POLISH POLAR RESEARCH (POL. POLAR RES.) POLSKIE BADANIA POLARNE	5	1-2	99—105	1984

Janusz KALINOWSKI

Department of Ichthyology, Sea Fisheries Institute,
al. Zjednoczenia 1, 81–345 Gdynia, Poland

The biomass of krill in the eastern part of Bransfield Strait, March 1981*)

ABSTRACT: Results from the hydro-acoustic studies aiming at evaluation of the *Euphausia superba* biomass in the Bransfield Strait in March 1981 are presented. These investigations, called conventionally Micro-FIBEX, were carried out on the r/v "Profesor Siedlecki" during 13–16 March 1981, as continuation of the studies carried out in that region within the scheme of the FIBEX programme in the period of 5–12 March 1981. The abundance of the biomass was estimated at 258 thousand ton, which at the investigated area of about 1755 NM^2 gives the mean value of biomass density 142 t/NM^2 (41.4 g/m^2).

Key words: Antarctic, krill, stock

1. Introduction

FIBEX research experiment carried out in 1981 was the first stage of the proceedings aiming at the solution of the problem of estimating krill resources in the Antarctic. The preliminary results of the research are presented in Anon (1981a, b). The results of the investigations carried out in Sector "A", covering the regions of Drake Passage and Bransfield Strait are published by Kalinowski (1982). The results of hydroacoustical estimation of krill biomass in the eastern part of Bransfield Strait are given hereinafter.

2. Material and methods

Investigations were carried out using hydroacoustical equipment installed on board of the r/v "Profesor Siedlecki". Observations were made in

*) Study performed within the MR-I-29A Project supported by the Polish Academy of Sciences, during the BIOMASS-FIBEX Expedition on r/v "Profesor Siedlecki", directed by Dr. S. Rakusa-Suszczewski.

a twenty-four-hour system of hydroacoustic watch using the following instruments:

— vertical echosounder Simrad EK–120;
— echointegrator Simrad QMMK II, co-operating with echosounder EK–120;
— vertical echosounder Simrad EK–38;
— digital depth indicator.

Prior to the measurements the apparatuses had been calibrated in acoustic and electrical units. For the echosounder EK–120 the following parameters were obtained:

— source level (SL) 224.1 dB/μPa ref. lm;
— voltage response (VR) — 101.8 dB/(1V) μPa;
— working frequency 120015 Hz;
— bandwidth 3110 Hz;
— power 441 W;
— pulse length 0.6 ms;
— TVG 20 log R + αR.

Echo integration was made continuously in the depths ranging from 10 to 130 m.

The measurements of geometrical parameters of the patches recorded in the form of echo on the paper of the echosounder, which could be determined as reflected from krill aggregations, were the main basis for the estimation of krill biomass. It has been assumed that a patch has the shape of a revolving ellipsoid. The vessel sailing over the patch moves along any of its cross-sections the length of which is recorded on the paper of the echosounder as an apparent length, d_A, and the height as an apparent height, h_A. Taking into account the angle of the effective fore-aft beam the following equation was obtained for the real length of the patch, d_T:

$$d_T = d_A - (G + D_A)\,\mathrm{tg}\,\frac{\Theta}{2} \tag{1}$$

where:

d_T — real length of the patch cross-section (m);
d_A — apparent length of the patch cross-section (m);
G — upper limit of patch depth (m);
D_A — apparent lower limit of patch depth (m);
Θ — angle of the effective fore-aft beam (deg).

It appears from statistical analyses that after cutting a circle at random the mean length of obtained chords comes up to $\pi/4$ of the diameter of that circle. On that basis it may be assumed that:

$$d_c = \frac{4}{\pi}\,d_T \tag{2}$$

where:

d_c — true length of the patch (m).

Taking into account duration of the pulse length the height of the patch on the echogram increases by the δ_h value, which under the working conditions of the echosounder EK–120 amounts to 0.86 m.

Therefore:

$$h_T = h_A - 0.86 \tag{3}$$

where:

h_T — real height of the vertical section of the patch (m);

h_A — apparent height of the vertical section of the patch (m).

To calculate the true height of the patch, h_c, it has been assumed that proportions of real dimensions of the vertical section of the patch determined from the echogram correspond to proportions of true dimensions. Therefore:

$$h_c = \frac{4}{\pi} h_T \tag{4}$$

where:

h_c — true height of the vertical section of the patch (m).

The volume of the patch was calculated after the formula for the volume of a revolving ellipsoid:

$$V = \frac{4}{3} \pi \left(\frac{dc}{2}\right)^2 \frac{hc}{2} \tag{5}$$

where:

V — patch volume (m^3).

Patch density was calculated after the formula:

$$\bar{\varrho} = 10^{0.1\,(\overline{Sv} - \overline{TS})} \cdot \overline{W_k} \tag{6}$$

where:

$\bar{\varrho}$ — mean density of patch (g/m^3);

$\overline{Sv}$ — mean volume back scattering strength (dB);

$\overline{TS}$ — mean target strength (dB);

$\overline{W_k}$ — mean body weight of krill specimens (g).

The Sv measurements were made by means of an echointergrator Simrad (1972), using the methods given by the producer of the hydro-acoustic equipment. The target strength was calculated after the formula:

$$TS = 2.3 \cdot L - 72 \tag{7}$$

where:

TS — target strength of krill (dB);

L — body length of krill specimens (cm).

On the basis of the values of the patch volume, V, and mean density, $\bar{\varrho}$, the mean weight of krill patch was determined:

$$W = \bar{\varrho} \cdot V \tag{8}$$

where:

W — weight of patch (kg).

On the basis of the measurements of the parameters of each krill patch biomass was determined per unit of the surface area:

$$\varrho_p = 1.852 \sum_{i=1}^{n} \frac{W_i}{d_{ci}}$$

where:

ϱ_p — biomass density (t/NM^2);
W_i — weight, of i — patch (kg);
d_{ci} — length, of i — patch (m);
n — number of patches.

The values of biomass density obtained in that way were grouped into the following classes (t/NM^2):

0
0.1 — 100
100 — 1000
1000 — 10000

In each of these classes a proper arthmetical mean of the biomass density was determined. In this way sub-areas with different values of mean biomass density were obtained. By multiplying the sub-area surface by mean biomass density the value of krill biomass in a given sub-area was determined. The sum of the biomass values from the total number of the sub-areas gave the required value of krill biomass over the whole region under investigation.

3. Material

Investigations were carried out 13—16 March 1981. They covered the region between King George Island and the Antarctic Peninsula. In this area of 1755 NM^2 581 krill aggregations were recorded and measured. On the basis of the measurements the values of krill biomass were estimated.

4. Results and discussion

The investigation area may be provisionally divided into two parts (Fig. 1). The first part covers the waters from the Antarctic Peninsula

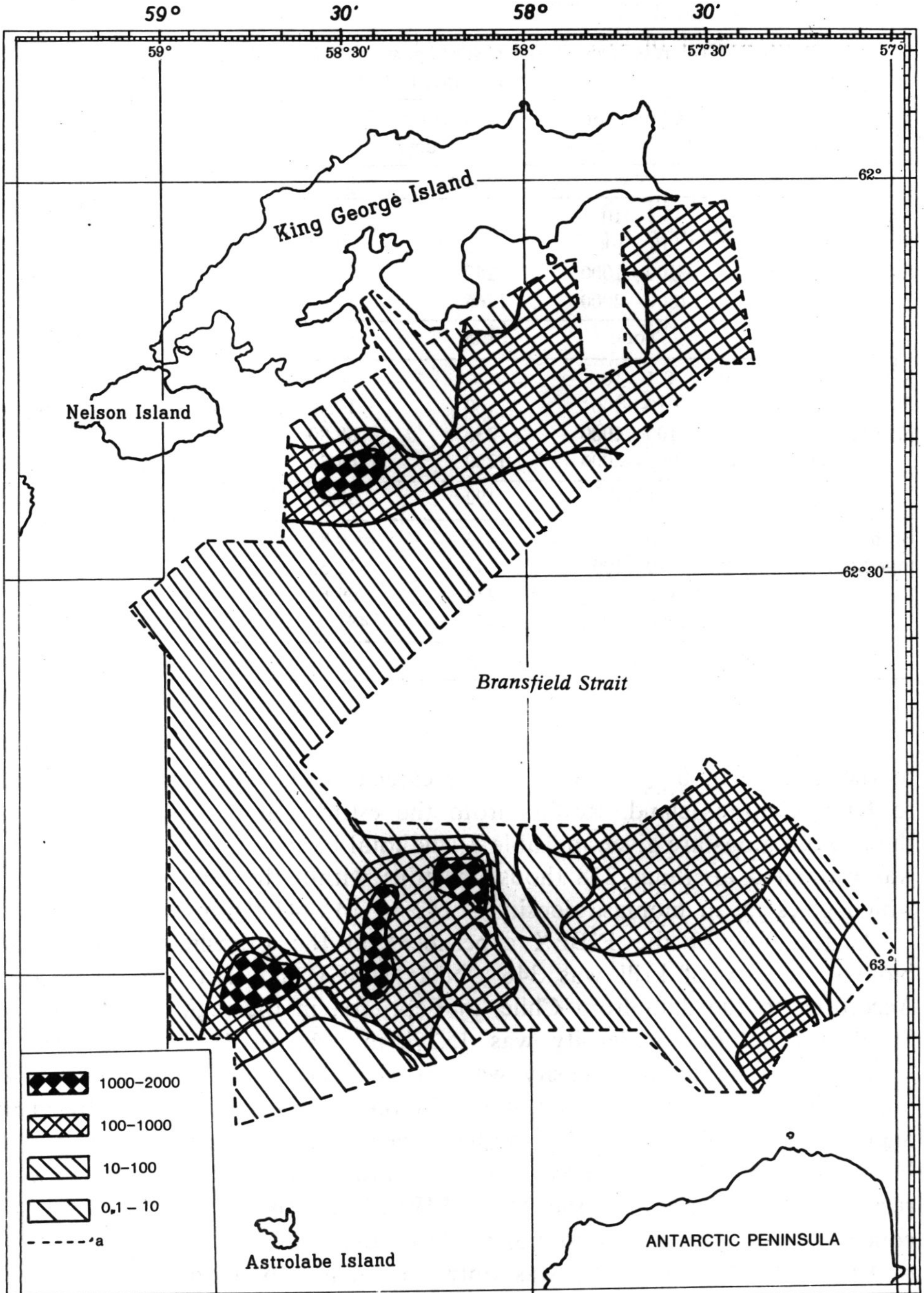

Fig. 1. Distribution of krill biomass (t/NM^2) 13–16 March 1981, during Micro–FIBEX programme

Density of biomass: 1000–2000 (t/NM^2), 100–1000 (t/NM^2), 10–100 (t/NM^2), 0.1–10 (t/NM^2), a — boundary of investigated area.

Table I.

Krill resources in the eastern part of Bransfield Strait, 13—16 March 1981

Region	Classes of krill density	Mean biomass density		Area	Biomass
	t/NM²	t/NM²	g/m²	NM²	1000 kg
Antarctic Peninsula	0.1—10	3	0.87	109	0.327
59°—57°W,	10—100	33	9.62	839	27.687
62°30'—63°10'S	100—1000	242	70.55	319	77.198
	1000—2000	1766	515	33	58.278
	Total	125	36.4	1300	163.490
King George Island	0.1—10	—	—	—	—
59°—57°20'W	10—100	60	17.49	194	11.640
62°30'S	100—1000	236	68.80	247	58.292
	1000—2000	1250	364.44	14	17.500
	Total	192	55.97	455	87.432
Both regions	0.10	3	0.87	109	0.327
together	10—100	43	12.53	1033	44.419
	100—1000	239	69.68	566	135.274
	1000—2000	1651	481	47	77.597
	Total	142	41.4	1755	257.617

to the latitude of 62°30'S, The second extends over the area from 62°30'S to King George Island. Results from the estimation of krill resources in these two regions are given in Table I. The total biomass of *Euphausia superba* was estimated at about 258 thousands tons within the area of 1755 NM^2, which gives mean biomass density — 142 t/NM^2 (41.4 g/m^2).

At the time of the FIBEX experiment in the Bransfield Strait mean biomass density of krill was 346 t/NM^2 (100 g/m^2) (Kalinowski 1982). According to the data from Chile, in February, in the region of Bransfield Strait, mean biomass density was 15.2 g/m^2 (Anon 1981 c). As can be seen, in March biomass density was much higher than in February. The high values of the biomass density in March were caused mainly by great agglomerations of krill in the southern part of Bransfield Strait, north of Hoseason Island and Trinity Island. Approximate biomass values were recorded in the region of the Micro-FIBEX investigation area. High krill concentrations were recorded north of Astrolabe Island while at the time of FIBEX experiment there was only one, markedly large agglomeration, which two weeks later was divided into three parts.

In the immediate vicinity of Admiralty Bay the biomass density was distinctly lower than in the southern parts of that region (about 50 t/NM^2, 14.5 g/m^2).

5. Резюме

Во время исследований, проведенных в 1981 г. в проливе Брансфилд на нис "Профессор Седлецки", была определена биомасса криля в восточной части пролива, между островом Кинг Джордж и Антарктическим полуостровом. Общая биомасса составляла ок. 258 тыс. тон, что при площади исследуемого района равной ок. 17.5 Мм^2, дает среднюю плотность биомассы 142 т/Мм^2 (41,4 г/м^2) (таблица I).

6. Streszczenie

W czasie badań przeprowadzonych w 1981 r. w Cieśninie Bransfielda na r/v "Profesor Siedlecki" oszacowano zasoby kryla we wschodniej jej części, pomiędzy Wyspą Króla Jerzego a Półwyspem Antarktycznym. Otrzymano łączną biomasę równą około 258 tys. ton, co przy powierzchni około 1755 Mm^2 dało średnią gęstość biomasy 142 t/Mm^2 (41.4 g/m^2) (tabela I).

7. References

1. Anon. 1981a — BIOMASS Newsletter — Vol. 3, No 1, 9 pp.
2. Anon. 1981 — Post-FIBEX Data Interpretation Workshop — BIOMASS Report Ser. 20. 38 pp.
3. Anon 1981c — Report of *ad hoc* Acoustics Working Group-Post-FIBEX Data Interpretation Workshop. September/October 1981, 47 pp.
4. Kalinowski J. 1982 — Distribution and stock of krill in the Drake Passage and Bransfield Strait during BIOMASS/FIBEX expedition — Pol. Polar Res., 3: 243–251.
5. Simrad 1972 — Echo Integration Publication P. 574 E. — Oslo 2.10–2.21.

Paper received 29 November 1982