(Poland)

Supplement to SC-CAMLR-III/9
5 September, 1984

SUMMARY OF INFORMATION ON FISH AND KRILL DISTRIBUTION AND ABUNDANCE, PROVIDED FOR THE CCAMLR AD HOC WORKING GROUP BY POLAND

Abstract

Information on fish and krill distribution and abundance published recently in Poland is summarised. The locations of concentrations for Champsocephalus gunnari, Notothenia squamifrons, and (to some extent) N. rossii off Kerguelen are determined. The distribution of about 60 species on the South Georgia shelf and the Scotia area is investigated. For selected species, more detailed biological analyses are undertaken. The by-catch of juvenile fish in krill fishery is studied in particular during FIBEX. The existence of deep scattering layers in the Pacific sector is reported.

Hydroacoustic surveys have indicated areas of largest and most permanent krill concentrations. These areas include the region of the Weddell-Scotia Confluence where the krill biomass exceeds 1000 tonnes/sq. mile. A concept for the formation of krill concentrations is proposed. The classification of different krill aggregations is made. It is proposed that the observed negative correlation between krill and phytoplankton concentrations is likely to be caused by different abiotic factors and does not necessarily reflect a relationship between krill and phytoplankton. The biological analyses of krill have led to a conclusion that the life span of krill is longer than two years. Large variability in the intensity and time of spawning is found while the location of spawning areas remains more or less unchanged.

The overall surface density of krill biomass in Antarctica was estimated to be 100-400 million tons.

A review of the Polish fishery and assessment of fish stock biomass off South Georgia is published separately as SC-CAMLR-III/BG/11.

RESUME DE LA DOCUMENTATION SUR LA REPARTITION ET L'ABONDANCE DES POISSONS ET DU KRILL, PRESENTE PAR LA POLOGNE AU GROUPE DE TRAVAIL AD HOC DE LA CCAMLR

Résumé

La documentation sur la répartition et l'abondance des poissons et du krill récemment publiée en Pologne est résumée. Les lieux des concentrations de Champsocephalus gunnari, Notothenia squamifrons, et (dans une certaine mesure) N. rossii au large

des Îles Kerguelen sont déterminés. La répartition d'environ 60 espèces sur les plateaux de la Géorgie du Sud et dans la zone de Scotia est examinée. Des analyses biologiques plus détaillées sont entreprises sur des espèces sélectionnées. La prise accidentelle de jeunes poissons au cours des opérations de pêche portant sur le krill fait l'objet d'études, en particulier durant l'expérience FIBEX. L'existence de couches profondes dispersées dans le secteur du Pacifique est relevée.

Des études hydro-acoustiques ont indiqué les zones où les concentrations de krill sont les plus étendues et les plus stables. Ces zones comprennent la région du confluent Weddell-Scotia, où la biomasse de krill dépasse les 1000 tonnes/mille carré. Une opinion sur la formation des concentrations de krill est avancée. Les différents regroupements de krill sont classifiés. Il est suggéré que la corrélation négative qui peut être observée entre les concentrations de krill et de phytoplancton est probablement causée par divers facteurs abiotiques et ne reflète pas forcément un rapport entre le krill et le phytoplancton. Les analyses biologiques du krill ont conduit à la conclusion que la longévité du krill était supérieure à deux ans. Une grande variabilité de l'intensité et de la période de reproduction peut être observée alors que la position des zones de frai ne change pratiquement pas.

On a estimé que la densité totale de surface de la biomasse de krill en Antarctique se situait entre 100 et 400 millions de tonnes.

Un examen des opérations de pêche polonaises et une estimation de la biomasse des stocks de poissons au large de la Géorgie du Sud sont publiés séparément sous la référence SC-CAMLR-III/BG/11.

СВОДКА ИНФОРМАЦИИ О РАСПРЕДЕЛЕНИИ И КОЛИЧЕСТВЕ РЫБЫ И КРИЛЯ, ПРЕДОСТАВЛЕННАЯ AD HOC РАБОЧЕЙ ГРУППЕ АНТКОМ'а ПОЛЬШЕЙ

Резюме

Суммируется информация о распределении и количестве рыбы и криля, опубликованная Польшей в недалеком прошлом. Определяется местоположение концентраций Champsocephalus gunnari, Notothenia squamifrons и(в некоторой мере) N. rossii в районе Кергелена. Рассматривается распределение приблизительно 60-ти видов в районе шельфа Южной Георгии и моря Скотия. Проводится более подробный анализ данных по отдельным видам. Рассматривается побочный вылов молодняка рыбы при промысле криля, в частности в течение

проведения эксперимента ФИБЕКС. Отмечается существование глубоких слоев рассеивания в тихоокеанском секторе.

В результате проведения гидроакустических съемок было определено местоположение районов, содержащих наиболее крупные и постоянные скопления криля. В число этих районов входит конфлуенция Уэдделла-Скотия, где биомасса криля превышает 1000 тонн на кв. милю. Предлагается теория образования скоплений криля. Классифицируются различные скопления криля. Высказывается мнение о том, что наблюдаемая отрицательная корреляция между концентрациями криля и фитопланктона, вероятно, вызвана различными абиотическими факторами и не обязательно является показателем взаимосвязи криля с фитопланктоном. Биологический анализ криля показал, что его продолжительность жизни превышает два года. Обнаружены значительные изменения интенсивности и времени нереста, в то время как районы нереста относительно постоянны.

Общая поверхностная плотность биомассы криля в Антарктике составляет, по оценкам, 100-400 миллионов тонн.

Обзор промысловой деятельности Польши и оценка биомассы рыбных запасов в районе Южной Георгии опубликованы отдельно под номером SC-CAMLR-III /BG/11.

RESUMEN DE LA INFORMACION SOBRE LA DISTRIBUCION Y ABUNDANCIA DE PECES Y KRILL, PROPORCIONADA POR POLONIA AL GRUPO DE TRABAJO AD HOC DE CCAMLR

Resumen

Se resume la información sobre la distribución y abundancia de peces y krill publicada recientemente en Polonia. Se determina la ubicación de las concentraciones de Champsocephalus gunnari, Notothenia squamifrons y (hasta cierto punto) N. rossii frente a Kerguelen. Se estudia la distribución de cerca de 60 especies en la plataforma de Georgia del Sur y el área Scotia. Se llevan a cabo análisis biológicos más detallados con respecto a especies seleccionadas. Durante FIBEX se estudia la captura accidental de peces juveniles durante la pesca del krill. Se informa sobre la existencia de capas dispersas profundas en el Sector Pacífico.

Los estudios hidroacústicos han revelado las áreas con las más grandes y más permanentes concentraciones de krill. Estas áreas incluyen la región de la Confluencia Weddell-Scotia, donde la biomasa de krill excede las 1000 toneladas por milla cuadrada. Se da una opinión sobre la formación de las concentraciones de krill. Se presenta una clasificación de diferentes agregados de krill. Se indica que es posible que la correlación negativa observada entre las concentraciones de krill y fitoplancton posiblemente sea causada por diferentes factores abióticos y no necesariamente refleja una relación entre el krill y el fitoplancton. Los análisis biológicos de krill han conducido a la conclusión de que la duración de la vida del krill es más de dos años. Se halla una gran variabilidad en la intensidad y tiempo de desove, mientras que la ubicación de las áreas de desove permanece más o menos igual.

Se estimó que la densidad de superficie general de la biomasa de krill en la Antártida era de 100 a 400 millones de toneladas.

Se ha publicado separadamente una revisión de la pesca de Polonia y evaluación de la biomasa de las existencias de peces frente a Georgia del Sur como documento SC-CAMLR-III/BG/11.

SUMMARY OF INFORMATION ON FISH AND KRILL DISTRIBUTION AND ABUNDANCE PROVIDED FOR THE CCAMLR AD HOC DATA WORKING GROUP BY POLAND

1. FISH

The majority of results of Polish ichthyological and fishery investigations in the Antarctic has not yet been published ; they remain in the form of cruise reports, limited in the number of copies. However, some of these materials are now ready for print.

1.1. Spatial and Temporal Distribution of Populations of Major Fish Species

Examination of Antarctic ichthyofauna and its distribution as well as biological and commercial characteristics of major fish species were the objective of many Polish Antarctic expeditions. The results of our first investigations in the Subantarctic area are given by Slósarczyk and Wysokiński (1980). Among the 15 fish species observed off the Kerguelen Islands, five abundant species were the object of detailed ichthyological investigations. For three species - Champsocephalus gunnari, Notothenia squamifrons, and (to some extent) N. rossi - the area inhabited by their concentrations was determined.

Fishery observations on the South Georgia shelf made during the first Polish expedition to the Western Antarctic were presented in a paper by Linkowski and Rembiszewski (1978). Ten fish species were caught in bottom hauls. Ichthyological research concentrated on detailed biological investigations of selected species, including a detailed analysis of their food. Observations of ichthyofauna distribution on a wider scale were carried out in the Scotia Sea area in one of the later Polish expeditions by Skóra and Sosiński (1983). On the basis of 137 hauls with a bottom and pelagic trawl, they give locations of occurrence of about 60 fish species,

dividing the area of investigations into ten separate subareas. The distribution and characteristics of the Champsocephalus gunnari populations in the Southern Ocean is the subject of a separate paper by Sosiński (1981), a result of many years of investigations conducted by the author in the Antarctic. The occurrence of deep scattering layers (DSL) in the Pacific sector of the Antarctic, formed by the fish from the family Myctophidae (mainly Electrona carlsbergi is reported by Linkowski (1983)).

A separate division in Polish ichthyological investigations deals with observations of juvenile Antarctic ichthyofauna found in krill concentrations. The first report on the subject is found in a paper by Rembiszewski et al. (1978). They observed 27 species, mostly juvenile Channichthyidae, in krill catches made in the area from Anvers I. to the South Sandwich Is. Detailed investigations of the distribution and abundance of juvenile fish in krill concentrations in the West Antarctic were carried out during the FIBEX programme (Ślósarczyk and Rembiszewski, 1982, Ślósarczyk - in print; Kellermann and Ślósarczyk, 1984) and in the first stage of SIBEX (Ślósarczyk and Cielniaszek - forthcoming). During the FIBEX expedition, 37 fish species, including 23 species of juvenile and postlarval Notothenioidei, were observed in krill catches made in the Bransfield Strait, the southern part of the Drake Passage, and the north-western part of the Weddell Sea. The most abundant among them were Channichthydae (Chionodraco rastrospinosus and Chaenodraco wilsoni). The distribution and abundance of fish were related to the distribution and movement of water masses. In krill catches made on the South Georgia fishing grounds, only six species of juvenile fish were noted but the abundance of three of them (Patagonotothen larseni, Champsocephalus gunnari, and Chaenocephalus aceratus) exceeded manifold the abundance observed off the Antarctic Peninsula. Equally high abundance of juvenile fish in krill concentrations was observed off the Balleny Is. in the Eastern Antarctic (Ślósarczyk 1983). In the opinion of the authors the intensive krill fishery may have a negative impact on the size of recruitment to adult fish stocks.

1.2. and 1.3. Spatial and Temporal Patterns of Fishing Over the Past Years. Studies of methods and data employed for assessment of the state of fish stocks

Both these subjects are discussed to some extent in the paper by Słósarczyk, Sosiński Mucha and Skóra (forthcoming) : "A review of Polish fishery and assessment of fish stocks biomass off South Georgia". This work sums up the results of our catches in this area in 1976-1982 and presents the assessment of major fish stocks by the "swept area" method. On the South Georgia fishing grounds, the Polish fishing fleet caught about 80,000 tons of fish and krill within that period. The size of catches fluctuated from 5,900 to 24,500 tons, depending on the size of fishing effort. Fishing operations were conducted by five to ten factory trawlers throughout the whole year, with 2-3-month long intervals, usually during the Antarctic winter. The catches consisted usually of five fish species : Champsocephalus gunnari, Chaenocephalus aceratus, Pseudochaenichthys georgianus, Notothenia gibberifrons, and N.rossi marmorata. The biomass estimate was based on materials collected by observers, directed by the Institute to fishing vessels throughout the whole period of exploitation of the South Georgia fishing grounds. Stock assessment refers to the near-bottom layer of a part of the island's shelf area. In the last two seasons considered, in the 50 to 500 m depth layer, the biomass of exploited stock of major commercial fish species was estimated at about 100-170,000 tons.

The result of long-term ichthyological investigations on the fishing grounds of the South Shetland Is. and South Orkney Is. will be published at a later date.

2. KRILL *

2.1. Spatial and Temporal Distribution of Krill Concentrations

The results of hydroacoustic investigations carried out in subsequent years on "R.V. PROFESSOR SIEDLECKI" enabled the determination of the areas of the largest and most often recurring krill concentrations. In the Western Antarctic, this means an area called the Weddell-Scotia Confluence, covering the waters of King George I., Elephant I., South Orkney Is., and South Georgia as well as situated more to the west waters of the Palmer Archipelago and the western shelf of the Antarctic Peninsula. At these locations, the biomass of krill sometimes exceeded 1,000 t/NM^2. A comparison of geostrophic currents with krill distribution and its patch size resulted in a concept of a mechanism of krill concentration formation. According to it, concentrations are formed in the areas of meanders and current eddies, which carry krill. The behavioural features of these organisms - their reactions to the turbulent flow of water and the shoal-forming instinct - cause krill to arrest their drift and make gatherings in these areas, despite the continuous exchange of water (Witek, Grelowski and Kalinowski 1982, Kalinowski and Witek 1984a).

A classification of different krill aggregations was made ; they range from concentrations - aggregations on a geographical scale, down to patches - aggregations on a local scale caused by, for example, instinct (shoals, swarms, schools). Measurements of patches recorded on hydroacoustic equipment enabled the determination of the distribution of density probability of the main patch parameter (length, density, number of krill in a patch) as well as krill behaviour in a 24-hour cycle.

In coastal areas, especially in concentration areas, krill concentrations turned out to be larger, denser, and contained more krill than those in the open waters. Changes in the 24-hour cycle included the

---

* Summary does not include results of Polish research on krill during SIBEX 1983/84 (draft paper dealing with it will be submitted to the III Meeting of SC-CAMLR).

loosening or even scattering of patches at night and vertical migrations leading krill closer to the surface at night. Besides light, these changes seemed to have been influenced by the amount and distribution of seston - krill's food (Kalinowski and Witek, 1980, 1982, 1984a).

In the vegetation season, the main component of seston are algae so special attention was paid to the relationships between the occurrence of phytoplankton and krill. In the light of these investigations, it seems that the often observed negative correlation between krill and net phytoplankton abundance over extensive areas is not a simple result of krill feeding. Large krill concentrations and small numbers of phytoplankton in some areas are rather an independent result of certain abiotic processes, e.g., hydrological processes. However, extensive eating of phytoplankton by krill or other filtrating organisms may take place on a microscale in local conditions (Witek, Pastuszak, Grelowski 1982).

Biological analyses were made on krill taken with a pelagic trawl or Bongo net ; they covered length and weight measurement, the determination of sex, gonads' maturity and the degree of alimentary tract filling. These investigations enabled the observation of several features of the spatial and temporal distribution of krill of various size and maturity as well as their diurnal feeding cycle. They led to a conclusion that krill life cycle is longer than two years, emphasizing large changeability of krill population structure in the same periods of different years. The investigations allowed also for an elaboration of criteria of estimating krill as raw material for processing (Jazdzewski et al. 1978, Wolnomiejski et al. 1980, Witek 1979, 1981, Witek et al. 1981, Wolnomiejski et al. 1982).

On the basis of krill eggs and larvae collected with plankton nets the intensity and time (location of spawning) of krill in individual years were determined. Large changeability in the intensity and time of spawning was observed while its location remained more or less unchanged (Witek, Koronkiewicz, and Soszka 1980).

2.2. Fishing Patterns

Since so far Poland has not begun commercial exploitation of krill, fishery-type investigations on krill have not been conducted.

2.3. Studies of Methods, Data Employed and Assessment of Krill Stocks

On the basis of the measurement of acoustic parameters of krill and echo sounding (with the use of an echointegrator), the surface density of krill biomass was determined ; it became the basis for stock assessment in the investigated area and in the whole of the Antarctic in 1979.

According to this estimate, the size of krill stocks in the whole of the Antarctic is contained within the interval 100-400 million tons. Such range was later confirmed by the investigations carried out under the FIBEX programme (Kalinowski, Kilian, Dyka 1980, Kalinowski and Witek 1981, 1984a and b).

Wiesław Ślósarczyk
Zbigniew Witek
Janusz Kalinowski

Sea Fisheries Institute
Gdynia, Poland

REFERENCES

1. EVERSON, I., 1980 - Areas of seabed within selected depth ranges in the South-West Atlantic and Antarctic Peninsula regions of the Southern Ocean - Life Sciences Division, BAS, Cambridge (mimeo).

2. JAZDZEWSKI, K., DZIK, J., POREBSKI, 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(3):607-631.

3. KALINOWSKI, J., DYKA, A., KILIAN, L., 1980 - Target strength of krill -- Pol. Polar Res. 1(4):147-153.

4. KALINOWSKI, J., WITEK, Z., 1980 - Diurnal vertical distribution of krill aggregations in the Western Antarctic -- Pol. Polar Res. 1(4):127-146.

5. KALINOWSKI, J., WITEK, Z., 1981 - The physical parameters of krill aggregations in the Western Antarcic -- ICES Symp. C.M. 1981/L:19 (mimeo).

6. KALINOWSKI, J., WITEK, Z., 1982 - Forms of Antarctic krill aggregations -- ICES Symp. C.M. 1982/L:60. (mimeo).

7. KALINOWSKI, J., WITEK, Z., 1984a - Elements of biology, forms of group occurrence, and stocks of krill Euphausia superba Dana - Ph.D.thesis (in Polish), Studia i Materiały MIR, B, 52, 150 pp.

8. KALINOWSKI, J., WITEK, Z., 1984b - An attempt at an estimation of the stocks of Antarctic krill Euphausia superba Dana -- Biuletyn MIR, 5(6), 33-36.

9. KELLERMANN, A., Słósarczyk, W., 1984 - Joint report on the distribution of postlarval and juvenile Notothenioidei in the Atlantic sector of the Southern Ocean during FIBEX 1981 - BIOMASS Res. Ser., 36.

10. LINKOWSKI, T.B., 1983 - Electrona carlsbergi (Taning, 1932), the principal component of a deep scattering layer in the Pacific sector of the Antarctic Ocean -- Pol. Polar Res. 4(1-4):71-78.

11. LINKOWSKI, T.B., REMBISZEWSKI, J.M., 1978 - Ichthyological observations off the South Georgia coasts. - Pol. Arch. Hydrobiol., 3, 697-704.

12. REMBISZEWSKI, J.M., KRZEPTOWSKI, M., LINKOWSKI, T.B., - Fishes (Pisces) as by-catch in fisheries of krill Euphausia superba Dana (Euphausiacea, Crustacea) - Pol. Arch. Hydrobiol., 3:677-695.

13. SKORA, K.E., SOSINSKI, J.,1983 - Observations on the ichthyofauna distribution in the regions of the Scotia Sea and Antarctic Peninsula -- Pol. Polar Res., 4(1-4):49-55.

14. SOSINSKI, J., 1981 - Biologia porównawcza kergulen (Champsocephalus gunnari, Lönnberg 1905) z róznych rejonów Antarktyki - Studia i Materiały Mor.Inst.Ryb., ser B. (48):1-91.

15. SOSINSKI, J., MUCHA, M., SKORA, K., SLOSARCZYK, W., 1984 - A review of Polish fishery and assessment of fish stocks off South Georgia (in Polish) -- Biuletyn MIR (in press).

16. SLOSARCZYK, W., 1983 - Juvenile Trematomus bernacchii and Pagothenia brachysoma (Pisces, Nototheniidae) within krill concentrations off Balleny Islands (Antarctic) -- Pol. Polar Res., 4(1-4):57-69.

17. SLOSARCZYK, W., (in print) - Preliminary estimation of abundance of juvenile Nototheniidae and Chanichthyidae within krill swarms east of South Georgia -- Acta Ichthyol. et Piscat. (in print).

18. SLOSARCZYK, W., REMBISZEWSKI, J.M., 1982 - The occurrence of juvenile Notothenioidei (Pisces) within krill concentrations in the region of the Bransfield Strait and the southern Drake Passage -- Pol. Polar Res., 3 (3-4):299-312.

19. SLOSARCZYK, W., WYSOKINSKI, A., 1980 - Ichthyological and fishery studies of the shelf fishing grounds in the region of Kerguelen Islands (Antarctic) -- Pol. Polar Res., 1(4):173-190.

20. SLOSARCZYK, W., CIELNIASZEK, Z., (in prep.) - Studies on juvenile Notothenioidei (Pisces) in the southern Drake Passage and the Bransfield Strait in 1983/1984 during BIOMASS - SIBEX programme -- Pol. Polar Res. (in prep.).

21. WITEK, Z., 1979 - Phytoplankton distribution and some aspects of the biology of Antarctic krill Euphausia superba Dana -- ICES Symp. C.M. 1979/L:14 (mimeo).

22. WITEK, Z., 1981 - On the life cycle of Antarctic krill Euphausia superba Dana -- ICES Symp. C.M. 1981/L:20 (mimeo).

23. WITEK, Z., GRELOWSKI, A., KALINOWSKI, J., 1982 - Formation of Antarctic krill concentrations in relation to hydrodynamic processes and social behaviour -- ICES Symp. C.M./L:59 (mimeo).

24. WITEK, Z., KALINOWSKI, J., GRELOWSKI, A., WOLNOMIEJSKI, N., 1981 - Studies of aggregations of krill (Euphausia superba) - Meeresforsch. 28(4):228-243.

25. WITEK, Z., KORONKIEWICZ, A., SOSZKA, J.G., 1980 - Certain aspects of the early life history of krill Euphausia superba Dana (Crustacea) -- Pol. Polar Res., 1(4):97-115.

26. WITEK, Z., PASTUSZAK, M., GRELOWSKI, A., 1982 - Net-phytoplankton abundance in western Antarctic and its relation to environmental conditions -- Meeresforsch. 29(3):166-180.

27. WOLNOMIEJSKI, N., CZYKIETA, H., STEPNIK, R., JACKOWSKA, H., 1982 - Biological characteristics of Euphausia superba Dana in the southern Drake Passage and the Bransfield Strait in February-March, 1981 (BIOMASS-FIBEX) -- Pol. Polar Res. 3(3-4):259-271.

28. WOLNOMIEJSKI, N., WITEK, Z., CZYKIETA, H., 1980 - Metody i kryteria biologicznej oceny przemysłowych skupien kryla antarktycznego -- Studia Materiały MIR, A(25):27-63.