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THE NET SELECTION FOR ANTARCTIC KRILL BY THE 1216 ## KRILL TRAWL *

by

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ABSTRACT

Size dependent net selection for Antarctic krill by the 1216 ## krill trawl was investigated, by means of comparative hauls with a plankton net. The results show krill shorter than 35 mm length to occur less frequently in the krill trawl catches than with the RMT 8. Although a selection curve is drawn, interpretation is doubtful due to reasons discussed.

INTRODUCTION

Harvesting krill (*Euphausia superba*) in the Southern Ocean will require management and conservation, both from a resource utilization point of view and on environmental grounds. For conservation, closed areas and seasons would be effective instruments. Mesh size minima are inadequate as a technique in controlling a krill fishery, because of the fragile nature of euphausiids.

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*Results of the Antarctic Expedition 1977/78 of the Federal Republic of Germany.

Nevertheless, a significant degree of variation is to be expected in mesh selction results when fishing with a commercial net for krill. In particular, adolescent krill and juveniles are expected to be underrepresented.

Hauls with a plankton net were conducted

- to obtain a more realistic size frequency distribution,
- to make catches of a commercial net comparable to plankton nets and to calculate conversion factors for them,
- to quantify selection by the commercial net.

The RMT 8 was used to quantify the degree of net selection by the 1216 # krill trawl. Possible net selection for krill should be discernable from different curves of the size frequency distribution.

MATERIAL AND METHODS

The 1216 # krill trawl

Extensive trials conducted by the Institut für Fangtechnik, Hamburg, led to the development of a midwater trawl for catching krill. It was used successfully during the course of the entire first German Antarctic Expedition in 1975/76. The net used consisted of a covering net and a small meshed liner. The former, a standard pelagic trawl net with a mesh size of 2oo mm, accomodated the load when trawling and hauling. This covering net was lined from the beginning of the belly with small-meshed netting, due to the small size of krill (STEINBERG, 1979), the rectangular mouth having a circumference of 1216 meshes. The wings had a mesh size of 1oo mm. The belly consisted of 2oo mm mesh and a 4o mm - mesh liner. In the intermediate section, the covering net was constructed of 1oo mm mesh with a lining mesh of 2o mm. In the cod-end mesh openings were reduced to 5o mm for the covering net and to 12 mm for the liner (all mesh-sizes given as stretched mesh size).

The towing speed was approximately 3 kn.

During the course of the expedition no significant reaction of krill to either the ship or gear was observed. On only a few occasions did krill seem to avoid the groundrope and headline, as indicated by netsonde traces. However, the chances of krill avoiding large krill trawls have been reported as very small.

The RMT 8

For comparison a plankton net was used, which had already been proven effective in catching krill: The RMT 8 (POMMERANZ, 1978).
The N.I.O. Combination Net (BAKER et al., 1973), which is commonly referred to as "Rectangular Midwater Trawl" (RMT 1+8) had been developed at the Institut of Oceanographic Sciences in Wormley/U.K.. Only RMT 8 catches were used for comparison with catches by the 1216 ## krill trawl. The RMT 8 has a mouth opening of approximately 8 m^2, the mesh size being 4.5 mm.

All catches for comparison were obtained during the 2. Antarctic Expedition of the Federal Republic of Germany in the austral summer 1977/78, with the FRV "Walther Herwig" and FMS "Julius Fock" in the Atlantic part of the Southern Ocean.

For the purpose of net selection analysis, all hauls in which clogging was suggested, were excluded, i.e. only catches of less than 3ooo kg caught with the 1216 ## krill trawl were included. Moreover only pairs of hauls were analysed which fished on the same patch of krill, meaning fishing on the same ground ($\leq$ 1' distance), at the same time ($\leq$ 3o min interval) and in the same fishing depth ($\leq$ 1o m difference). Only 14 pairs of hauls met all these requirements.

Subsamples of the catches were taken on board, and preserved in 4 % formaldehyd buffered with borax. Further subsampling was sometimes necessary in the laboratory for measuring and staging krill. Numbers of animals handled ranged from 9o to 777 individuals per haul. The length of krill was measured to the mm - below, from the anterior margin of the eyes to the tip of the telson. A total of 94o6 animals were handled. The krill examined varied in length from 25 to 59 mm. Animals shorter than 25 mm length were excluded from the analysis because of probable mesh selection of the RMT 8. It is possible,the RMT 8 catches only animals longer than 3o mm (POMMERANZ, 198o).

RESULTS

The size frequencies of the 2 x 14 krill samples were summed in each length class after correcting for unequal sample size by an appropriate factor. The two length frequency distributions obtained in this way show the cumulative frequencies of the RMT 8 and the 1216 ⩩ krill trawl and are directly comparable (fig. 1). Relative frequencies of krill below 35 mm length are clearly less in the krill trawl results than with the RMT 8 data. Hence, fewer animals compared with the RMT 8 are retained by the meshes of the krill trawl. The percentage deviation of the krill trawl value from the corresponding RMT 8 value describes the selection curve of the 1216 ⩩ krill trawl for the length classes. When the percentage deviation approaches the 1oo % - value, the two nets catch krill of that length to the same extent.

On the assumption that the net selection for the length classes fits the following function (POPE et al., 1964), an approximate selection curve was fitted to the data :

$$p = \frac{1}{1 + e^{-(a + b\,l)}}$$

where p is the proportion of animals in the length class 1, which are retained by the meshes of the 1216 ⩩ krill trawl; 1 is the length of the animal in mm and a and b are constants of the fitted function. The data yield the following values: a = - 6.11 and b = o.19. For fitting and estimating a and b the maximum-likelihood-method as described by BERKSON (1957) was used.

In order to demonstrate the tendency of the values to approach the 1oo % - mark, and excluding the large oscillations in the last part of the data, a logistic form was fitted for the percentage of length classes between 25 and 42 mm length, following the method described above. This yielded the following values: a = -12.93, b = o.4. This curve (fig. 2), as expected, rises more steeply than the selection curve of the first fitting. Fig. 2 shows the original data scattered to a considerable degree around the ideal logistic curve of sigmoid shape. Moreover, the selective process in the net is not clearly defined; the approximated selection curve rises only slowly with increasing animal length.

DISCUSSION OF RESULTS

Calculating values for selection factors proved to be slightly difficult for the 1216 ## krill trawl. Catches of krill with a large commercial net show an unusual relationship between animal size and the magnitude of the catch. A catch of 2o tons contains approximately 3o x $1o^{6}$ animals, and therefore small meshes are required, creating a huge net drag, for which an engine power of 25oo - 3ooo hp is required. So the commonly used covered cod-end technique doesn't seem to be applicable with the 1216 ## krill trawl.

Krill fishing concentrates on patches or swarms. The best catches in this sampling programme were of the order of 15 tons of krill in 2o min fishing time (MOHR, 1979). The effect of this is a totally unselective fishery due to immediate clogging. A clear relationship of animal size to mesh size can not then be expected. Furthermor krill is not thought to be frightened into the middle of the net, so the front section of the net also effects selection. This is shown by meshed krill commonly found in the belly. This is due to the size and swimming speed of the krill in relation to the krill trawl. In general, selection processes in the krill trawl would not be expected to resemble those of a pelagic trawl with very active and fast swimming fishes. However, it is important to remember that the RMT 8 is also affected to a certain degree by avoidance.

KILS (1979) observed, with underwater TV-cameras, swimming krill at a speed of o.5 m sec^{-1}, possibly sustainable for several metres. So adult krill theoretically could avoid an approaching net, in particular those at the border of the net. RAGULIN (1969) reported escape reactions when divers approached to 1.5 - 2 metres. Hence, when a krill noticed a net

2 metres distant approaching with a speed of 3 kn, and fled in the right direction, it would have 1.3 sec time for flight, enough to reach a distance of o.65 m.

But probably not all animals would escape with maximum swimming speed and not all of them in the right direction. Furthermore, animals which are actually out of the projected mouth opening of the net might be induced to flee but are then caught. Hence the catch could possibly be near to that which would have occurred if there was no reaction of krill.

Interpretation of the selection curve has to be done carefully due to the following sources of error : The curve is influenced by avoidance to an unknown degree. The first part of the curve is affected by selection of both nets. Above 55 mm length, few animals were caught by the RMT 8, which led to insufficient samples of the length classes above 55 mm. Data used in formulation of a selection curve for the 1216 # krill trawl must be obtained only from hauls with rather small catches, to avoid the problem of clogging and consequently unselective fishing.

To summarize, the following conclusion can be drawn : Samples of the 1216 # krill trawl are only valid for estimating biomass of krill provided that correction factors are applied, which take into consideration small sized krill. Quantitative analysis of relative frequencies of juveniles and adults are doubtful, using only material from commercial trawls.

During the FIBEX acoustical survey, one of the major unknown factors in krill abundance assessment is the target strength of krill as a function of size, frequency and orientation. So the acoustical survey will require calibration of the acoustical data by net samples. For this purpose the combined RMT 1+8 is required, due to net selection of both a krill trawl and a RMT 8, as reported here. Moreover, a RMT 1 with 3oo μ mesh size (in combination with a RMT 8) is needed due to mesh selection of the RMT 8, in order to obtain more realistic size-frequency distributions for interpreting acoustical data.

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length classes [mm]	cumulative frequencies of the RMT 8	cumulative frequencies of the 1216 # krill trawl	p_{actual} [%]	$p_{calculated}$ [%]	$p_{calculated}$ [%] for length classes between 25 and 42 mm
25	28	2	7.1	22.52	5.12
6	43	2	4.7	26.10	7.45
7	51	5.9	11.6	30.03	10.73
8	44	4.9	11.1	34.28	15.21
9	56	20.8	37.1	38.79	21.12
30	86	20.6	24.0	43.51	28.55
1	71	41.5	58.5	48.34	37.36
2	93	42.6	45.8	53.21	47.10
3	74	21.7	29.3	58.02	57.06
4	107	41.4	38.7	62.70	66.48
5	104	101.9	98.0	67.12	74.75
6	142	94.9	66.8	71.27	81.54
7	162	139.7	86.3	75.09	86.83
8	155	170.2	109.8	78.55	90.77
9	168	160.0	97.6	81.65	93.62
40	276	261.0	94.6	84.40	95.64
1	310	314.7	101.5	86.79	97.03
2	416	392.4	94.3	88.87	98.00
3	340	456.7	134.3	90.66	
4	428	424.5	99.2	92.18	
5	469	591.1	126.0	93.48	
6	508	533.0	104.9	94.57	
7	458	464.1	101.3	95.49	
8	372	526.1	141.4	96.26	
9	269	360.3	133.9	96.90	
50	218	270.1	123.9	97.43	
1	120	126.5	105.4	97.88	
2	97	82.2	84.7	98.25	
3	43	52.2	121.4	98.55	
4	23	12.5	54.4	98.80	
5	11	6.5	59.1	99.02	
6	5	1.7	34.0	99.19	
7	1	0.8	80.0	99.33	
8	1	–	–	–	
9	1	0.8	80.0	99.55	

Fig. 1 : The cumulative length frequency distributions for krill caught by the 1216 # krill trawl and the RMT 8 and the actual and calculated proportions (p) of animals in the length classes. Fractional numbers result from the use of correcting factors because of unequal sample sizes.

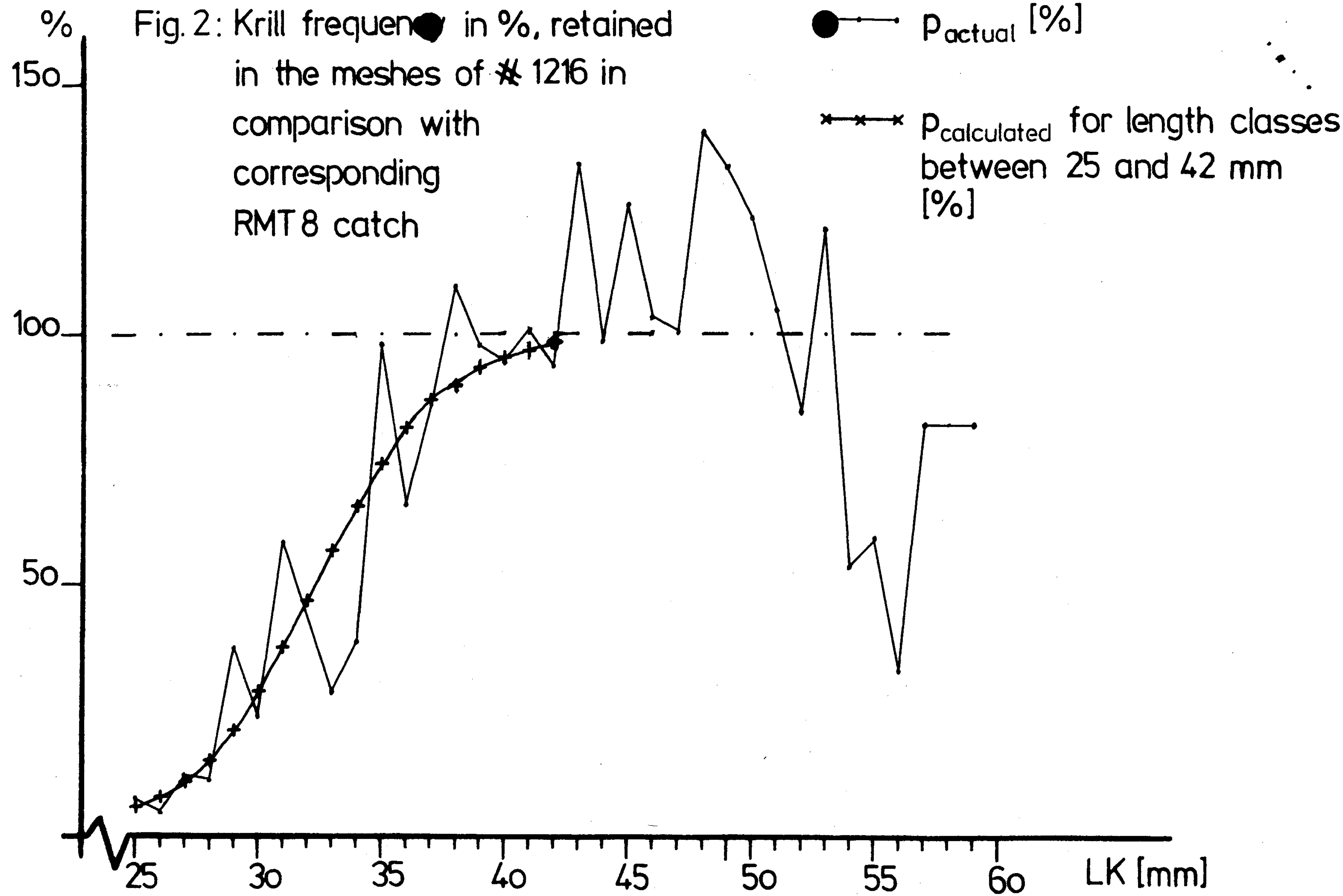

Fig. 2: Krill frequency in %, retained in the meshes of # 1216 in comparison with corresponding RMT 8 catch