Krill. Nemoto
superseded McWhinnie

Introduction

The decrease of marine living resources in the world ocean has brought on the idea to take the un-exploited living resources especially of zooplankton and micronekton in the sea. Among them, the Antarctic krill (Euphausia superba) attracts enthusiastic attention and the heavy decline of baleen whale stocks also enforces the thought that there may be the abundant surplus which is left from the fed up by decreased whales. The pilot-scale commercial fisheries have been already operated by Japan and U.S.S.R.. The annual catch apparently amounts already over some thousand tons.

The biological data of the Antarctic krill has been greatly accumulated by many countries and organizations (Discovery Investigation of United Kingdom, Norway, U.S.S.R, Japan, etc.). However, the research on population studies and biological characteristics on large swarms of krill which will be available for possible commercial fishing are still in the early stage of the progress.

The present objects of study, including long and short term ones, will be concentrate to fundamental biology of krill again and the interaction with other living organisms of the Antarctic ecosystem. Especially the quantitative aspects of krill in the comparatively short food chain or simple trophic relationships in the Antarctic should be clarified.

Objectives

As it is well known, the Antarctic krill (mostly of Euphausia superba) directly depend on the primary production in the Antarctic. On the other hand, krill is the only available food for higher trophic levels of animals such as baleen whales, crabeater-seals, squids, and fish in the Antarctic. Birds are also one of main predators in the Antarctic. The qualitative and quantitative analysis of food chains around this krill should be established, as one of the basic study to utilize living resources in the Antarctic.

The pilot-scale fisheries exploitation of the Antarctic krill has been operated for these several years (by fleets of Japan and U.S.S.R.). Some initial trials started in the early 1960's. Other countries also have been interested in fishing operation, and they may operate in the Antarctic in coming season.

The amount of catch is still low, say about several thousands in ton, in recent operation. However, the fishing and semi-commercial fishing operation also concentrate into certain areas where heavy occurrences of krill swarms have been observed. This possibly greatly affects the local ecosystem, especially of predators of krill as the catch is concentrated to the large sized groups of E. superba. Although rough estimates of sustainable catch have been discussed only from the surplus from the decreased organisms such as whales, the catch of krill apparently some effects to the ecosystem of the Antarctic.

Many biological parameters, which are very important for the estimate of population stocks, should be obtained to clarify this subject, especially from those heavy swarms of krill.

The consideration should be done for the establishment of the scientific frame works of the rational utilization and management of krill stocks. This work is, of course, supported by diversed studies on the whole Antarctic ecosystem in which krill play the role. One of the basic idea is that, considering standing crops and productivities, we should gather the harvest of each trophic level and make the sum of total harvests a maximum for human utilization. Even in the final stages of exploitation of the Antarctic krill, the catch should be stand on the balance of the Antarctic ecosystem where all predators survive on the rest of the fisheries.

Proposal of studies on ecology and population dynamics of krill

1. It is very urgent to obtain precise biological parameters, which are very important for the population dynamics of krill, with respect to

- Characteristics of mature/adult animals, size, (size range), weight/volume, sex ratios, spermatophore load,
- Characteristics of adolescents, size, weight/volume, correlations with gonadal development, duration of this phase, mortality rates (all especially in winter season),
- Larval types, sequence, longevity (calendar age) and variation, mortality rate,
- Fecundity, spawning place and depth, hatching rate.

Special attention should be paid to the change and variation of biological parameters of krill after the extensive fisheries operation.

2. It is important to estimate standing stocks in each locality. The rapid scanning by acoustic survey may be the most promissing at present. Correlation should be developed between sonic scattering layers and bona fide analyses of krill and plankton populations responsible for these layers. Degital biomass counter for krill using sonic reverberation, which is already used for commercial fish, should be invented. Data permitting estimates on the potential krill harvest must be developed also not only from such surface studies but from other new methods also, satellite imagery or scanning of multi-colour photography from air-craft for examples. The trial for marking of krill may be interesting to study the population stock size as well as identification of local populations.

3. Population characteristics of krill should be studied in major water masses, especially in relation to the West Wind Drift and the East Wind Drift. These identification of population may be studied by examination of different growth rates, enzymatic analyses (gene based isozymic patterns), morphological assessment and cytological analyses.

Characteristics of krill population in swarms such as age classes, homogeneity, sex ratio, condition of maturity, mating, etc. must be defined. This examination should be done for natural swarms of various sizes and swarms resulting from artificial induction (illumination, electrical discharges, etc.).

4. Factors and forces which induce natural swarming and concentration of swarms in the certain area must be elucidated though this aspect of E. superba biology has its highest priority primarily from the point of commercial harvesting. Correlations of larval and adolescent distribution with temperature, e.g. sampling particular depth horizons through which finely resolved thermal profiles should be concurrently taken. Thus the distribution of heavy swarms (available for fishing) should be examined in relation to vertical and horizontal structure of physical and chemical environments. The clear (or non-clear) correlation between the krill swarms and primary producers (mainly diatoms phytoplankton) should be re-examined.

Based on existing data and researches under operation, geographic and temporal variation in population and concentration of krill should be verified, detailed and correlated with hydrographic and meteorological features according to years and seasons, etc.

5. Because of the near-shore occurrence of this species, as well as its oceanic distribution, it is recommended further that shore-based studies be initiated at feasible coastal stations.

The experimental studies in the laboratory condition or larger plant also should be operated in the well equiped land or ship laboratories. Many interesting biological informations of krill (e.g. moulting, physiological characteristics) may be obtained through the rearing and maintenance of krill in these studies. Some important physiological and ecological parameters (feeding, moulting frequency and growth increment) are also determined thus in the laboratory. Perhaps laboratory maintenance for longtime may reveal more precise consideration on krill behaviour.

6. It is essential that studies be conducted throughout all seasons within the pack-ice zone, at its edge and under the shelf ice. The studies should be conducted both in the ship survey and in coastal stations. One of the important item to clear is the show growth rate of krill in the winter season. The primary production study throughout the year is also very important and the variation of the abundance in particulate matter concentration which are utilized by krill as food should be examined.

7. To realize the whole Antarctic ecosystem, correlative biotic characteristics (phytoplankton populations, organic particulate matters, consumer populations such as baleen whales, seals, birds, fish and squids) should be examined to determine the quantitative prey-predator relationship.

It is urgent to get precise information about the

quantitative aspects of each trophic levels of organisms in the Antarctic where the food chain is possibly the shortest. It is important to establish a quantitative model of trophic relationship of whole Antarctic organisms in which krill plays the role as the key species of second producer.

8. It is recommended that a multi-nation and multi-ship research program be developed to provide a strong scientific inventry and synthesis upon which reasonable krill harvesting can be based.

We feel it is essential to study in international coordination and cooperation both on board research ships and in the SCAR institutions, as proposed at Montreal meeting namely International Biological Expedition of the Southern Ocean.

Consequent to existing and immient efforts to harvest and study krill, it is further desirable that information-flow keep pace with development of a krill-fisheries and studies. It is hoped international scientific group organization will take the initiative to organize experts and materials on krill and krill fisheries, and exchange the information and statistics. These information includes at least, important biological parameter catch statistics of krill which are important for population dynamics in standardized forms. This organization should also treat the information of scientific operations in the Antarctic by each nation.

During the course of comprehensive studies, international conferences seem essential to achieve the highest yield from the large research effort and cost which these recommendations portend.