GEOGRAPHICAL DISTRIBUTION OF THE ANTARCTIC KRILL, *Euphausia superba* DANA, AND ITS ENVIRONMENTAL STRUCTURE (EXTENDED ABSTRACT)

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The purpose of this report is to briefly discuss the implications of certain conclusions from the viewpoints of the regional and whole scale geographical distribution of the Antarctic krill, *Euphausia superba* DANA, and its environmental structure in the summer season.

1. Regional Scale

The data of this study are based on the results of the KAIYO MARU observations, which were carried out in the region encircled by 61°–66°S and 100°–120°E from January through February 1980, and the region encircled by 61°–68°S and 30°–85°E from December 1980 through February 1981 in the Antarctic Ocean. Both observations were carried out as part of the international BIOMASS program. The observations carried out were largely biological sampling for *E. superba*, and were associated with physical and chemical environment observations. Besides, the data from the latter cruise included acoustic observations using the Scientific Echo Sounder.

In order to find out the relation between the geographical distribution of the krill and its environment, the quantity of the krill sampled by nets and the scattering strength received by the Scientific Echo Sounder were compared with the integrated value of water temperatures from the surface to 200 m in depth Z,

$$\bar{Q}_{200} = 1/200 \int_0^{200} (\text{temperature})\, dz.$$

The reasons why $\bar{Q}_{200}$ is selected are as follows.

1) Water temperature is generally regarded as one of the most important environmental factors for living organisms.

2) The integrated temperatures are mostly regarded as among the best vertical environmental indicators of the vertical distribution of the krill, because the vertical distribution of the krill concentrates between the surface and 50 m, and decreases with increasing depth untill about 200 m.

3) It is useful as an index of oceanographic structure in the upper layer.

Figure 1 shows the results. The area of the higher concentration of the krill coincides largely with the area of low observed values of the temperature index $\bar{Q}_{200}$ chiefly falling in the range from 0°C to −1.5°C in the southern part of the Antarctic

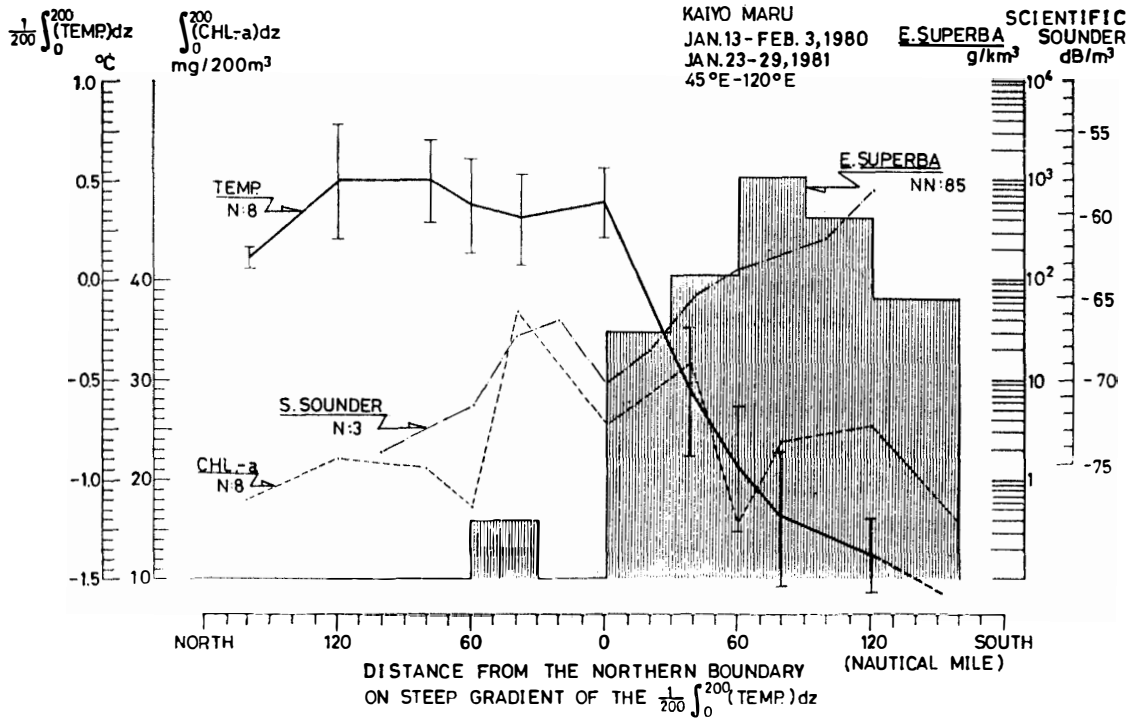

Fig. 1. Mean of $1/200 \int_0^{200}$ *(temperature) dz, the back scattering strength per unit between 10* m *and 100* m *by Scientific Echo Sounder,* $\int_0^{200}$ *(chlorophyll-a) dz and the catch per unit effort of E. superba corresponded to distance from the northern boundary on steep gradient of* $1/200 \int_0^{200}$ *(temp.) dz along the longitude. Vertical lines on the temperature line show standard deviations. N: Number of observation lines used. NN: Number of samples.*

Divergence zone, and with the areas to the south from 45°E to 120°E which have been examined from January to February, when the pack ice line is located in the southernmost part in all seasons. The result of the Scientific Echo Sounder survey also supports the higher concentrated areas of the krill.

On the other hand, the areas of the higher concentration of the krill are recognized in the above or northern part of the Antarctic Divergence zone in December, when the pack ice is not melted and still exists offshore. The areas of the distribution in December are almost all located under about 0°C same as the case in January and February. This geographical difference of the higher concentration of the krill in December and January–February indicates a possibility of the krill's migration from the north to the south with the melting of the pack ice. Although no definite proof of the migration is available, this hypothesis is supported by the fact that the krill fishing grounds move to the south as the pack ice melts.

2. Whole Scale

The result based on the analysis of the temperature index $\overline{Q}_{200}$ associated with the distribution of high densities of the krill in the region from 45°E to 120°E in Janu-

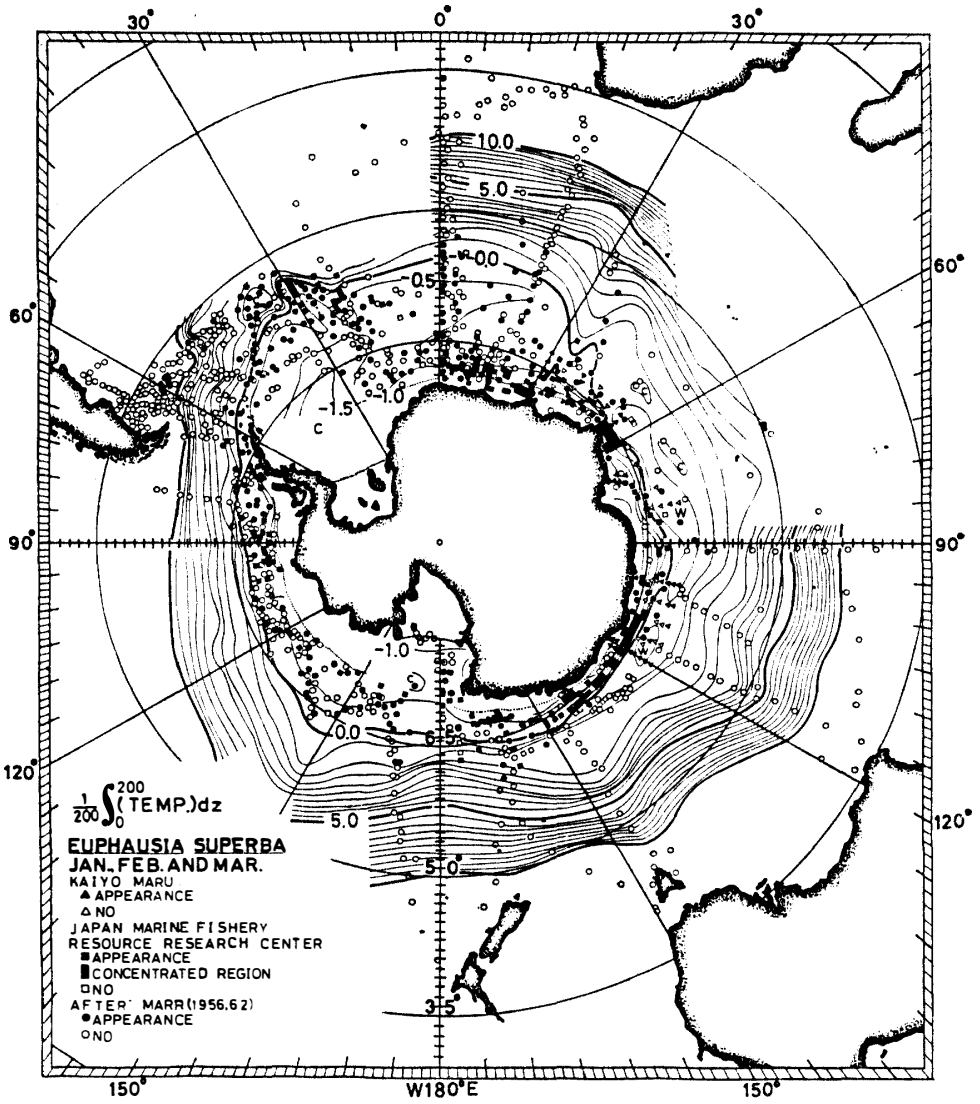

Fig. 2. Distribution of E. superba in January, February and March and the temperature index $1/200 \int_0^{200}$ *(temp.) dz.*

ary and February is extrapolated to the whole Antarctic Ocean in January, February and March (Fig. 2).

The data for the macrodistribution of the krill are based on the results of MARR (Discovery Rep., **32**, 37, 1962), who arranged the results of the Discovery Committee's observations, on the results of the Japan Marine Fishery Resource Research Center (1972–1980) and on the results of the KAIYO MARU (1980, 1981).

The data for environmental factors are the observations collected from 1925 through 1981 by the following research vessels; the DISCOVERY, the W. SCORESBY, the ELTANIN, the OB, the FUJI, the UMITAKA MARU, the HAKUHO MARU, the KAIYO MARU, the KUROSHIO MARU and others.

The areas of high krill density distribution roughly coincides with the colder region below 0°C except in a few cases. The higher concentration of the krill from longitude 0° to 150°E coincides with the area showing the remarkable horizontal

temperature gradient from 0°C to below −1.0°C. The map indicates the upwelling zone of the Warm Deep Water between 40°E and 120°E. The upwelling zone, however, is not recognized distinctly from 70°W to 150°W. In the vicinity of the Ross Sea, the distribution of the krill stands out as in the offing of the region below 0°C. In the Weddell Sea the region below 0°C stands out until about 55°S, and the distribution of the krill also stands out there. The krill are distributed in the warmer region above 0°C surrounding the South Sandwich Islands and South Georgia Island in the vicinity of 30°W and 55°S. It is considered that the modes of the distribution are the regional peculiarity of island region under the influence of the Weddell Drift current.

Further examination of the relation between the distribution of the krill and the temperature index $\bar{Q}_{200}$ from a viewpoint of the physical environment should reveal the whole area of distribution of the krill. The present results, if valid, may supplement the estimation of the stock biomass of the krill by the Scientific Echo Sounder, because the Sounder alone is unable to distinguish the species of fish reflected and therefore it is difficult to clarify the area of the distribution of the krill by the Sounder only.

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