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**Detection and counting of individual free-swimming krill
using a 2MHz scanning sonar**

by

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ABSTRACT

The euphausiid crustacean *Meganyctiphanes norvegica* (M. Sars) have been detected and counted in the scanning section of a 2 MHz scanning sonar beam up to 3 meters from the sonar head. The tests completes a pilot investigation on equipment needed to study krill behaviour in relation to sampling gears used for biomass estimation of euphausiids.

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INTRODUCTION

Euphausiids are an important link between phytoplankton and nekton in many marine pelagic communities. In order to fully understand and properly manage the fish stocks in such ecosystems, a thorough knowledge of the standing crops of euphausiids is needed. Conventional acoustic echo sounding has been used to map the vertical distribution and abundance of "krill", (the common name among Norwegian whalers, for *Meganyctiphanes norvegica* (M. Sars)) for several decades (BARY, 1966; MCNAUGHT, 1968), and larger research programs aim towards an absolute abundance measurement of the large Antarctic stock of krill, *Euphausia superba* (Dana) (EVERSON, 1987; ANON, 1986).

Adjustment of the now standardized acoustic method for fish abundance has been the dominating technique, but also more advanced multifrequency systems have been used (HOLLIDAY & PIPER, 1980; KRISTENSEN & DALEN, 1986).

One of the basic elements of the acoustic fish assessment method includes intense and periodic sampling of the scattering targets for classification of the acoustic energy to different parts of the population in what is called the scrutinizing process (FORBES & NAKKEN, 1972). Since the classification and weighing are made on the basis of the catch composition and knowledge of the scattering properties of the different species, a common and simple assumption is made : "The sampling gear is representative with respect to the length distribution and species composition of the sampled organisms".

Several investigations on fish have shown that this assumption is likely to be wrong, and that the main part of the bias, and also the variance in an acoustic estimate occur when pooling the acoustic data with the trawl data (GODØ, 1990). In simple, single species situations where one or two year classes are dominant, however, the assumption may be validated.

Sampling gears used for euphausiids are significantly smaller than the ones used for fish (WIEBE et al., 1976; SAMEOTO et al., 1980; HERMAN & DAUPHINEE, 1980), and several have compared acoustic density estimates with trawl data (MACAULEY, 1978; PEARCY et al., 1983; EVERSON & BONE, 1986; SAMEOTO et al., 1990). In cases where the estimates are comparable, the investigators are satisfied, but when they do not, one of the methods is easily blamed.

In principle, any sampling gear is selective, and should ideally be designed for a specific animal or size group in order to catch this group quantitatively. In most situations, it is also required to combine several sampling devices at the same location if a detailed scrutinizing of the "true" mixture of acoustic targets is needed.

Alternative techniques like underwater video and photography has also been used to study the behaviour of the animal and the gear, and in particular the interaction between the often avoiding animal and the sampling gear. When designing, or deciding for a specific gear type, both visual techniques and acoustical methods may be valuable in evaluating the optimal size of the trawl, meshing and towing speed to minimize the effect of active avoidance and mesh selection.

It is the intension of this paper to present results from a test of a high frequency

scanning sonar system, which can be used in determining the close range spatial distribution and behaviour of krill in front of the sampling gear during sampling. The system will be used to quantitatively evaluate the sampling efficiency of existing euphausiid gears.

MATERIAL & METHODS

Catch and biological material

The krill *Meganyctiphanes norvegica* (M. Sars) used in the experiment was sampled in Raunefjorden, western Norway close to Bergen, using a 3" Isaacs-Kidd Midwater Trawl (IKMT) with a specialized cod end for minimal animal damage. The animals were kept alive in a barge during transport to a circular tank originally used in studies of fish behaviour at the Institute of Marine Research (IMR). In connection with target strength experiments on the same euphausiids, the tank was divided into 10 different compartments, in which one of them, with a volume of 20 m³, was used for this particular investigation. The animals could swim freely and probably maintained a nearly natural behaviour in the tank. The light level was regulated by closing the top part of the compartment. The water in the tank was pumped continuously from approximately 70m depth in Byfjorden close to IMR, which assured a constant mean temperature and salinity of 9.1°C and 34.9‰ respectively during the experiment. A density of about 3 - 15 animals per cubic meter was used. The average total length of the euphausiids sampled in the tank was 25.7 mm, giving an average target strength at 120 kHz of -72 to -74 dB.

Scanning sonar

A Mesotech Mod. 971 2.0 MHz short range sonar system, originally built for sewer inspections, was used in image mode, scanning a horizontal slice of 0.4° by 360° of the compartment, and mechanically moved along the depth axis of the tank to hit a sufficient number of targets (Fig. 1). Still photos of the sonar display were taken at regular intervals. The basic data on the sonar is given in Table 1. A 30 m long test cable between the sonar head and the display processor were used during this experiment. In a field situation however, the sonar head can be operated with a 3000 m low impedance coax cable, to a depth of 1000 m. The planned setup during a field experiment is outlined in Fig. 2.

Table 1. Data on the Mesotech Mod. 971, scanning sonar head.

Power supply	22-26 VDC, 1A.
Beam width	0.4° Conical
Operating frequency	2MHz
Max range	5 m
TVG	20logR
Pulse length	0.05 msec
Scanning angles	360,30,60,120,180 deg.
Weigth Air/Water	7.7kg/5.7kg

RESULTS

The individual krill ranging in size from 19.2-37.9 mm total length, gave clear echoes at the 2MHz sonar, and they could easily be counted and positioned within the tank, Fig. 3. Even animals moving very close to the wall (1-2 cm), could be clearly distinguished. Individual distance between the animals can be evaluated as well as volume density. A small adjustment of the TVG function in the first 20 cm of the signal could be preferable.

DISCUSSION

The results obtained in the experimental tank have convinced us that the instrument, without many adjustments, can be used to determine the position of individual krill in the engulfed section of a plankton sampler. Presumably a comparison of the euphausiid distribution pattern in front of a plankton gear and in the near field outside its sampling range but within the sonar range (see Fig. 2), will make it possible to estimate the sampling efficiency of the gear. Using a horizontal sonar scan as outlined in the experimental setup (Fig. 1), will give additional information with respect to the euphausiid distribution in front of the net. It might also provide data on how close the gear can approach before it is seen or sensed by the euphausiids.

Similar techniques with scanning sonars, operating at a lower frequency, 330 kHz, have been used to detect single fish and to quantify the entrance pattern of different fish species in bottom and pelagic trawls (ONA & EGER, 1986; ONA & EGER, 1987; ENGÅS & ONA, 1990; ONA & TORESEN, 1988). They are now commercially used for aimed trawling by a large part of the pelagic trawlers for pollock and blue whiting.

Evaluating the catch sampling devices used for krill is important both for assessment of krill by trawls, and for the acoustic estimation of these stocks. Since comparative work have indicated that some of the systems used today can underestimate krill density by 10^2 to 10^3 times (SAMEOTO et al., 1990), caused by animal avoidance, a total re-evaluation of some of the standing stock estimates may have to be made.

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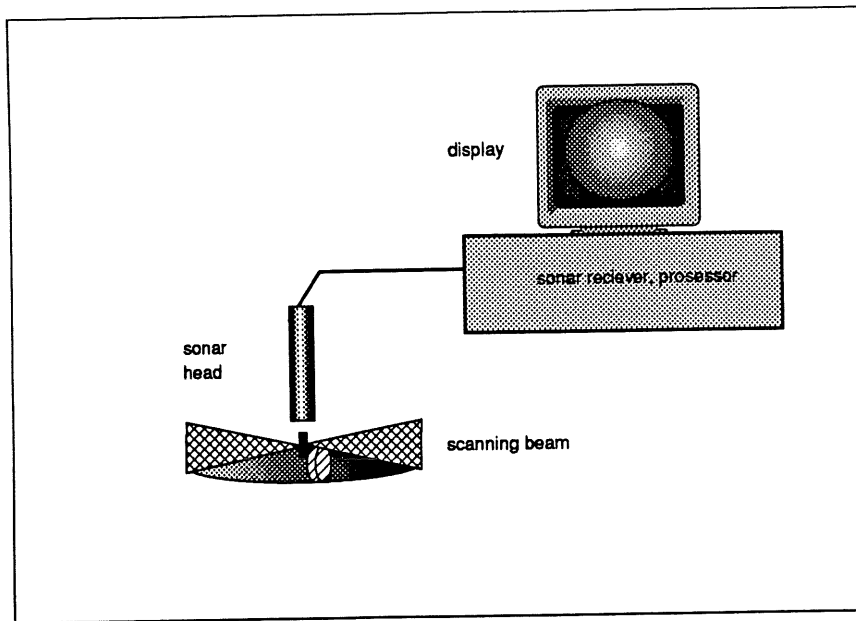


Fig.1. The scanning sonar setup in the tank experiment.

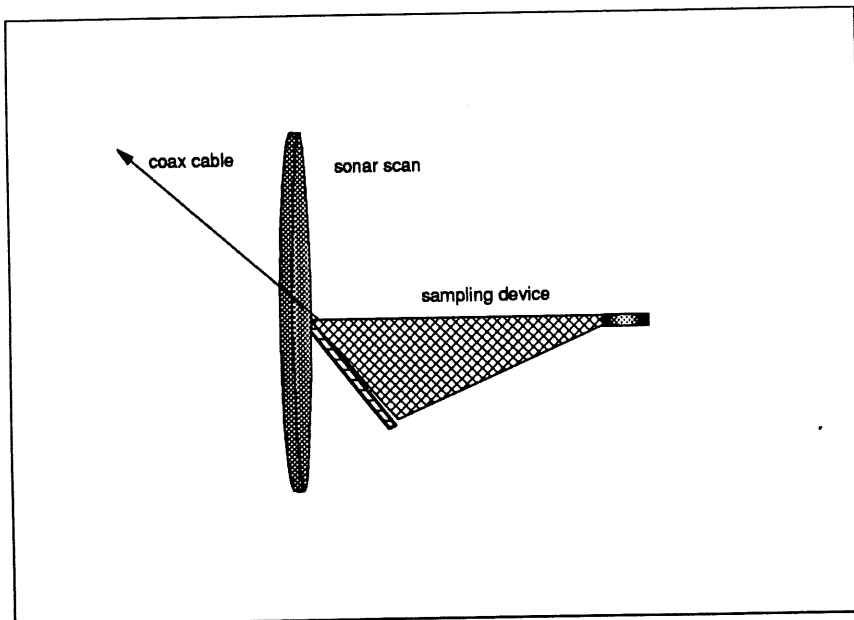


Fig.2. Planned setup during field experiments.

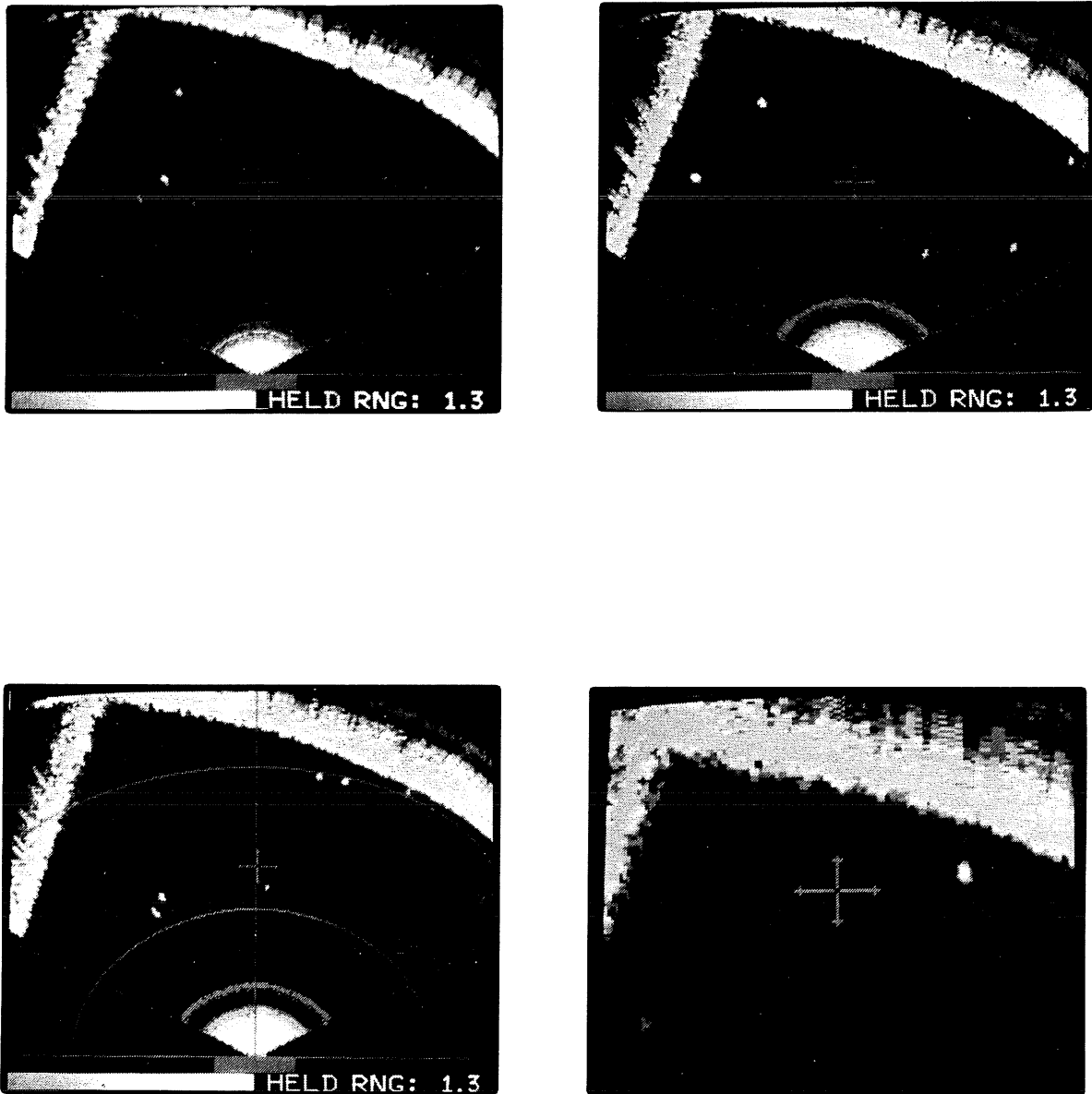


Fig. 3
Sonar displays of detected krill and tank wall, with range rings, (lower left),
and zoomed display of a krill within 5 cm from the wall, (lower right).