KRILL RESOURCES

8.1 The representative of SCAR reported that the BIOMASS resource review on krill, being prepared by Dr Hampton (South Africa), in conjunction with Dr Nemoto (Japan) and which makes use of an earlier publication by Dr Lubimova and other USSR authors, was not yet complete. A preliminary draft version of part of the review dealing with acoustic estimation of krill and krill abundance was however available (SC-CAMLR-III/INF.14) and this formed the basis for subsequent discussions.

8.2 It was recognised that several topics requiring research activities would be identified during the course of the meeting and that these would benefit from discussion and clarification before being put to the Scientific Committee.

8.3 Dr Beddington (UK) was therefore invited to convene an *Ad Hoc* Working Group on Krill Research Priorities for the duration of this meeting. The conclusions of that group have been incorporated into the relevant sections of the report.

Krill Distribution

8.4 The circumpolar nature of the krill distribution, determined by 'Discovery' investigations has been confirmed by modern expeditions, particularly from USSR and Japan.

8.5 Evidence from physical oceanography in conjunction with the discontinuous nature of the krill distribution indicated the probability that several stocks may exist. Although this hypothesis had not been confirmed by electrophoresis, possibly because the transfer of individuals from one stock to another would mask any differences, it was felt that the hypothesis would be reasonable for management purposes.

8.6 Considerable discussion focussed on the recently observed low krill abundance in the Scotia Sea, particularly in the vicinity of Elephant Island and South Georgia. It was noted that this was not the first time such an event had occurred. Scientists from USSR reported that the 1969 season as South Georgia had been characterised by a paucity of krill while several nations, notably FRG, Poland, USSR and UK, had noted a similar situation in 1977/78. The situation during the 1983 winter, reported by UK, was of low krill abundance at South Georgia, across the Scotia Sea and in the vicinity of Elephant Island. This situation had continued through to the 1983/84 summer and had been observed by scientists from FRG, Poland (SC-CAMLR-III/BG/10), USA and USSR. Also mortality rates amongst krill-eating

birds and seals at South Georgia were very high. Although oceanographic data have not been fully worked up, the available evidence indicated that the phenomenon was coincident with a southward shift of the secondary polar front, a hypothesis supported by the presence of krill concentrations in the South Orkney and South Sandwich Islands areas. Changes in the distribution of krill were evident but this did not necessarily mean that there had been a significant change in total krill abundance.

8.7 It was questioned whether the observed low abundance might be due to poor recruitment. Bearing in mind that the lifespan of krill is now thought to be seven years, this was thought highly unlikely. The Committee felt that all the evidence indicated that the cause was a natural variation in water circulation and was not the result of fishing.

8.8 The krill distribution in Prydz Bay, a region that had been studied during FIBEX and subsequent seasons by scientists from Australia, France, Japan, South Africa and USSR, had changed. Whereas initially the krill were concentrated within the bay, during the last season the main concentrations had been somewhat to the north.

8.9 The question was raised as to whether the Scotia Sea phenomenon might be present at Prydz Bay during a subsequent season and it was suggested that the monitoring during FIBEX and SIBEX be continued for a few seasons to see if this was the case.

8.10 Scientific Committee noted that SIBEX will be completed in April, 1985. Bearing in mind the importance of FIBEX and SIBEX to gaining a better understanding of ecosystem processes the Secretariat was asked to obtain a report on SIBEX results at least in preliminary form prior to the next meeting.

8.11 During a recent meeting of SCOR WG74, 'General Circulation of the Southern Ocean', held in conjunction with a meeting of IOC experts on oceanography in relation to the Antarctic marine ecosystems (Kiel, May 1984), it was discussed whether and to what extent ocean variability could have caused a different distribution and/or behaviour of krill. Further consultations led to the development of a plan for a 'Scientific Seminar on Antarctic Ocean Variability and its Influence on Marine Living Resources, Particularly Krill', to be sponsored possibly by CCAMLR, FAO and IOC in cooperation with SCAR/ SCOR/ACMRR/IABO and to be held presumably in 1986 (see also paragraph 10.10).

8.12 Acoustic methods of estimating krill abundance described in SC-CAMLR-III/INF.14 were discussed. The need for a rigorous survey design was noted. Sources of error in the estimates were discussed. These are summarised below:

- instrument calibration;
- uncertainty over Target Strength (TS) to size relationship;
- bias due to krill being outside the range of echosounders;
- bias caused by very dispersed krill going undetected.

The importance of intercalibration between ships was noted. Data should be stored as Mean Volume Backscattering Strength (MVBS) to facilitate updating biomass estimates in the light of better TS data. It was emphasised that net hauls should form an integral part of any acoustic survey by:

- confirming that echosounder data do relate to krill;
- providing size frequency distribution so as to use the most appropriate TS;
- estimating abundance of dispersed krill.

The importance of further studies on swarming was noted.

8.13 The *Ad Hoc* Group on Krill Research Priorities noted that a key factor in estimating krill abundance using hydroacoustic techniques is accurate information on the relationships between Target Strength and size and physiological state of krill, their orientation in the sound field and the operating frequency of the echosounder. It was recommended that consideration be given to undertaking experimental studies to investigate the points raised above.

Krill Growth

8.14 The *Ad Hoc* Group on Krill Research Priorities had noted that considerable progress has been made in estimating krill growth. It noted that analyses of size frequency distribution from commercial catches provided results in line with growth estimates by other methods. The lipofuscin technique was proving very useful, although currently the analytical procedures are not sufficiently fast for the processing of large samples. Some progress has been made in relating age as determined by lipofuscin analysis to morphometric measurements, which could alleviate this problem. The Group recommended that the following key areas for study be considered in the formulation of research projects:

a) calibration of the techniques by studies on animals of known age;

b) cross calibration of lipofuscin estimates with morphometric measurements preferably using an image analyser such as the one developed at National Marine Fisheries Service, Narragansett Laboratory, USA, in collaboration with scientists from France and Japan;

c) development of automated sample processing.

Whilst (a) and (b) above could run concurrently, it was felt that development of large scale analysis should wait until the techniques had been fully proven.

Krill Production and Fishery

8.15 Developments in krill fishing were discussed. Fishing began in 1974 and steadily increased to a peak level of 530,000 t in the 1981/82 season. The catch has gone down to about 250,000 t during the 1982/83 and 1983/84 seasons. This reduction in total catch was, according to Soviet scientists, due to problems with processing and marketing and was not due to difficulties in finding or catching krill. The Japanese catch of krill had risen steadily to nearly 50,000 t in the past 10 years. The catch/haul was 6.23 t/haul during 82/83 and 6.95 t/haul in 83/84 – this stable CPUE reflects a saturation in processing capacity rather than giving any real indication as to the state of the resource.

8.16 Soviet estimates of annual production of krill based on applying growth functions to biomass data from net hauls and acoustic surveys in the area dominated by krill (13–15 million km^2) in 1980 were 24 to 47 g/m^3 and 67 g/m^3 in 1982.

8.17 Although considered under another agenda item, consideration was given to identifying problems in using predators as indicator species for monitoring changes in the krill stocks. It was noted that certain predators such as birds and seals are severely limited in their foraging ranges during the breeding season and are therefore dependent on the presence of localised krill concentrations. The size and location of such areas need to be taken into account in any assessment plans.

8.18 The *Ad Hoc* Group on Krill Research Priorities noted that currently there is no quantitative information on the effect of fishing mortality on local krill abundance. While recognising the differences between research activities and commercial activities, the group considered that such information might be obtained by regular surveys in regions of fishing activity along with detailed catch and effort information from the fishing fleet. Some

information on abundance might also be obtained from examination of echosounder records from fishing boats although it was appreciated that the analytical procedures on such data might be very complicated. It was recommended that consideration be given to undertaking a feasibility study on the use of such records. Areas for operating such a project would clearly need to be designated paying due regard to the deployment of fishing effort. Suitable areas considered might include Prydz Bay and the SIBEX area in the S.W. Atlantic. It was recommended consideration be given to establishing study programs in suitable areas. The Scientific Committee endorsed these recommendations.

8.19 Several specific requirements for data collection were identified. The normal method of expressing effort in terms of hours trawling was considered inappropriate. It was felt that an index based on searching time would be preferable. It was considered advisable to collect data on as fine a spatial scale as possible (at least 1° longitude by 0.5° latitude) in the event that it might be required to that level for analysis (see paragraphs 6.29 – 6.33).

8.20 The Scientific Committee considered it essential that the best indices of effort be identified so as to improve analyses based on CPUE. The *Ad Hoc* Group recommended that the best way of achieving this was through a workshop meeting at which a variety of modelling and simulation approaches could be run so as to identify the key factors. Such a workshop would last about 5 days and might be held during the intersessional period, probably immediately prior to CCAMLR-IV. The workshop would require a representative small but comprehensive sample of commercial data, preferably from all fishing nations. The assistance of special experts for this meeting may be required and the Committee recommended that an appropriate provision in the budget should be made.

8.21 The importance of obtaining high quality data from both research and commercial vessels was emphasised. Three main areas were seen as being important: biological data, information on non-target species and data on fishing effort. It was felt that the acquisition of such data from commercial vessels would be facilitated if scientific personnel could be made available. The provision of such observers on catching vessels was recommended.

8.22 Discussions during SC-CAMLR-II had indicated that collections of additional data would be needed to assess the impact of harvesting. Members were reminded of their obligations under Article XX paragraphs 1 and 4 of the Convention to collect and provide such data.