SIZE AND DENSITY OF KRILL LAYERS FISHED BY A JAPANESE TRAWLER IN THE WATERS NORTH OF LIVINGSTON ISLAND IN JANUARY 1988

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Abstract

The size and density of fishable krill layers in the northern waters of Livingston Island were determined during the co-operative survey carried out by RV *Kaiyo Maru* and a Japanese trawler. The mean values of layer length, thickness and surface density were 3.25 km, 13.3 m and 228.0 g wet weight/m^2, respectively. The krill layers fished by the trawler during the co-operative survey were 44.5 times longer and 2.7 times thicker but 25% less dense than the typical swarms encountered during FIBEX surveys.

Résumé

L'étendue et la densité des couches exploitables de krill dans les eaux du nord de l'île Livingston ont été déterminées lors de la campagne d'évaluation coopérative effectuée par le navire de recherche *Kaiyo Maru* et un chalutier japonais. Les valeurs moyennes de longueur, d'épaisseur et de densité à la surface des couches étaient respectivement de 3,25 km, 13,3 m et 228,0 g de poids humide/m^2. Les couches de krill pêchées par le chalutier au cours de la campagne d'évaluation coopérative étaient de 44,5 fois plus longues, 2,7 fois plus épaisses mais de 25% moins denses que les essaims types rencontrés lors des campagnes d'évaluation de la FIBEX.

Резюме

Данные по размеру и плотности слоев криля были получены в ходе совместной съемки, выполненной НИС *Kaiyo Maru* и японским траулером. Средняя длина слоя равнялась 3,25 км, толщина слоя - 13,3 м и плотность у поверхности - 228,0 г. сырого веса/м^2. Протраленные в ходе совместной съемки слои были в 44,5 раза длиннее, 2,7 раза толще, но на 25% менее плотны, чем типичные скопления, обнаруженные при проведении съемок по программе FIBEX.

Resumen

La densidad y tamaño de las capas explotables de krill en las aguas al norte de la Isla Livingston, fueron determinadas durante el estudio co-operativo llevado a cabo por un buque de arrastre japonés y el RV *Kaiyo Maru.* Los valores medios de la longitud de la capa, grosor y densidad de la superficie fueron 3.25 km, 13.3 m y 228.0 g peso húmedo/m^2, respectivamente. Las capas de krill explotadas por el buque de arrastre durante el estudio co-operativo fueron 44.5 veces más largas y 2.7 veces más gruesas pero 25% menos densas que los cardúmenes típicos encontrados durante los estudios FIBEX.

1. INTRODUCTION

Extensive information on size, shape and density of Antarctic krill aggregations has been obtained by research vessels (e.g. BIOMASS, 1986). Information on harvestable aggregations, however, is scarce, although this is necessary in order to estimate the possible effect of fishing on krill abundance.

This paper provides information on the layers fished by a Japanese trawler during the co-operative survey with RV *Kaiyo Maru* on the fishing ground north of Livingston Island in January 1988.

2. MATERIALS AND METHODS

The co-operative survey between RV *Kaiyo Maru* and a Japanese trawler was conducted from 17 to 20 January 1988 on the fishing ground north of Livingston Island (Figure 1). A total of 30 experiments on TS measurement and net calibration were carried out during the survey. Information on 34 trawling operations including 30 co-operative experiments, was provided by the trawler.

The number of krill aggregations per tow and their shape and dimension were determined from the echogram of a fish finder on the trawler (50 kHz). Since most of the aggregations were long and stratified layers, the thickness of an aggregation was measured at its densest part every five minutes on the echogram.

The density of each layer was estimated from the catch, mouth area of the net (560 m^2) and towing time. The towing time in this case denotes the time from the moment when the aggregation entered the net, which can be ascertained by a net recorder, to the moment when the net started to be raised. The net volume density was calculated by dividing the density by the ratio of thickness of the layer to the net height (28 m), which was recorded on a net recorder chart.

3. RESULTS AND DISCUSSION

The number of aggregations per tow were: one (30 instances); two (one instance); three (two instances); and six (one instance). All the aggregations were layers except the last instance where six swarms were fished. A typical layer recorded by an echogram is shown in Figure 2. Note the stratified appearance of the layer.

The towed layer length ranged from 241 m to 6.0 km with a mean of 3.25 km (N=38, SD=1.66 km) (Figure 3a). The intersected length of six swarms encountered in a tow ranged from 37 to 370 m with a mean of 135.8 m (SD=122.5 m).

The mean thickness of the layer(s) of each tow ranged from 6.1 to 22.8 m with the overall mean of 13.3 m (N=33, SD=3.96 m) (Figure 3b).

The density of each layer was calculated for those tows during which a layer did not end. The density thus calculated ranged from 1.43 to 52.07 g/m^3 with a mean of 7.17 g/m^3 (N=30, SD=8.84 g/m^3). The net density ranged from 4.49 to 73.33 g/m^3 with a mean of 17.14 g/m^3 (N=30, SD=12.70 g/m^3) (Figure 3c). The mean ratio of layer thickness to net height was 0.43. As the net height was 28 m, the layer thickness must be 12 m, which is close to the value obtained from the echogram, 13.3 m. The surface density of layers can be calculated by multiplying 17.14 g/m^3 by the mean thickness, 13.3 m. Thus 228.0 g/m^2 was gained.

Butterworth (1988) assumes that about five swarms are fished per haul in his modified simulation model. In this study, however, one layer was fished per haul in 88% of hauls.

The mean towed layer length was 3.25 km (the mode was 4.5 km) (Figure 3a), which is 44.5 times longer than that obtained from SIBEX surveys (BIOMASS, 1986) and used for a base case model by Butterworth (1988), 73 m. The value of 3.25 km, however, does not seem unusual because Ichii (1987) reported higher values in the fishing ground off Wilkes Land during the 1985/86 season.

The combined results from FIBEX give a mean swarm thickness of 5 m (BIOMASS, 1986), which is less than half that obtained in this study, 13.3 m.

In this study, the mean surface density of krill within a layer was 228.0 g/m^2. This value is less than that calculated by Butterworth from FIBEX data, 300 g/m^2.

As shown above, the krill layers fished by the trawler during the co-operative survey were 44.5 times longer and 2.7 times thicker but 25% less dense than the typical swarms encountered during FIBEX surveys. Fishing vessels were selecting larger aggregations than the average-sized ones found by research vessels.

Towed length and thickness of layers were underestimated because the trawler curtailed the haul before the layer ended in 30 out of 34 hauls and because the trawl net could not fish the deeper parts of the layers in at least 16 out of 34 hauls.

Catch per tow ranged from 1.1 to 23.0 tonnes during the co-operative survey.

After the co-operative survey with the trawler, RV *Kaiyo Maru* sailed around the fishing ground in order to estimate krill biomass by means of an echo integrator (Figure 1). Layers were the main form of aggregation along the track lines except the southern area, lines G-J, where swarms were recorded on the echogram. On lines B-F, L and N, layers never ended. The longest layer was recorded on line C which is more than 18.5 km long. The survey area of RV *Kaiyo Maru* was too small to cover the horizontal extent of the concentration. The longitudinal length of the concentration proved to be more than 52 km (from 60° to 61° W at 62°S).

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ICHII, T. 1987. Observations of fishing operations on a krill trawler and distributional behaviour of krill off Wilkes Land during the 1985/86 season. *SC-CAMLR-SSP/4*: 337-363.

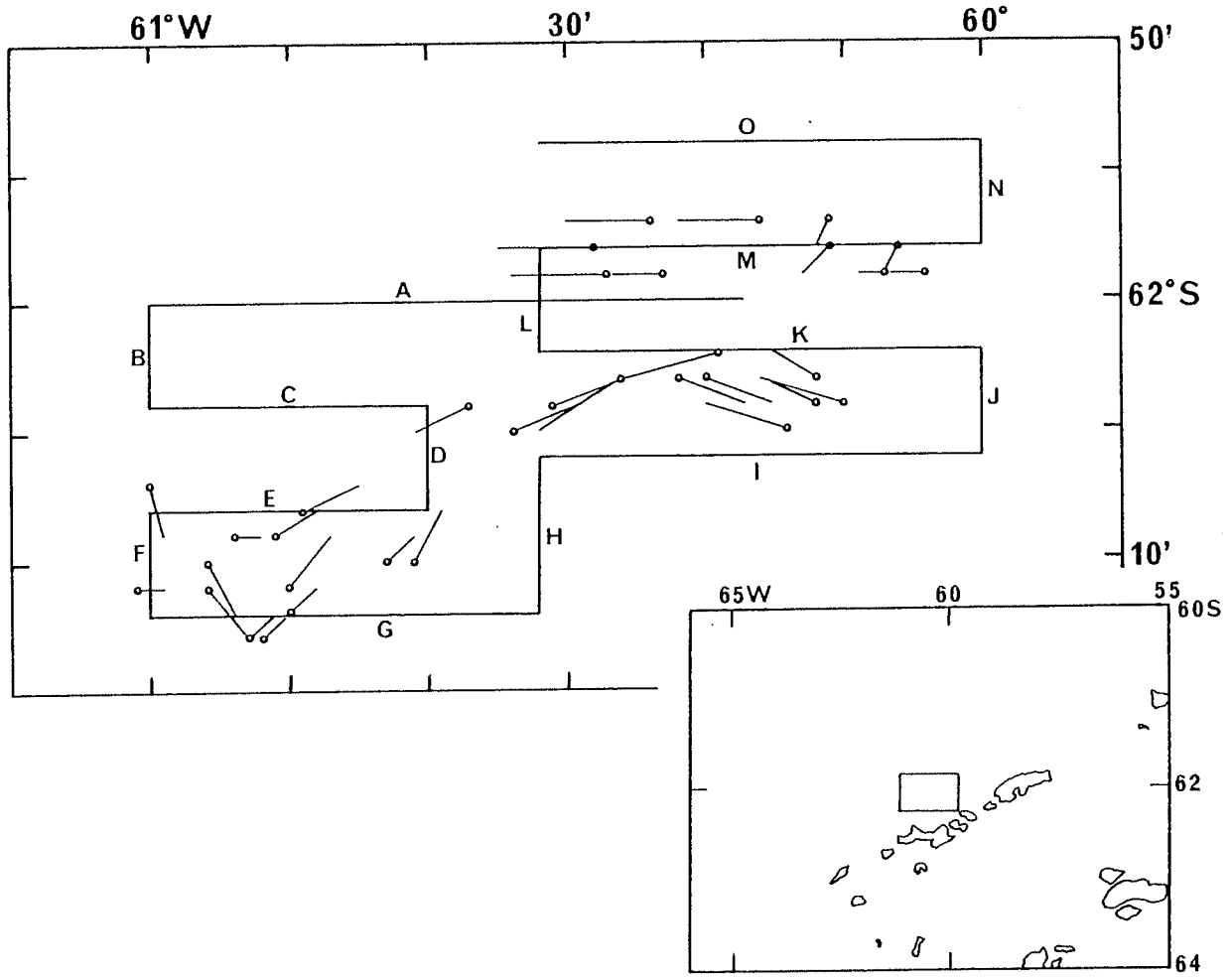


Figure 1: The fishing ground north of Livingston Island. The position and course of 34 trawls carried out by a Japanese trawler during the co-operative survey and RV *Kaiyo Maru*'s track line to estimate krill biomass are shown.

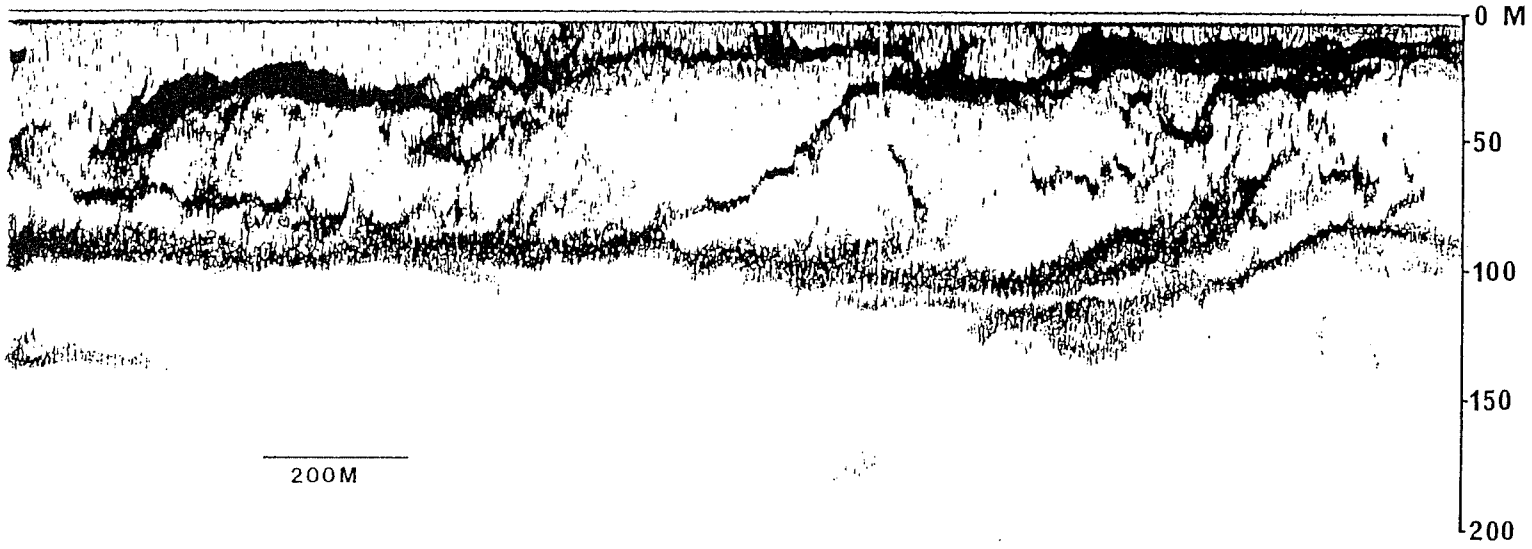
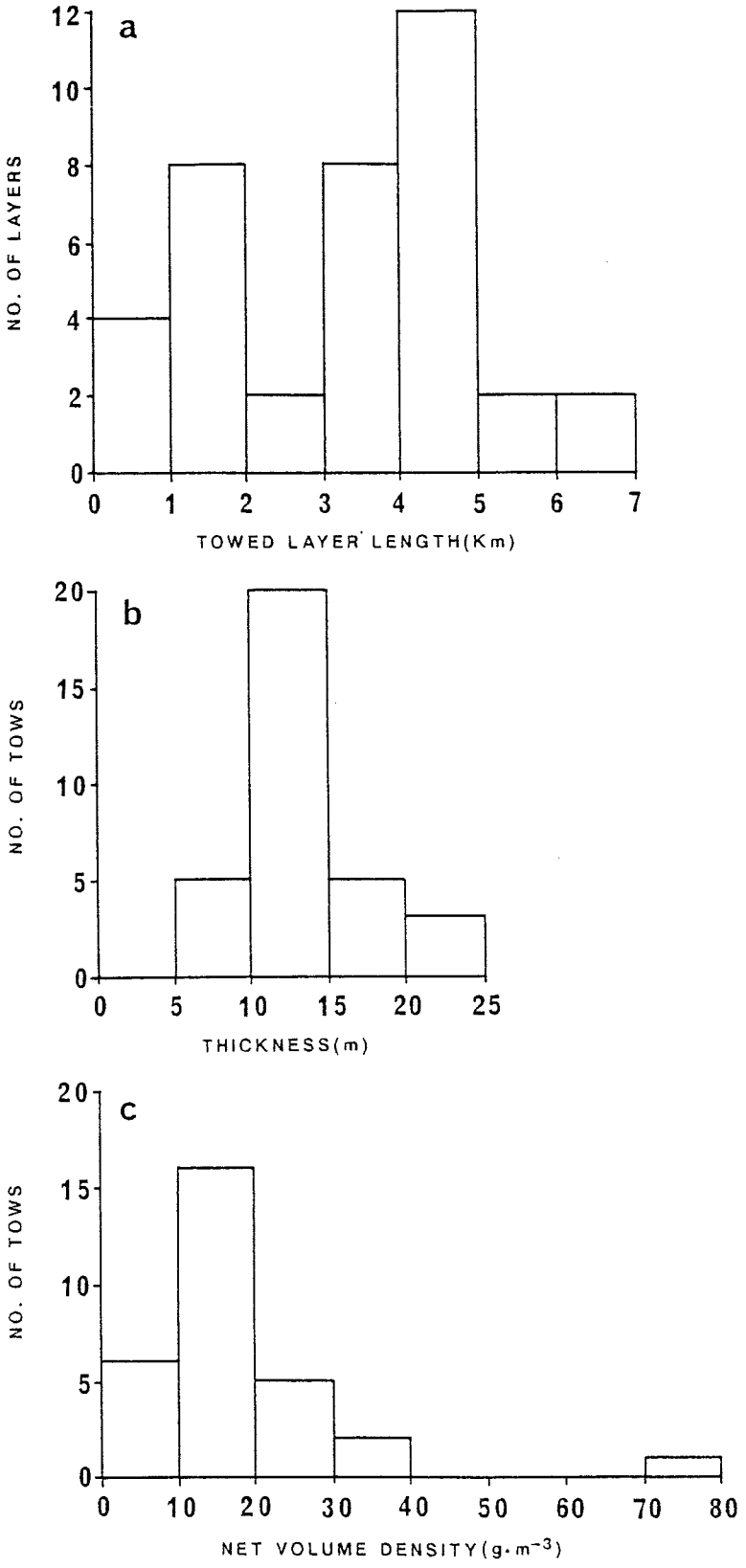


Figure 2: A typical krill layer, extending to 2.0 km in length, recorded on an echogram by a Japanese trawler.



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