POLISH POLAR RESEARCH (POL. POLAR RES.) POLSKIE BADANIA POLARNE	1	4	97—115	1980

Zbigniew WITEK[1]), Andrzej KORONKIEWICZ[2]) and Grzegorz Jan SOSZKA[3])

[1]) Department of Oceanography, Sea Fisheries Institute, Gdynia,
[2]) Sea Fisheries Institute, Świnoujście Branch,
[3]) Department of Hygene Radiation, Central Laboratory of Radiological Protection, Warszawa

Certain aspects of the early life history of krill *Euphausia superba* Dana (*Crustacea*)

ABSTRACT: Distribution and population age structure of krill *Euphausia superba* larvae is presented for four consequent years on the basis of the summer materials from 1976 to 1979. An approximate rate of growth of krill larvae was calculated on the basis of the above observations and the literature data on the occurrence of particular larval stages. This allowed to determine the main period of krill breeding in particular years. Intense breeding of krill took place from January to middle of March in summers 1976/1977 and 1977/1978, but much earlier — mid November to mid January in 1975/1976. In summer of 1978/1979 the breeding of krill was poor till March.

Key words: Antarctic, krill, early life history

1. Introduction

Biology of Antarctic krill *Euphausia superba* Dana is not sufficiently known up to now. Large differences in the size and maturity of particular populations found in summer seasons led scientists to draw hypotheses of two, three or even four years long life span. The place and time of breeding and the rate of growth are of great importance. Intense British studies from the pre-war period (Fraser 1936, Bargmann 1945) supplied the first sound data on morphology of the particular developmental stages, and on the place and time of their occurrence. British achievements in studies of krill biology, continued also after the war, are summarized in an extensive monography by Marr (1962). The same data supported valuable ideas of the life cycle of *E. superba* drawn by Mackintosh (1972). In the above papers a lot of consideration was devoted to the larval period of krill life. In the recent years systematic studies of Antarctic waters were also started by other countries. New data on the occurrence of eggs and larvae of *E. superba* were presented by Makarov (1974), I. Hempel and G. Hempel (1978) and by I. Hempel, G. Hempel and Baker (1979). A relatively large

material gathered the four Polish Antarctic Expeditions in years 1976—1979 allows to add to the knowledge of larval period of krill.

Age structure and distribution of krill larvae populations in particular seasons of investigations are presented in this paper. An approximate rate of the larval growth was calculated on the basis of the own and available literature data for the determination of the breeding period. This allowed to compare the time of krill breeding in particular years and regions.

2. Material and methods

Plankton was sampled during the four consequent summer seasons: 28 January — 31 March 1976, 15 February — 17 April 1977, 19 December 1977 — 27 March 1978 and 13 December 1978 — 27 March 1979. The following regions were sampled in the above periods: Scotia Sea and adjacent waters — in the first and second summer, Antarctic waters around the continent — in the third one, and Scotia Sea, Bellingshausen Sea and adjacent waters in the fourth summer.

Various types of plankton nets were used in the first season. Clark-Bumpus type sampler with inlet area 0.07 m^2 and mesh size 0.24 mm and MPS type sampler with inlet area 0.5, and mesh size 0.24 mm were used for oblique houls. Both of the above types of samplers were equiped with flow meters. The vertical houls were made with kopenhagen net with inlet area 0.2 m^2 and mesh size 0.064 mm and with Nansen net with inlet area 0.4 m^2 and mesh size 0.20 mm. The nets had no flow meters. During the remaining seasons only vertical houls were made with kopenhagen nets (layer 100—0 m) and Nansen net (layer below 100 m). The MPS sampler was used only few times during the second season.

Plankton was sampled usually in three layers: 100—0 m, 250 (300)—100 m and 500—250 (300) m. In the fourth season the layer 500—100 m was sampled with one houl. At places shallower than 500 m a houl was done from 5—10 m above the bottom.

Our sampling is representative only for stages older than metanauplii, as acc. to Fraser (1936) the majority of larvae in stage *calyptopis* 1 and older occur above 500 m depth both during the days and nights, but *nauplii* usually occur deeper.

For the quantitative comparison of larval occurrence at particular stations sampled with various type of nets, all data were calculated per meter square of the sea surface.

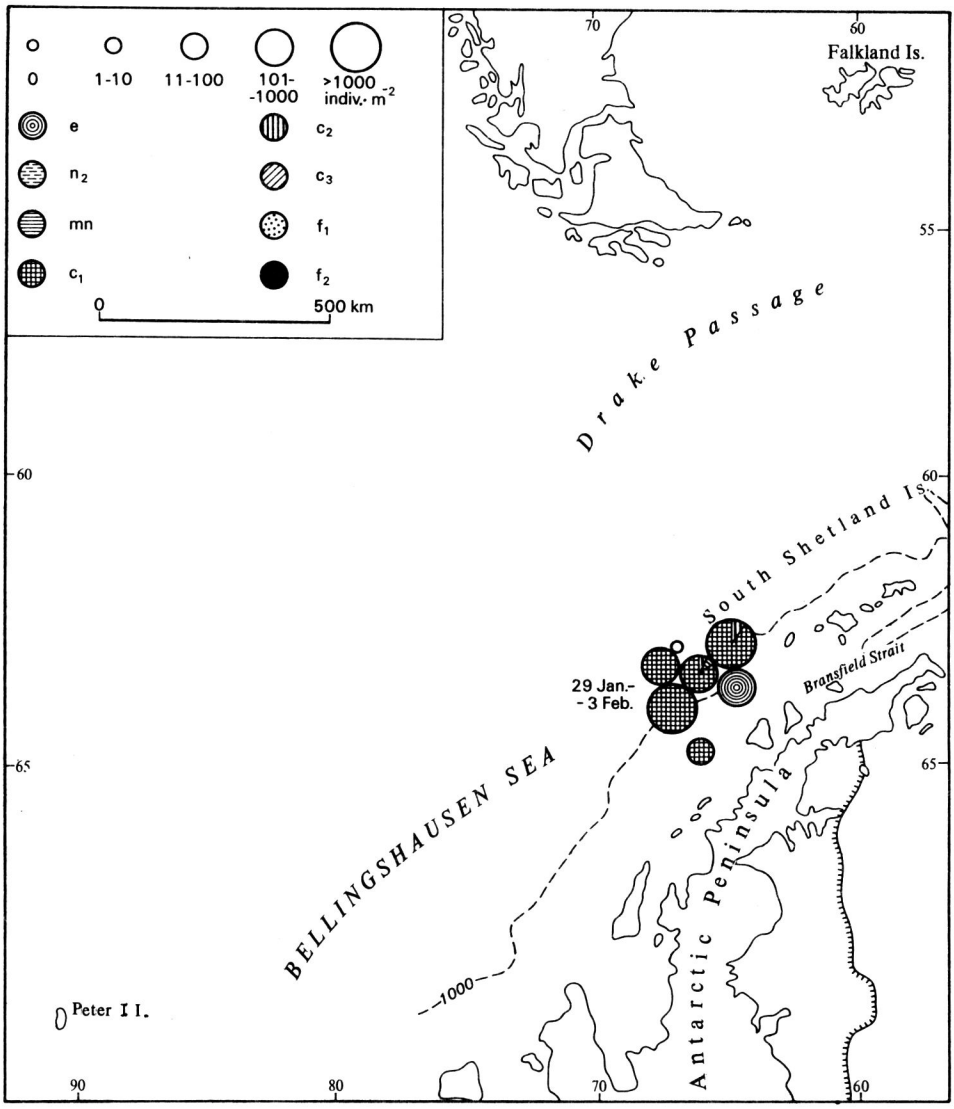
Segregation and determination of eggs and larvae from the first three seasons were done in laboratories of the Sea Fisheries Institute, whole material from the fourth season was elaborated on board. The species and developmental stages were distinguished acc. to descriptions of John (1936), Fraser (1936) and Mauchline and Fisher (1969). The number of eggs and krill larvae from particular seasons of investigations are shown in Table I.

Table I

The number of *Euphausia superba* eggs and larvae collected in particular seasons

Season	Number of stations	Number of stations with krill eggs or larvae	Number of found eggs and larvae									
			e	n_1	n_2	*mn*	c_1	c_2	c_3	f_1	f_2	f_3
1975/1976	48	19	928	4	4	2	2236	3905	1742	407	72	6
1976/1977	50	39	840	—	1	7	2540	811	168	40	—	—
1977/1978	25	8	7	—	9	26	228	2335	61	—	—	—
1977/1979	173	64	734	1	2	1	392	32	8	3	—	—

e — eggs, n_1 — *nauplii* 1, n_2 — *nauplii* 2, *mn* — *metanauplii*, c_1 — *calyptopes* 1, c_2 — *calyptopes* 2, c_3 — *calyptopes* 3, f_1 — *furciliae* 1, f_2 — *furciliae* 2, f_3 — *furciliae* 3



3. Results and discussion

In summer 1975/1976 the studies were started in the region of Antarctic Peninsula, west from South Shetland Islands, at the turn of January and February. The largest concentrations of larvae in this region were found beyond the shelf, in the zone of the continental slope (200—1140 ind.·m^{-2}) (Fig. 1). Stages *calyptopis* 1 dominated decisively. The number of larvae above the shelf was considerably lower (several ind·m^{-2}), eggs only were found at one of the stations (Fig. 1).

Region of the Bransfield Strait, between King George and Elephant

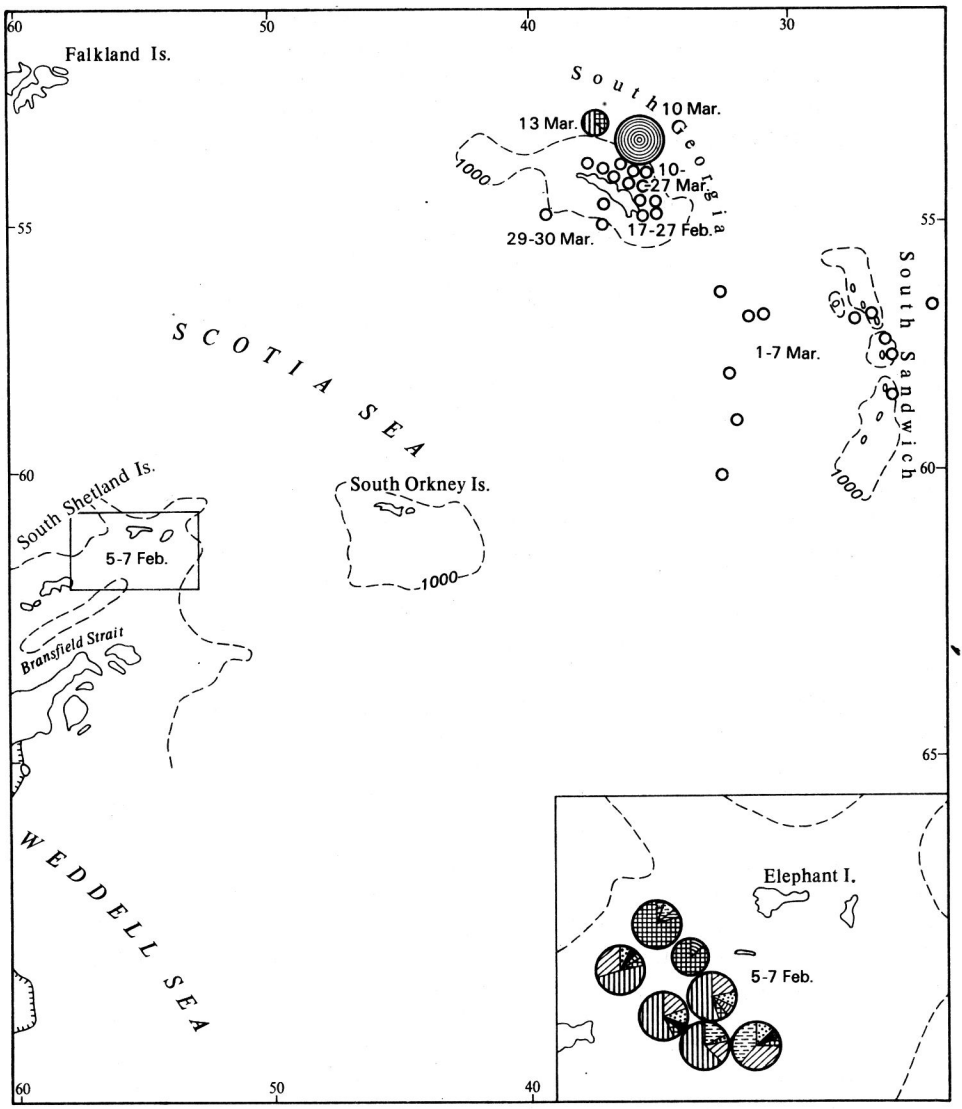


Fig. 1. The distribution of krill eggs and larvae in Scotia Sea and adjacent waters in summer season of 1976

e — eggs, n_2 — *nauplii* 2; mn — *metanauplii*; $c_{1,2,3}$ — *calyptopes* 1, 2, 3; $f_{1,2,3}$ — *furciliae* 1, 2, 3.

Islands of South Shetlands archipelago was studied during the first ten days of February. This is a deep shelf region, with depths 500—800 m, and over 1600 m in one case. There were large numbers of larvae (160—4600 ind·m^{-2}) in stages *calyptopis* 1 to *furcilia* 2, generally with the majority of *calyptopis* 2. Few individuals of *furcilia* 3 were caught twice. Eggs were absent, or they occurred in relatively low numbers (up to 195 ind·m^{-2}), amounting to not more than 20% of the total number of eggs and larvae (Fig. 1).

The region of South Georgia, studied intensively in the second half of February and from 10 March to the end of this month, was nearly lacking the eggs and larvae. Single eggs and *calyptopes* 1 were found at only three of twenty stations located over the shelf. However, over 1100 eggs per square meter were found at one of the station located beyond the self (10 March) (Fig. 1).

Netting for eggs and larvae in the eastern part of Scotia Sea and in the region of South Sandwich gave negative results.

In summer of 1976/1977 during the second half of February, the krill larvae were found at nearly all stations in the region of Antarctic Peninsula, from Adelaida Island to South Shetland Islands. Usually the *calyptopis* 1 larvae were the most numerous (Fig. 2). Several times only the krill eggs occurred in the southern part of the region. Larvae in this region show a tendency to the more numerous occurrence close to the continental slope.

In the southern part of Scotia Sea during the first 10 days of March eggs of *E. superba* ocurred. The were especially numerous (about 1800 eggs per square meter) over the shelf in South Orkney region (Fig. 2).

In the region of South Georgia the eggs occurred sporadically and were scarse over the shelf in March and first fortnight of April. Farther from the island, beyond the shelf, larvae occurred in quantities of several to several hundreds individuals per square meter, mainly the stages of *calyptopis* 1 and 2 (Fig. 2).

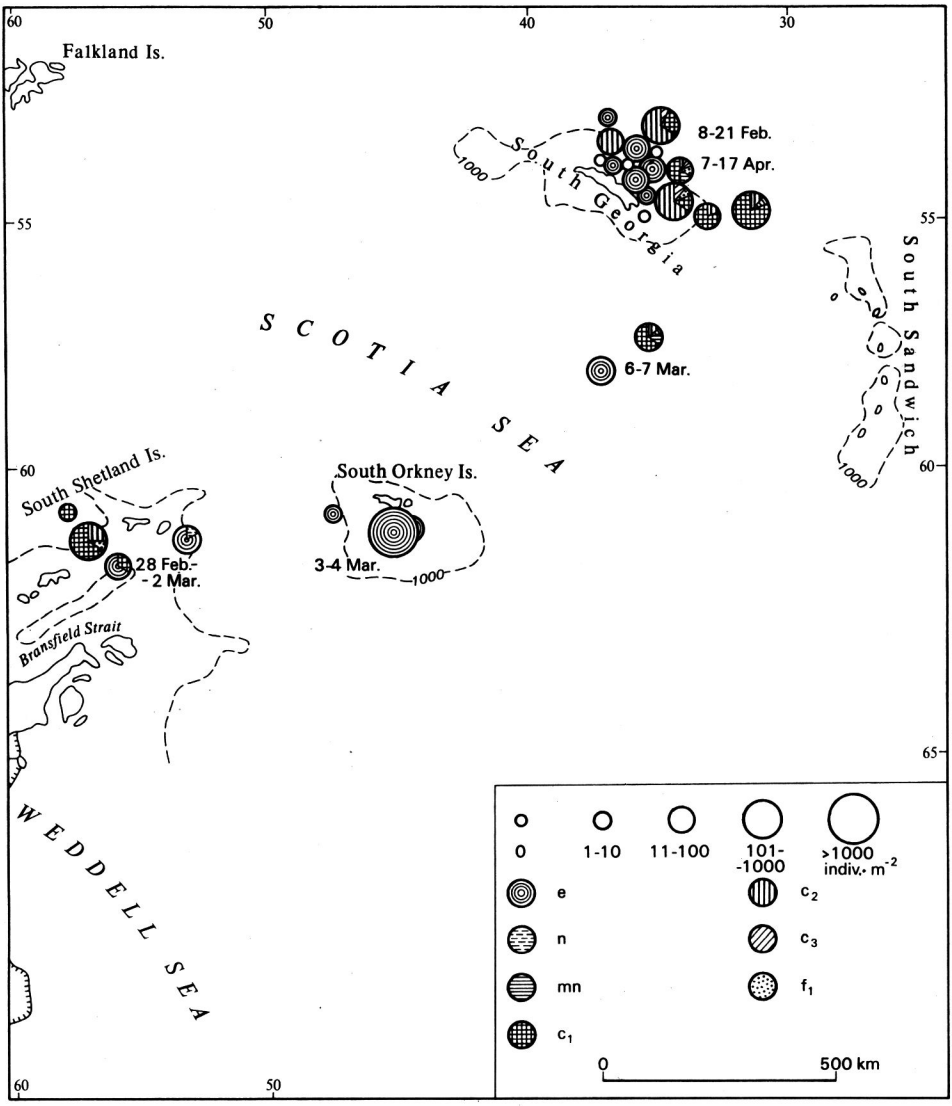
The studies of waters surrounding the Antarctic continent were carried out in season of 1977/1978 (Fig. 3). Regions of South Georgia, Scotia Sea and region from Antarctic Peninsula to Ross Sea were studied from 19 December to 12 January. Neither the eggs nor the larvae of krill were found there. However, as these studies were limited to houls in layer 0—100 m, the results can not be considered as representative, and these stations are not shown on the map (Fig. 3). Two stations located over the shelf on Ross Sea, where similarily as in the next regions, houls covered the whole depth, there was found a small number of eggs and larvae of *nauplius* 2, *metanauplius* and *calyptopis* 1 stages (20—21 January) (Fig. 3).

Next finding of krill larvae took place during the westward cruise in the Indian sector of Antarctic. The *calyptopis* 2 stages were found mainly, and *calyptopis* 1 and *calyptopis* 3 in smaller numbers. Especially numerous were the samples collected in March in the region of Knox Land (7510 ind·m^{-2}), and ones from the region of Enderby Land (5380 ind·m^{-2}). Both of these stations were located beyond the shelf, in the zone of continental slope (Fig. 3).

The region of South Georgia was studied in summer 1978/1979 at first (in December 1978). Neither the eggs or the larvae of *E. superba* were found there. However, the *furciliae* of *Euphausia frygida* Hansen were very numerous in the region.

Moderate numbers of *calyptopis* 1 (maximum 510 ind·m^{-2}) were found in the southern part of Scotia Sea, in region of South Orkneys and eastward from these islands (Fig. 4).

The krill eggs occurred in numbers up to 130 eggs per square meter in the northern part of South Sandwich Islands. Eggs of *E. superba* were



found also during the repeated exploration of South Georgia region (8—13 January), numbering from below ten to 430 eggs per square meter.

In the region of Bransfield Strait (studied in period 22—31 January and 19—25 February) krill eggs amounted to several hundreds per square meter, there were scarse *calyptopis* 1—3, too. The most numerous eggs were found close to Joinville Island (130 and 430 eggs per square meter in January) and close to King George Island (120 and 160 eggs per square meter in February) (Fig. 4).

On the whole vast area of Bellingshausen Sea from the Antarctic Peninsula to Peter I Island there were neither the larvae nor the eggs of krill, except a small region westward from Anvers Island in Palmer Archipelago, where few eggs were found.

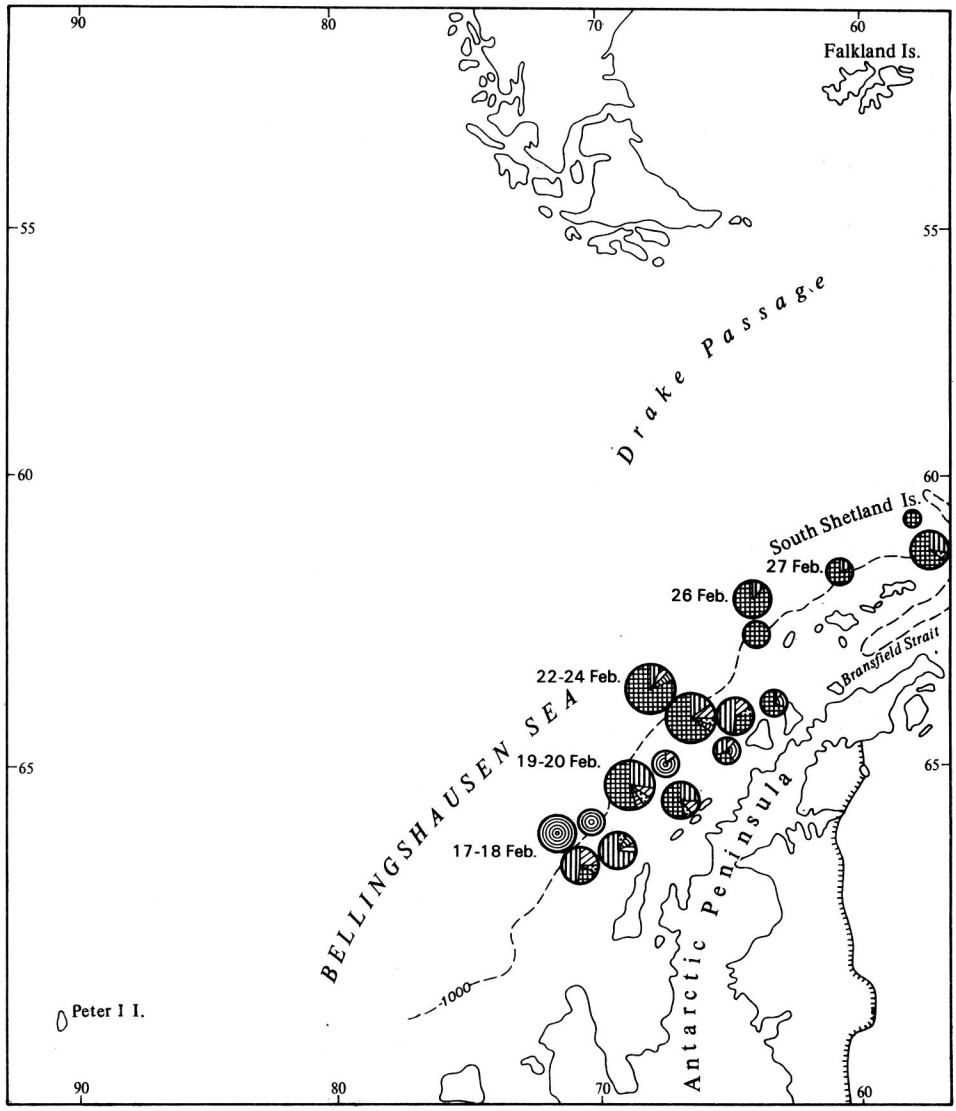


Fig. 2. The distribution of krill eggs and larvae in Scotia Sea and adjacent waters in summer season of 1977
Explanations as for Fig. 1

During the third cruise in this season, in the region of South Georgia, in March, neither the eggs nor the larvae of krill were found. The single eggs only, and small amounts of larvae in *calyptopis* stage, mainly *calyptopis* 2, were found in the area from South Orkneys to the eastern part of Bransfield Strait in this month (Fig. 4).

Analysing the geographic distribution of eggs and larvae of *E. superba* during the four studied vegetation seasons from 1975/1976 to 1978/1979 it was found that they occurred on the deep shelf or in the zone of continental

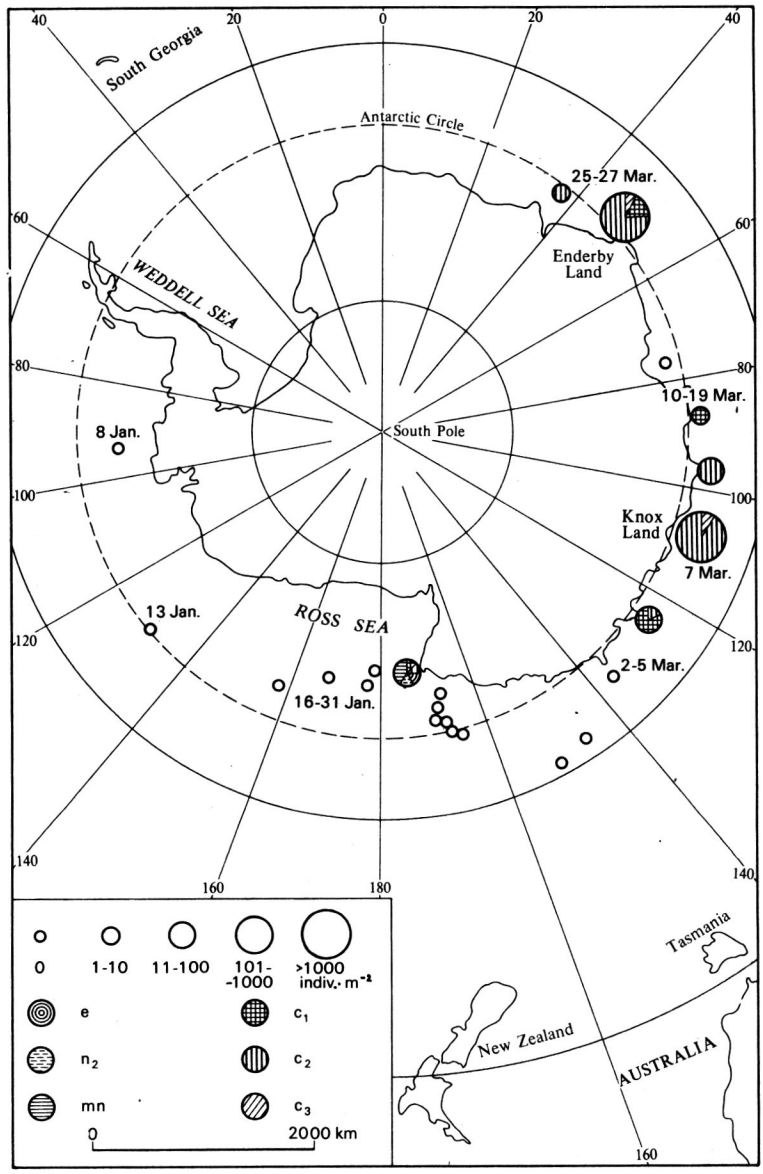
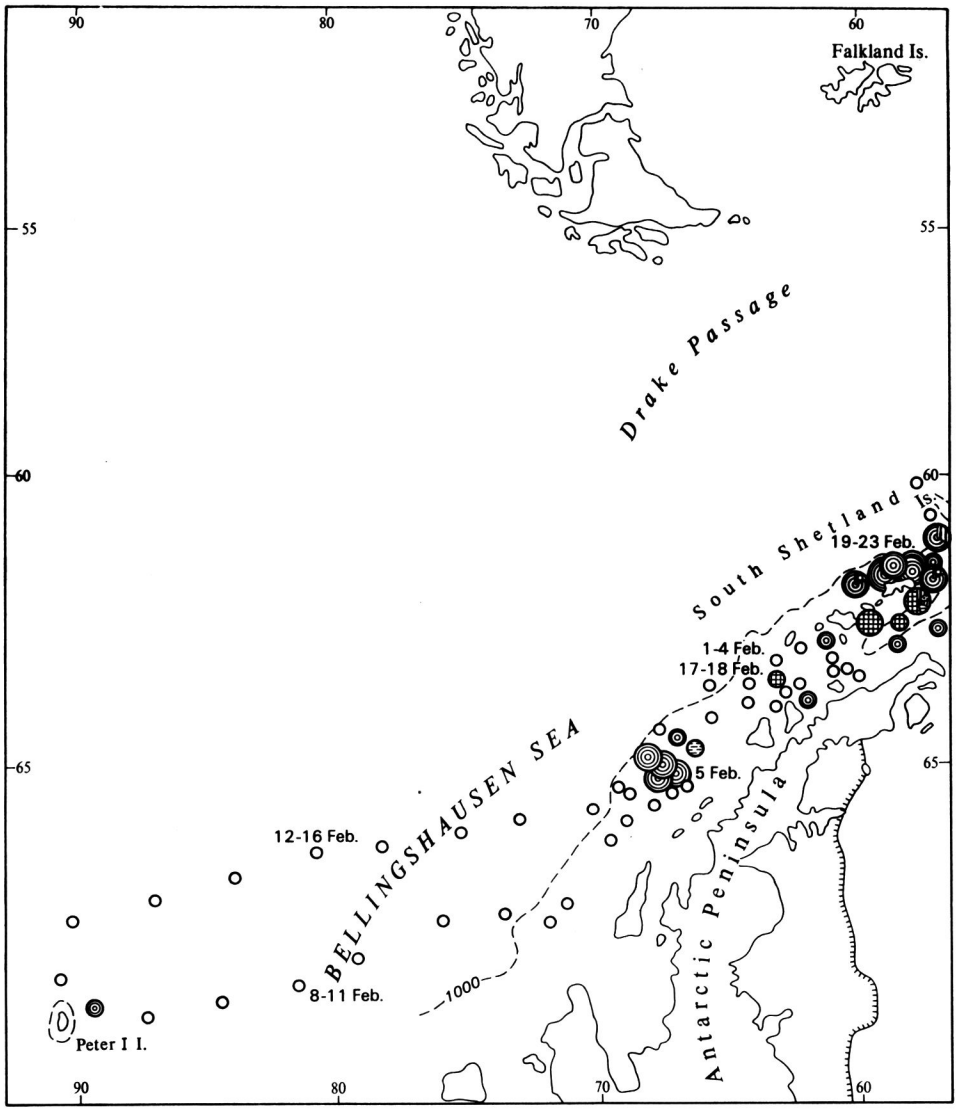


Fig. 3. The distribution of krill eggs and larvae in Antarctic waters around the continent in summer season of 1977/1978
Explanations as for Fig. 1



slope in Atlantic and Indian sectors of Antarctic. They concentrated especially in regions of Antarctic Peninsula, eastern part of Bransfield Strait, South Orkneys, neighbourhood of South Georgia, Knox Land and Enderby Land (Figs. 1—4).

It is understood that within a year, with time passing, the older and older developmental stages should dominate. The period of occurrence of particular stages of *E. superba* is extremely difficult to determine, even of for the peculiar developmental conditions in postembrional period, when consequent stages of *nauplius* 1 and 2, *metanauplius* and *calyptopis* 1 migrate from large depths, where the eggs have sunk, towards the surface (Marr 1962). Recently McWhinnie and Denys (1978) determined experimentally the period between laying an egg to *nauplius* 1 hatching, (3—4 days), and

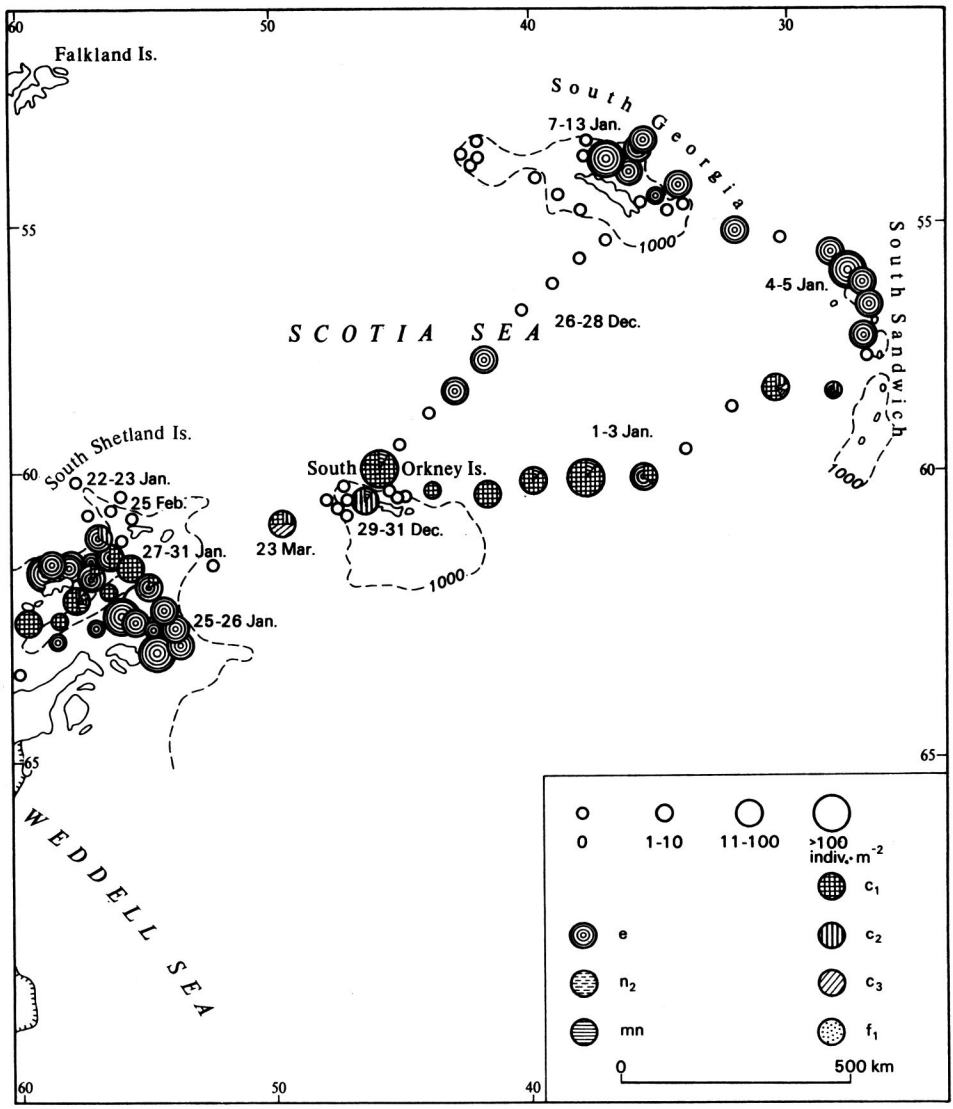


Fig. 4. The distribution of krill eggs and larvae in Scotia Sea, Bellingshausen Sea and adjacent waters in summer season of 1978/1979
Explanations as for Fig. 1

to its transformation into *nauplius* 2 (7—8 days) and into the *metanauplius* stage (10—18 days or more). These are, unfortunately, probably the only data on the subject, and they cover only a short period of development. However, it seems that analysis of available data on the time of occurrence of particular stages, obtained by various authors for various years, will allow an approximate determination of an average time from depositing the eggs to the appearance of particular larval stages.

The dates of the occurrence of particular larval stages, independent from

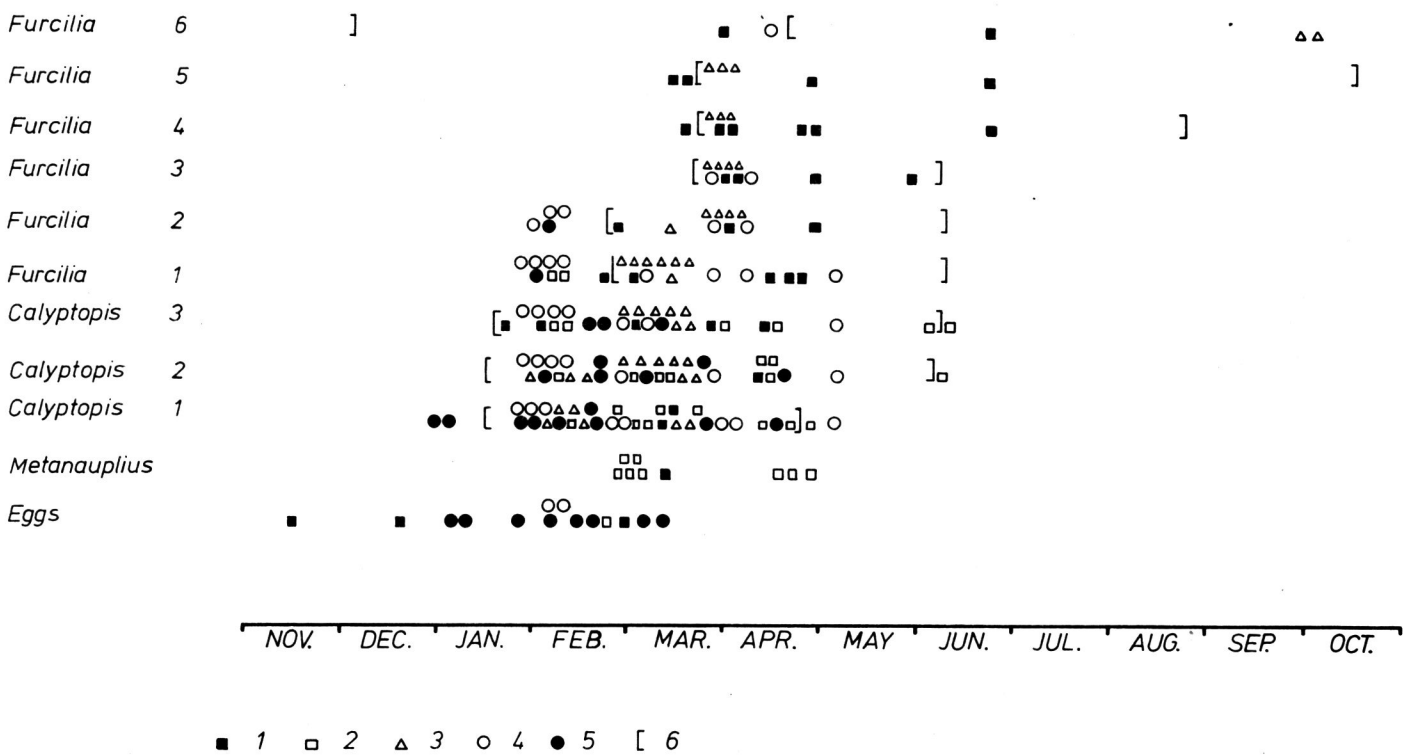


Fig. 5. The time of occurrence of larval stages of krill
1 — acc. to *Fraser* (1936), 2 — acc. to *Mackintosh* (1972), 3 — acc. to *Makarov* (1974), 4 — acc. to I. *Hempel* and G. *Hempel* (1972) and I. *Hempel*, G. *Hempel* and *Baker* (1979), 5 — own data, 6 — limits of the period of occurrence acc. to *Marr* (1962), further explanations in text

the year and place of study, were gathered from the own and literature data (Fig. 5). Only the observations of the presence of considerable numbers of individuals in particular stage were considered. The criterion of this numerous occurrence was for stages *metanauplius* to *furcilia* 2100 individuals in sample (for British and Russian data), 100 individuals in 1000 m^3 (for German data) or 100 individuals per 1 m^2 (for own data). For the stage of *furcilia* 3—20 individuals, for *furcilia* 4—15 individuals, for *furcilia* 5 and 6—10 individuals per sample, 1000 m^3 or 1 m^2, respectively, was assumed as the above criterion.

The earliest date of finding the eggs of *E. superba* in larger numbers is 16 November (Fig. 5). Although other observations are mainly from January and February, it should be considered that because of the weather and ice conditions an intense studies of Antarctic are carried out usually in period January — April. Only few expeditions covered an earlier period. The last date of finding a considerable amount of eggs is 10 March, but finding a large numbers of *metanauplii* up to 27 April (Fig. 5) dictates, according to the quoted above results of McWhinnie and Denys (1978) to shift the time limit of egg occurrence to more or less mid April.

The number of data on the occurrence time of *nauplii* and *metanauplii* is scarse because of the known fact of their occurrence on large depths (Marr 1962), studied very seldom.

Larger numbers of *calyptopis* 1 occurred from last days of December to first days of May (Fig. 5). Considerable numbers of *calyptopis* 2 were noted from mid January. However, a possible period of occurrence of this stage should be shifted to more or less beginning of this month, as older *calyptopis* 3 were found about 20 January, already. End of the period of the occurrence of this stadium is at the beginning of June (Fig. 5). *Calyptopis* 3 occurred from the second half of January tu June.

The presence of *furcilia* 1 stage was noted from end of January to 10 June (Fig. 5). The end of the possible period of occurrence of *furcilia* 1 and of 2 and 3 is difficult to establish as it is during the winter months, when a large part of the region of occurrence of *E. superba* is covered by ice, thus unaccessible for studies. Samples collected in period July — October in regions without ice contained the larvae, which, as it may be assumed, had better feeding conditions and surely quicker rate of growth. This could explain the fact that larvae younger than *furciliae* 4 were not found in winter. Sampling from under the ice would probably indicate the presence of younger *furcilia* stages, too.

The stages *furciliae* 2 were found frequently from early February till 10 June (Fig. 5). The occurrence of this stage could be expected also in winter, in an agreement with remarks on the occurrence of *furcilia* 1. *Furciliae* 3 were met since the end of March, but as *furciliae* 4 and 5 were met in the second decade of March, already, the period of *furciliae* 3 occurrence should be prolonged to more or less mid February. Their occurrence ends probably in winter months. The stages *furciliae* 4 were found in larger numbers from 20 March to August (Fig. 5), but because of slightly earlier findings of *furciliae* 5, the beginning of their occurrence should be the beginning of March. *Furciliae* 5 occurred from the second

half of March till mid October (Fig. 5). The earliest date of numerous appearance of *furcilia* 6 is 1 April, the latest — 3 December (Fig. 5).

An assembly of periods of occurrence of particular developmental stages allows to calculate three variants of assumed time from lying eggs to the development of particular stage (Table II). The first variant is based on calculating the rate of growth based on the first dates of the occurrence, the second one — on the dates in the middle of the occurrence period, the third — on the last dates of the occurrence. It is interesting that the gap between the values calculated from above variants grows with maturing of larvae (Table II). It seems that this is related with differences in the

Table II

Period of occurrence and the average age of larval stages of krill (*Euphausia superba*) (acc. to the own and literature data)

Stage	Period of occurrence			Time from breeding (days)		
	beginning	middle	end	*A***)	*B***)	*C***)
eggs	15. Nov.	1. Feb.	15. Apr.			
calyptopis 1	15. Dec.	1. Mar.	15. May	30	30	30
calyptopis 2	1. Jan.	20. Mar.	15. Jun.	45	50	60
calyptopis 3	15. Jan.	10. Apr.	30. Jun.	60	70	75
furcilia 1	25. Jan.	20. Apr.*)	15. Jul.*)	70	80*)	90*)
furcilia 2	1. Feb.	1. May*)	30. Jul.*)	75	90*)	105*)
furcilia 3	15. Feb.	15. May*)	15. Aug.*)	90	105*)	120*)
furcilia 4	1. Mar.	1. Jun.	30. Aug.	105	120	135
furcilia 5	15. Mar.	1. Jul.	15. Oct.	120	150	180
furcilia 6	1. Apr.	10. Aug.	15. Dec.	135	190	240

*) questionable data

**) According to: *A* — the first occurrence,
B — the middle date of occurrence,
C — the last date of occurrence.

growth rate dependent on the environmental conditions — mainly on the amount of food. In the case of stage *furcilia* 6 the difference between the results obtained by the first and the third variant is over 100 days (Table II).

The rate of body weight growth was determined on the basis of average length of particular larval stages of *E. superba* (Fraser 1936) and weights of these stages, calculated by geometric method for individuals with average length for each stage (Fig. 6). This rate equaled on the average from 0.015 mg × × day^{-1} for *calyptopis* to 0.07 mg·day^{-1} for *furciliae* (Fig. 6).

The time of krill breeding can be determined with certain approximation on the basis of the age structure of larval population and the dates of occurrence in particular years and regions, and applying the data from Table II. Such calculations were performed on the basis of the middle dates of the occurrence of particular stages (Fig. 7).

The breeding in season 1975/1976 in the region of Antarctic Peninsula and Bransfield Strait took place relatively early, from November to January, the most probably in December. In the region of South Georgia the breeding took place in the first forthight of March (Fig. 7).

The most intense breeding of krill in 1976/1977 took place in the region

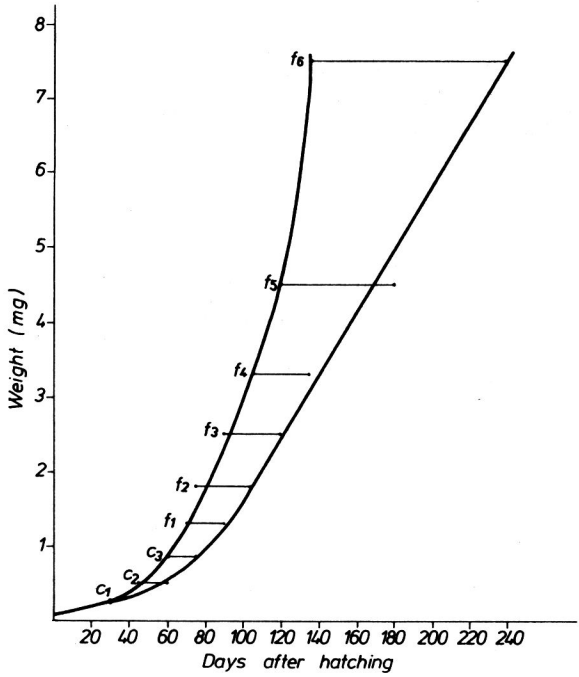


Fig. 6. The rate of growth of krill larvae calculated on the basis of the first and the last dates of their occurrence
c_{1-3} — *calyptopes* 1—3, f_{1-6} — *furciliae* 1—6

of Antarctic Peninsula in January and in the region of South Orkney in March (Fig. 7).

During 1977/1978 krill in the region of Knox Land bred in January, and in the region of Enderby Land in February. The breeding in the region of Bransfield Strait took place also in February, as it is confirmed by a large number of eggs found there (I. Hempel, G. Hempel and Baker 1979). The breeding in 1978/1979 was relatively poor and took place in January and February (Fig. 7).

Above described geographic distribution of krill eggs and larvae of *E. superba* is not different from the results of previous studies (Marr 1962, Makarov 1974). The obtained data on distribution of larvae should not be treated as a complete picture even for the extensively studied region of the western part of Atlantic sector of Antarctic, as our studied concentrated in selected regions of large occurrence of postlarval krill. The numerous occurrence of larvae in the open waters is confirmed by the results of German studies in Scotia Sea (I. Hempel and G. Hempel 1978).

An analysis of the geographic distribution of eggs and larvae of *E. superba* is a popular problem in literature dealing with krill biology. Different from the above problems, our calculations of the growth rate of larvae are one of the first. The differences in the rate of growth, found in this paper, increasing with the maturing of larvae, may halp to explain the size differentia-

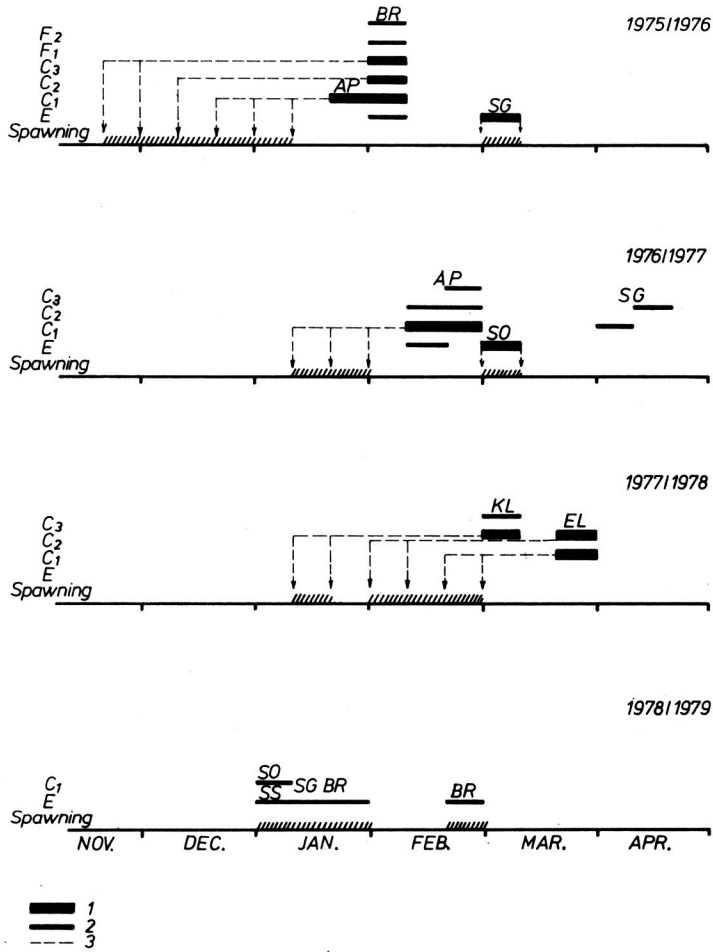


Fig. 7. The composition of larval populations and the time of krill breeding in particular years

1 — over 1000 ind·m^{-2}, 2 — 100—1000 ind·m^{-2}, 3 — time of breeding acc. to the middle dates of the stage occurrence (Table II) *AP* — Antarctic Peninsula, *BR* — Bransfield Strait, *EL* — Enderby Land, *KL* — Knox Land, *SG* — South Georgia, *SO* — South Orkney, *SS* — South Sandwich

tions of postlarval krill, observed frequently in various regions and at various time of the year (Jażdżewski et al. 1978, Wolnomiejski and Boberski, in press). The differences in the larval rate of growth, resulting from unequal period of their stay in unfavourable food conditions (e.g. under the ice) can result in such a differentiation of populations of a year old krill. An additional confirmation of this conclusion is a known existence of populations composed of especially small individuals in areas close to the ice cover and continental shore, where ice stays the longest time (Witek, unpublished data)[1]). Differentiation of the year old krill population can be

[1]) 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.

also an effect of earlier or later beginning of breeding by a parential generation.

Our determination of the time of krill breeding in particular seasons was possible thanks to the calculation of the rate of growth of larvae. It is possible that further systematic studies of the intensity and period of breeding in particular regions and years, related to the observations of environmental factors, would permit to prognosticate the size and abundance of postlarval krill in the next years.

4. Conclusions

1. The numerous appearance of eggs and larvae of *E. superba* was found in the Atlantic and Indian sectors of Antarctic in the contrary to the Pacific sector.

2. A tendency of larval stages to more numerous occurrence was found for the zones of deep shelf and continental slope.

3. The rate of growth of krill larvae was from 0.015 mg·day^{-1} for stage *calyptopis* to 0.07 mg·day^{-1} for *furcilia*. The time from the breeding to the development of the last larval stage equals from about 135 days to about 240 days.

4. The differences in the rate of growth of larvae are so large, that they can cause the frequently observed differentiations of the postlarval krill.

5. The proposed rate of growth allows to evaluate, on the basis of larval population analysis, the time of krill breeding in particular years.

6. The time of breeding can be considerably different in particular years and regions. In season of 1975/1976 the breeding took place exceptionally early — from November to January, in the remaining studied seasons it occurred from January to March.

We acknowledge the following coleagues: Dr. N. Wolnomiejski, M. Sc. H. Czykieta, Dr. J. Porębski, Dr. K. Chłapowski and Mr. S. Sołończyk, the members of Antarctic expeditions who took part in collecting the material for this paper, and Ms. E. Bielaszewska, who helped in the laboratory work.

5. Summary

The distribution and population age structure of *Euphausia superba* larvae were studied during the four austral summers (1976—1979) (Table I). The sampling covered the layer of 500—0 m. Krill eggs were found, very scarse *nauplii* and *metanauplii*, stages *calyptopis* 1—3 and *furcilia* 1—3 (Figs. 1—4). The eggs and larvae were found in Atlantic and Indian sectores of Antarctic. They concentrated especially in the regions of Antarctic Peninsula, eastern part of Bransfield Strait, South Orkney Islands, area of South Georgia and in the regions of Knox Land and Enderby Land (Figs. 1—4). These are the regions of deep shelf or continental slope. An approximate rate of growth of krill larvae (Figs. 5 and 6, Table II) was calculated on the basis of own and literature data on the occurrence of particular stages. This allowed to determine the time of krill breeding in particular years of studies (Fig. 7). The intense breeding in seasons of 1976/1977 and 1977/1978 took place from January to about mid March. It was much earlier in 1975/1976 — from mid November to mid January.

The breeding in 1978/1979 was very poor, at least till March (Fig. 7). The average rate of growth of krill larvae was from 0.015 mg·day^{-1} for *calyptopis* to 0.07 mg·day^{-1} for *furciliae*, and the time from breeding to the last larval stage equals 135 to about 240 days.

6. Резюме

Во время четырёх сезонов антарктического лета (1976—79) собрано материял по расположению и составу популяции личинок крыля *Euphausia superba* (таблица I). Планктонные неводы обнимали слой 500—0 м. Найдено фйца крыля, немногие науплюсы и метаноауплюсы, стадии *calyptopis* 1—3, а также стадии *furcilia* 1—6 (рис. 1—5). Яйца и личинки встречено в атлантическом и индейском секторе Антарктики. Места отдельных концентрации это: район Антарктического Полуострова, восточная часть Пролива Брансфильда, район Южных Оркадов, окрестности Южной Джорджи, район Кнокс Ланд и район Эндербы Ланд (рис. 1—4). Это были области глубокого шельфа или континентального склона. На основании собственных наблюдений, а также с использованием литературных данных о выступлении каждой стадии скалькулировано проблизительное темпо рости личинок крыля (рис. 5, таблица II и рис. 6). Это помогло наметить главный период размножения в отдельных наблюдательных годах (рис. 7). В сезонах 1976/77 и 1977/78 интенсивное размножение выступало около января до половины марта. В сезоне 1975/76 оно было более ранее и длилось от половины ноября до половины января. Размножение в сезоме 1978/79 по крайней мере до марта было слабое (рис. 7). Темп роста личинок крыля равнялся с 0,015 до 0,007 мг в сутки, а время расмножения с 135 до 240 дней.

7. Streszczenie

W trakcie czterech sezonów antarktycznego lata (1976—1979) zebrano materiał z zakresu rozmieszczenia i składu populacji larw kryla *Euphausia superba* (tabela I). Zaciągi planktonowe obejmowały warstwę 500—0 m. Znajdowano jaja kryla, bardzo nieliczne naupliusy i metanaupliusy, stadia *calyptopes* 1—3 oraz stadia *furcilia* 1—3 (rys. 1—4). Jaja i larwy spotykano w atlantyckim i indyjskim sektorach Antarktyki. Miejsca poszczególnych koncentracji to rejon Półwyspu Antarktycznego, wschodnia część Cieśniny Bransfielda, rejon Południowych Orkadów, okolice Południowej Georgii, rejon Knox Land i rejon Enderby Land (rys. 1—4). Były to obszary głębokiego szelfu bądź skłonu kontynentalnego. Na podstawie własnych obserwacji oraz przy wykorzystaniu dostępnych danych literaturowych o występowaniu każdego stadium, skalkulowano przybliżone tempo wzrostu larw kryla (rys. 5, tabela II i rys. 6). Pozwoliło to na wyznaczenie głównego okresu rozrodu kryla w poszczególnych latach badań (rys. 7). W sezonach 1976/1977 i 1977/1978 intensywny rozród miał miejsce od stycznia do około połowy marca. W sezonie 1975/1976 był on znacznie wcześniejszy i przypadał na okres od połowy listopada do połowy stycznia. Rozród w sezonie 1978/1979, przynajmniej do marca, był słaby (rys. 7). Tempo wzrostu larw kryla wynosiło od 0,015 dla stadiów *calyptopis* do 0,07 mg na dobę dla stadiów *furcilia*, a czas od rozrodu do ostatniego stadium larwalnego od około 135 do około 240 dni.

8. References

1. Bargmann H. E. 1945 — The development and life-history of adolescent and adult krill *Euphausia superba* — Discovery Rep., 23: 103—176.

2. Fraser F. C. 1936 — On the development and distribution of the young stages of krill (*Euphausia superba*) — Discovery Rep., 14: 1—192.
3. Hempel I., Hempel G. 1978 — Larval krill (*Euphausia superba*) in the plankton and neuston samples of the German Antarctic Expedition 1975/76 — Meeresforsch., 26: 206—216.
4. Hempel I., Hempel G., Baker A. de C. 1979 — Early life history stages of krill (*Euphausia superba*) in Bransfield Strait and Weddell Sea — Meeresforsch., 27: 267—281.
5. Jażdżewski K., Dzik J., Porębski J., Rakusa-Suszczewski S., Witek Z., Wolnomiejski N. 1978 — Biological and populational studies on krill near South Shetland Islands, Scotia Sea and South Georgia in the summer 1976 — Pol. Arch. Hydrobiol., 25: 607—631.
6. John D. D. 1936 — The southern species of the genus *Euphausia* — Discovery Rep., 14: 195—324.
7. Mackintosh N. A. 1972 — Life cycle of Antarctic krill in relation to ice and water conditions — Discovery Rep., 36: 1—94.
8. Makarov R. R. 1974 — Planktonnye ličinki *Euphausia superba* Dana v more Skotia — Trudy VNIRO, 99: 84—103.
9. Marr J. W. S. 1962 — The natural history and geography of the Antarctic krill (*Euphausia superba* Dana) — Discovery Rep., 32: 33—464.
10. Mauchline J. J., Fisher L. P. 1969 — The biology of euphausiids — Adv. Mar. Biol., 7: 1—454.
11. McWhinnie M. A., Denys C. 1978 — Biological studies of antarctic krill, austrial summer, 1977—78 — Antarct. J. US, 13: 133—135.
12. Wolnomiejski N., Boberski E. (in press) — Czynniki wpływające na ilościowy charakter występowania postlarwalnego kryla (*Euphausia superba* Dana) w atlantyckim sektorze Antarktyki — Pol. Polar Res.

Paper received 15 April 1980

AUTHORS' ADDRESSES:

Mgr Zbigniew Witek
Zakład Oceanografii,
Morskiego Instytutu Rybackiego
Al. Zjednoczenia 1,
81-345 Gdynia

Mgr Andrzej Koronkiewicz
Oddział w Świnoujściu
Morskiego Instytutu Rybackiego
Plac Słowiański 1,
72-600 Świnoujście

Dr Grzegorz Jan Soszka
Zakład Higieny Radiacyjnej,
Centralnego Laboratorium Ochrony Radiologicznej
Konwaliowa 7,
03-194 Warszawa, Poland