.) the Bongo net, having a small mounth opening, collects krill in a selective way. In the present work, this could be illustrated by the results obtained near the Elephant Island where trawlings were done in close distances from one another. The parameters of krill collected six times by a stern-trawl and by the Bongo net are following (numbers

in parenthesis pertain to Bongo net): average length; 49.4 to 52.7 mm (42.2 mm), modal length: 51 to 53 mm (36 and 41 mm), percent contribution of mature individuals; 69 to 94% (46%). Also in the remaining areas, krill collected by the Bongo net was of smaller sizes compared with krill obtained by the trawl net.

Similarly to the observations made during pervious years, mass occurrences of krill were limited to the close vicinity of islands and the Antarctic Peninsula, that is to waters above the shelf and shelf's slope. Krill was either not found at all, or only in small quantities, in the open waters of the Drake Passage. The farthest north located station, during the FIBEX experiment, where krill was found in a Bongo net collection, was station 47 (60°02.3' S and 59°59.9' W). But only two specimens were fished. Quantitative distributions of krill, based on hydroacoustic data, are presented by Kalinowski (1982).

Krill caught, by us in nets in the summer of 1981 in the western part of the Atlantic Ocean sector of Antarctic was characterized by relatively large contribution of sexually immature forms. Krill swarms with the predominance of large, mature individuals occurred mainly at some distance from the continent, in the vicinity of the Palmer Archipelago and the South Shetland Islands. Sexually immature krill dominated closer to the Antarctic Peninsula, however, many mature forms were also present there. This confirms previous observations made in this area (Marr 1962, Makarov 1970, Jażdżewski et al., 1978, Makarov 1979, Witek 1979[3]), Witek et al. 1980). In the present investigations, an insignificant percentage of gravid females, and an absolute absence of spent females were characteristic for mature krill. Only three samples contained each one gravid female. During the investigations of 1976, 1977 and 1979, the presence of substantial quantities of individuals in this stadium of development, had been found many times particularly in the neighbourhood of the Anvers Island and King George Island (Jażdżewski et al. 1978, Wolnomiejski and Boberski 1979[4]), Witek et al. 1980, Witek 1981[5])). It is very likely, that in the spring of 1980/1981, and thus in the period immediately preceding our works, there had occurred simultaneous, mass reproduction of krill, less expanded in time in comparison with the previous year. This supposition has been based on the fact of the occurrence of very high numbers of *E. superba* larvae during the FIBEX investigations (Kittel and Jażdżewski 1982). Such rich concentrations of larvae had never been found before during previous Polish investigations.

A tendency to exist in dispersion (as if outside a swarm) was noted for the occurrence of mature males. This had been also noted earlier by Jażdżewski et al. (1978) and Wolnomiejski (in prep.). This phenomenon is illustrated by data showing the contribution of mature males in 18 trawl-net catches dominated by mature krill. In six cases, when the yield had not exceeded 1 ton per 1 hour of trawling, the average contribution mature males was 59% (range 41 to 79%). In a group of 12 trawls

[3]) [4]) [5]) see page 259, 260

with the average hourly yield greater than 2,5 tons, the average quantity of males constituted 29% (range 5–53%).

Juvenile forms contributed little to krill populations. Their presence was noted in only 14 out of 49 analysed catches obtained by the stern-trawl-net. However, they were present in all Bongo-net materials. The maximum contribution of juveniles among krill from industrial trawls was 9% (at station 28). In Bongo-nets they made up to 13% (station 53) of total krill. A slight contribution to, or even absence of the juvenile *E. superba* forms from the summer populations, does not seem to be of any greater significance, since according to Makarov and Ševcov (1971), the rates of growth and maturing of krill are, in a high degree, dependent on the variations in climatic conditions in different years and seasons. They may also depend on the local habitat conditions (Mackintosh 1972). In previous investigations near the Antarctic Peninsula, large quantities of juveniles had been noted frequently. In some cases they had contributed more than 50% to the total krill quantities.

Interesting were the variations in krill in relation to the spatial east-west krill distribution. Krill populations with the highest contribution of mature forms were found in distant places, north-east of the Palmer Archipelago, and west of the Elephant Island. When the percent contributions of the different developmental stages were considered, the greatest similarities were noted for krill from the areas of "South Shetland Islands — Drake Passage" and "South Shetland Islands — Bransfield Strait", as well as from the area of Antarctic Peninsula (Figs. 2, 4 and 5).

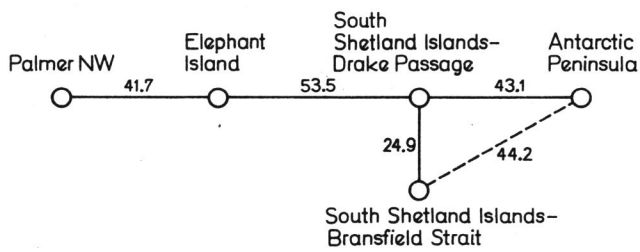

Fig. 5. Dendrites of the least differences between research regions in the percent structure of developmental stages of *Euphausia superba*

Analysis of the mean size of individuals within the same development stages showed, that west border edges of the "A" area were inhabited by krill of the largest size, while the east parts (the Elephant Island area) contained krill of distinctly smaller size, particularly with regard to females (Figs. 3 and 4).

The following hypothesis could be put forward on the basis of the similarities between the two distinguished subregions. Sexually mature krill, of large size, had been probably brought by currents from the Bellinghausen Sea into the waters north-west of the Palmer's Archipelago. Part of these populations had been carried farther away, through the Drake Passage, along the South Shetland Islands. The eastern edge of the "A" area was under the influence of waters from the Weddell Sea carrying both mature

and immature krill of smaller size (Mackintosh 1973). These krill populations could partly mix, either in the Bransfield Strait, or north of the South Shetland Islands with krill incoming from the Bellingshausen Sea. This would be also ewident from the lessening contribution of small individuals in the direction north from the continent. Aside from all this mixing of populations of a different origin, the Bransfield Strait might be inhabited by a local krill population.

5. Conclusions

1. The waters of the Bransfield Strait and the Drake Passage were, in most cases examined, dominated by scxually immature krill populations. Out of the total of 58 catches obtained by a stern-trawl and a Bongo net, immature krill was dominant in 38, and mature in 20 analysed catches.
2. A very small contribution of juvenile forms and gravid females was observed. No spent females were noted.
3. Similarly to previous results from this area, immature krill occurred mainly near the Antarctic Peninsula. Sexually mature populations dominated, in most cases, farther north around the South Shetland Islands, and also north-west of the Palmer's Archipelago.
4. As far as the same stages of development are concerned, krill of the largest size was present at the Palmer's Archipelago, and of the smallest size at the Antarctic Peninsula and close to the Elephant Island.
5. On the basis of data about the structure and size of the various developmental stages of krill occurring in two distinguished subregions, it is supposed that:
   — the north-west area off the Palmer's Archipelago was inhabited by a krill population of particularly large individual sizes; this population had been brought by currents from the Bellingshausen Sea,
   — krill swarms in the Bransfield Strait, and also north of the South Shetlands were formed as a result of mixing of krill brought in from the Weddell Sea (dominance of immature forms of smaller size) with krill populations carried by a west current from the Bellingshausen Sea (dominance of mature, large size forms) in the direction of the South Shetlands. It is also probable, that the Bransfield Strait has a local krill population.

6. Резюме

Исследования проводились в южной части пролива Дрейка и в проливе Брансфилда (район "А" программы БИОМАСС-ФИБЭКС) в феврале и марте 1981 г. В работе представлены подробные результаты биологического анализа криля из этого района (таблица 1). Обнаружено чрезвычайно низкое количество ювенильных форм и икриных самок; не вылавливались самки после нереста. Неполовозрелый криль (молодь) наблюдался главным образом вблизи Антарктического полуострова. В районе Южных Шетландских островов, а также к северу и к западу от архипелага Пальмера преобла-

дали половозрелые особи криля (рис. 2). Самый большой криль был обнаружен вблизи архипелага Пальмера, самый маленький у Антарктического полуострова и о. Элефант (рис. 3 и 4). Гипотетически предполагается, что к северо-западу от архипелага Пальмера существовала популяция большого криля, принесенного из бассейна моря Беллинсгаузена. Скопление криля, установленное в свою очередь в проливе Брансфилда и к северу от Южных Шетландских о-вов, возникло в результате перемешивания криля, приносимого из моря Уэддела и моря Беллинсгаузена.

7. Streszczenie

Badania prowadzono w południowej części Cieśniny Drake'a i w Cieśninie Bransfielda (rejon "A" programu BIOMASS-FIBEX) w lutym i marcu 1981 roku. W pracy przedstawiono szczegółowe wyniki analizy biologicznej kryla z tego rejonu (tabela I). Stwierdzono bardzo mały udział form juvenilnych i samic z wypełnionymi jajnikami, nie łowiono samic potarłowych. Kryl niedojrzały płciowo występował głównie w pobliżu Półwyspu Antarktycznego. W okolicy Szetlandów Południowych oraz na północ i zachód od Archipelagu Palmera najczęściej dominował kryl dojrzały płciowo (rys. 2). Największy kryl występował w okolicy Archipelagu Palmera, najmniejszy przy Półwyspie Antarktycznym i Wyspie Elephant (rys. 3 i 4). Zakłada się hipotetycznie, że na północny zachód od Archipelagu Palmera bytowała populacja kryla dużego, naniesionego z basenu Morza Bellingshausena. Natomiast zgrupowanie kryla w Cieśninie Bransfielda i na północ od Szetlandów Południowych utworzone zostało przez zmieszanie kryla naniesionego z Morza Weddella i Morza Bellingshausena.

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