24

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Investigation on bottom trawl selectivity in relation to the Barents Sea shrimp (Pandalus borealis).

by

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A b s t r a c t

Results of experiments on selectivity of bottom trawls with mesh sizes 19,28 and 37 mm during shrimp fishery in the Barents Sea are presented.

The highest loss of shrimp was observed to be through the cod-end (about 99 % of all escaped specimens), 2/3 of this number escape through its upper half. The 50 % carapace selection length for 19 mm mesh is 11.8 mm and for 28 and 37 mm meshes - 14.7 and 18.2 mm respectively. Regulation of a trawl mesh size appeared to be of great significanse for fisheries management of this species population.

Résumé

Il s'agit des résultats des essais sur la sélectivité des chaluts de fond avec les mailles de 19,28 et 37mm lors de la pêche de la crevette dans la mer de Barents.

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On a démontré que l'esquive maximum de la crevette du chalut se fait dans le cul de chalut, ce qui représente environ 95% de tous les indivudus esquivés. Les deux tiers de cette quantité s'esquivent par la nappe supérieure.

La longueur sélective du carapaxe de 50% est égale à 11,8mm pour la maille de 19mm; pour la maille de 28 et 37mm elle fait respectivement 14,7 et 18,2mm. Il s'est avéré que la réglémentation des dimensions de la maille joue un rôle important dans la régulation de l'exploitation des populations de cette espèce.

Introduction

In the 70-ies shrimp (Pandalus borealis) fisheries started intensively in the North Atlantic (ICES,1978).A pressing question at present is therefore to solve a problem of fishery management of this species.

Limitations of the mesh size of a trawl fishing gear are being introduced for some areas of shrimp fishery. Thus,a minimum allowable trawl mesh size to use in Icelandic and Norwegian economic zones is 35 mm, off Greenland - 40 mm.Until recently, a mesh size of the Soviet fishing gears in the Barents Sea varied between 16 - 20 mm.The above mesh made it possible to catch specimens of younger age groups.In 1978-1979 the Polar Institute have therefore conducted experiments on bottom trawls selectivity in relation to shrimp aimed at the determination of regulated mesh size for fisheries of this species in the Barents Sea - results of which are given below.

Materials and methods

Preliminary experiments were made to study in general a loss of shrimp through various trawl parts (its cod-end etc.).In order to know whether escape of shrimp is uniform through all parts of a trawl or is chiefly through either of them we covered a square,central and near-cod-end part as well as the cod-end itself thus recording escaped specimens through each part of a trawl separately.For the cover of each part five trawlings were made.Results showed that about 95 % of shrimp escape through cod-end.This is significant for two reasons:

(a) - for change of effect of fishery on shrimp stock it is enough to regulate mesh size in the cod-end.

(b) - studies of trawl selection characteristics are simplified as the experiments can be confined to cod-end.

A comparative efficiency of known cover designs was made. To determine a number of shrimp which escape through upper and lower halves of a trawl two sets of hauls (5 in number) were made using covers consisting of two separate parts for the outside covering of each half of the cod-end.During the first set of experiments a cod-end was fitted with the 16-18 mm meshed netting whilst during the second set of experiments - with the 35-37 mm one.Results showed that about 2/3 of all escaped shrimps esxaped through upper half of the trawl and 1/3 - did so through a lower one.Following therefore ICES recommendations (ICES,Coop.Res.Rep. 1964/2) to use cod-end topside cover with inside blinders to cover a lower half of the cod-end we always obtain reduced selectivity of the cod-end.For this reason we object to use the above cover.

Later on we used an outside cover completely covering the cod-end. A cover was made of small-meshed net material with a mesh size of 10 mm and of a rectangular form.Its dimensions were 1.5 times wider and 3 m longer than the cod-end itself.

To determine "masking" effect of the cover alternate trawlings with covered and uncovered cod-end were made.Experiments were made with cod-ends nettings of which were approximately of the same mesh size.Comparison of frequency length distributions of catches taken during 5 hauls (Fig.1) showed that the effect of the cover on the cod-end was insignificant.Effect of cover is greater when net material of a finer mesh size is used (e.g. 5 mm) due to closure of mesh and change of filtration of the cover (Thomassen and Ulltang,ø,1975).

Collection of data on selectivity of the cod-end fitted with alternate nettings of different mesh size was made during sets of hauls (5 - 6 hauls in a set).Trawlings were made during the daytime (from 6 to 18 hrs) for at night catches are decreased due to vertical migrations of fish (Bryazgin V.F,1970). Catches in the cod-end and in the cover were measured by a volume of 8 litres.Shrimp in this volume were weighed and counted - thus mass of catches was determined.

Field analysis included measuring the carapace length of not fewer than 400 specimens taken at random.100 spec. (also taken at random) were weighed with an accuracy of 0.1 gr.,length of carapace and the total length of a body were measured and sex was determined as well as the carapace density and a mean weight of them (a number of specimens per kilogram) were measured, according to Rasmussen (1942) biometric parameters were measured.

When the catches were weighed meshes in the cylindrical part of the netting were measured with a wedge-shaped plate (ICNAF type) inserted under the pressure of 0.5 kgs.

Trawl selectivity,as it is known,is determined by a formula:

$$S_i = \frac{C_i}{C_i + D_i} \qquad (I)$$

where S_i - selectivity of a certain length group per trawling;

C_i - a number of specimens of a certain length group in the cod-end;

D_i - a number of specimens of a certain length group in the cover,

To measure a whole catch in the cod-end and in the cover requires a great amount of time, that is why, random samples were taken from all catches. Since samples, as a rule, are representative of different parts of catches in the cod-end and in the cover it is necessary to make a correction to the length composition of samples, thus reducing them to one sampling fraction. Selectivity then will take the formula:

$$S_i = \frac{k\, C_i}{k\, C_i + d_i} \qquad (2)$$

where: $C_i d_i$ - a number of specimens of a certain length group in the cod-end and cover samples respectively

k - proportionality koefficient equal to a ratio of a number of sampling fractions in the cod-end to those in the cover;

Results of selectivity for each haul of the given set were generalised: a mean selectivity value for each length group and a standard deviation were determined.

Experiments were made in the eastern (Goose Bank) and in the central (Demidov Bank) areas of the Barents Sea where the 38.2/39.4 and 28.4/29.1 m bottom trawls were used respectively. Trawl bags were fitted with nettings made of polyamide netting yarn (kapron) with designation K 1300 tex.

Duration of trawlings - 1 - 2 hrs, speed of the vessel with a towed trawl - 2.5 - 3.0 knots.

The 16 mm mesh cover did not permit us to determine selectivity of the 19 mm mesh cod-end for some number of specimens with carapace of under 14 mm seemed to escape through the cod-end and cover simultaneously. To use a cover of a smaller mesh size, as was mentioned before, would result in marked increase of "masking" effect.

Due to the fact that specimens under 14 mm are within the 25 - 75 % selectivity range of the above cod-end, to use formula (2) in this case is not right. Approximate selectivity was therefore determined according to Thomassen and Ulltang (ICES, C.M.1975) assuming that shrimp with the carapace of 18 mm and longer are all captured by the 19 mm mesh. The length composition of the population was determined by the use of a 5 mm meshed netting inserted into the trawl.

Discussion of results

Exploitation of a stock causes changes in the length-age structure of the population and affect the equilibrium of the latter if the stock is fished to the extent that the reproduction is disordered either by increase of fishing effort or by the use of the fishing gears with greater catchability.

According to Bryazgin (1970) the life time of P.borealis inhabiting the south-eastern Barents Sea is 6 years. Shrimp males (shrimp - protandrous hermaphrodites) become mature at their third year of life when the carapace is 15 - 17 mm long; at age 3 - 4 they grow into females and spawn when they are 17 - 25 mm. long.

Use of the 19 mm trawl in this area allows to capture shrimps at age 2 entering the commercial stock for the first time. Males make up 79 % and females -21 % in a catch. The 2 - 3 year-olds constituted the major part of a catch. Since sexual inversion occurs by the third year of life all females can be captured all fishing season through. Males made up 77 % and females 23 % of a catch taken with a 28 mm meshed trawl.

Possible use of a 35 mm trawl can positively effect the population under study. Judging by the results of the experiments we can note that in various years a 35 mm mesh trawl captures different age groups of the population (the 2 and 3d year-olds). In this case it means that males, independent of the year season, are all practically left by the fishery and the major bulk of females have therefore the opportunity for at least one-year reproduction, before they are caught.

Comparing the obtained data (Figs.2 and 3) allows to note a sharp increase in mean selection length with a slight increase in mesh size. The trawl mesh size regulation appeared to be of great significance for fisheries management of this species.

Based on the results of biological investigations and selection experiments carried out by the Polar Institute the 35 mm trawl mesh size as a minimum one for shrimp fisheries was introduced by the Soviet Union since January 1,1980.

References

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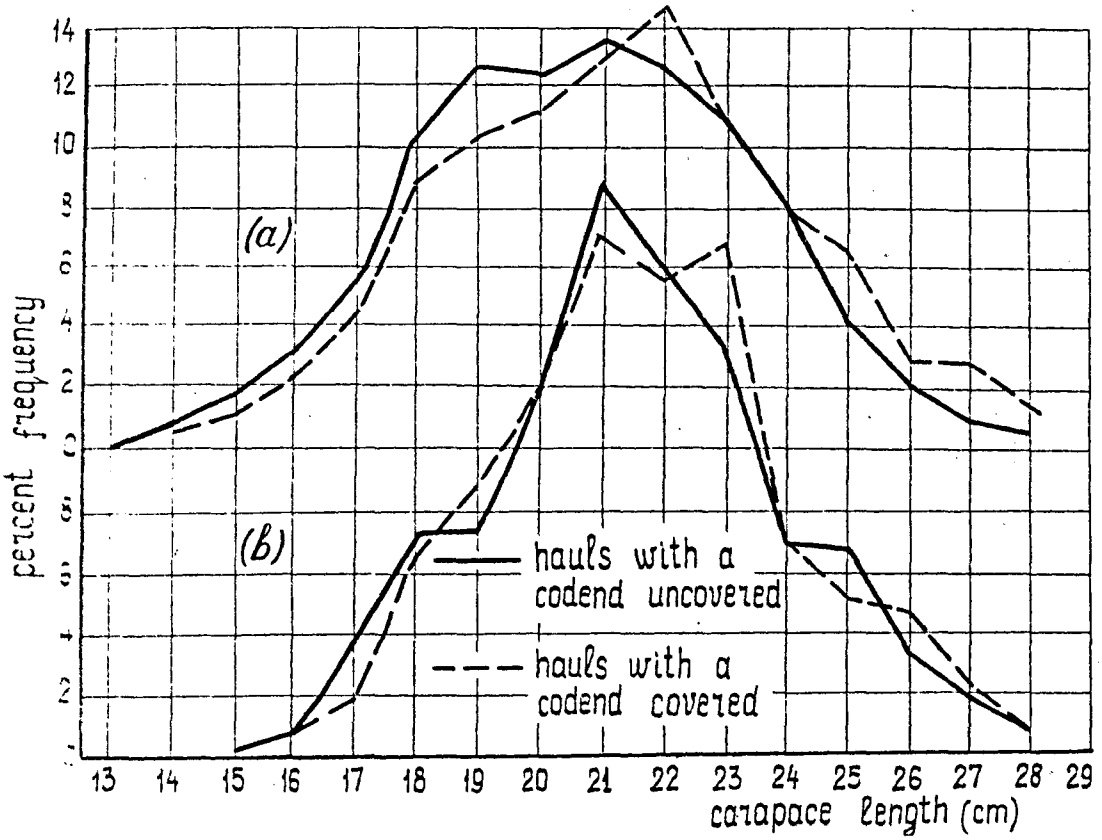
percent frequency
(a)
(b)
hauls with a codend uncovered
hauls with a codend covered
carapace length (cm)

Fig. 1

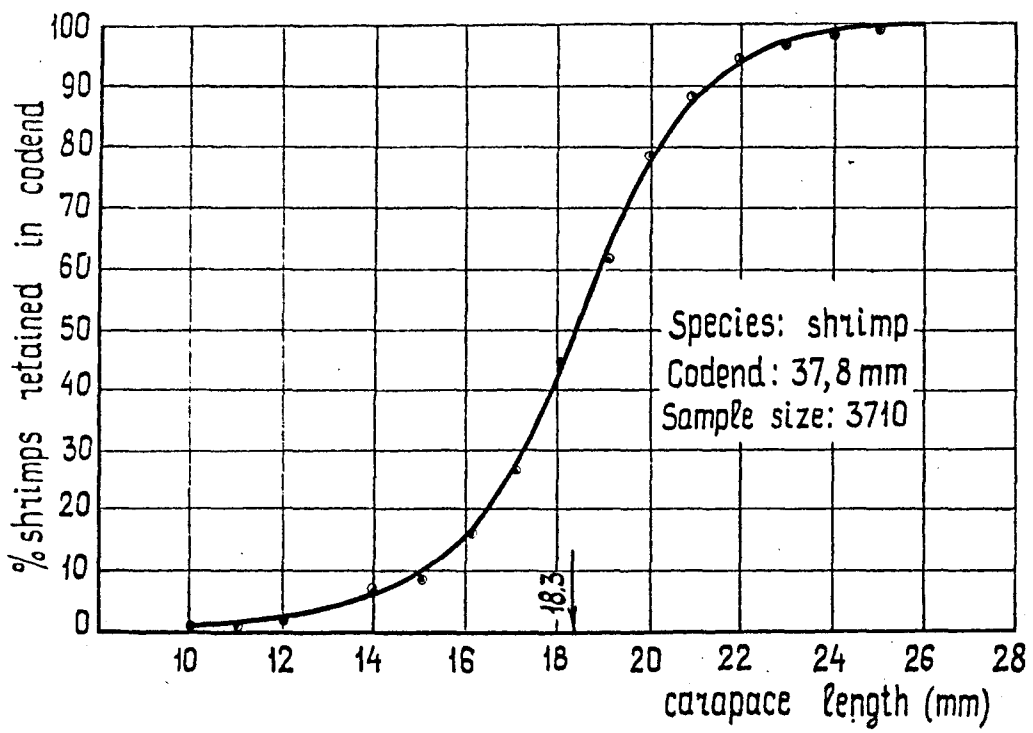
% shrimps retained in codend
Species: shrimp
Codend: 37,8 mm
Sample size: 3710
18.3
carapace length (mm)

Fig. 2

Headings for figures

Fig.I. Length compositions of shrimp catches taken with a trawl with covered and uncovered cod-end:
(a) - cod-end mesh size 19 mm;
(b) " " " " " 27 mm

Fig.2. Experimental selectivity curve in relation to shrimp. Goose Bank, December 1978.

Fig.3. Experimental selectivity curves in relation to shrimp on the basis of different methods:
(I) - alternate trawlings;
(2 and 3) - with covered cod-end.
Demidov Bank, June 1979.

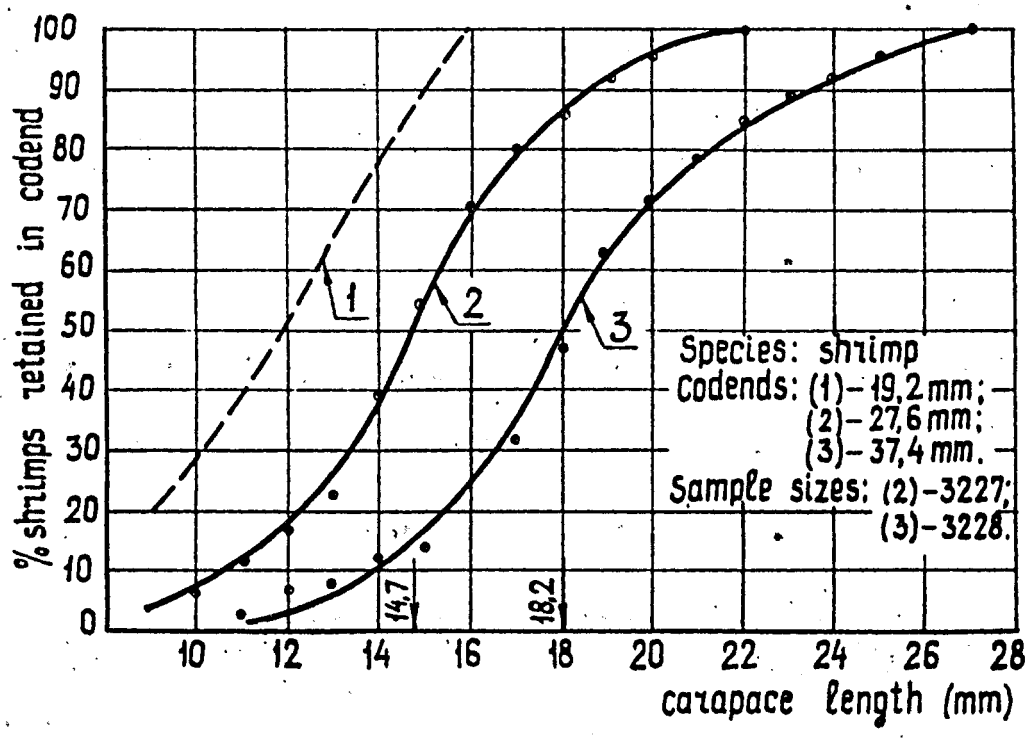

Fig. 3