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SELECTIVITY EXPERIMENTS WITH SQUARE MESH CODENDS IN BOTTOM TRAWL

by

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ABSTRACT

During selectivity experiments with square and diamond mesh codends, an
evaluation of the covered codend method and a modified trouser trawl
method went in favour of the last one. Both twisted knotless- and
braided knotted material was used for the experiments. Square mesh
codends gave higher 50% retention lengths and selection factor than the
diamond mesh codend, both for cod and haddock. Fished commercially, the
square mesh codend of knotted netting caught fewer undersized fish than
the diamond mesh codend. Big bycatches of redfish caused heavy meshing
in the square mesh codend and reduced the selectivity. Due to the fixed
circumference of the square mesh codend some problems arose when
emptying big hauls on a sterntrawler.

INTRODUCTION

The escape of fish from a diamond mesh codend has appeared to take place in just a small fraction of the whole codend at any time. Both indirect methods (Beverton 1963) and visual and photographic observations (Pope et al. 1975) has indicated that escape of fish through the codend meshes first occur at the distal end. As the codend fills up with fish, the main escape zone moves forwards just in front of the accumulated catch, where the meshes are wide open. Due to the load of the catch, the meshes in front of this "escape zone" are more or less closed, and provides poor escaping possibilities for fish.

In 1983 Robertson gave a report on codend with "square meshes", i.e. the netting of the codend was hung on bars, like a tennis net. This codend appeared to retain its cylindrical - and square meshed shape along the whole length of the codend, independent of catch size. Square mesh codends have also proven to possess better selective properties than diamond mesh codends, i.e. higher l_{50} and to some extent narrower selection range (Robertson and Stewart 1986). Observations by remotely controlled underwater television vehicles (RCTV), such as described by Priestly et al. (1985), have shown that the square meshes in these codends made of knotless netting retain their square shape better than if made from knotted netting (von Marlen et al. 1985).

In the coming years, several good yearclasses of cod and haddock will recruite the commercial trawl fishery in the Barents Sea. Since high increasing catch rates lead to a reduction in selection factor, S.F., (e.g. von Brandt 1960, Beverton 1963, and Beltestad 1977), this will lead to increased catches of small and undersized cod and haddock, a waste of resources that possibly could be avoided by the use of square mesh codends. To look into these prospects, two experiments with square mesh codends were carried out in 1985/86 off the east coast of Finnmark and on the North Cape Bank.

MATERIALS AND METHODS

The selectivity of two sizes of diamond (120 mm and 135 mm) and two sizes of square mesh codends (120 mm and 135 mm) was investigated (Fig. 1b). The 120 mm codends were constructed from single twisted polyamide (210 d/512) knotless material (Figure 1a), while the 135 mm codends were made from double 6 mm braided polyamide knotted netting, actually the same as used by commercial trawlers for codends.

During the first trip a RCTV was used to evaluate two methods of establishing selection curves; the covered codend method and a variant of the alternate haul method; the trouser-trawl. RCTV-observations were also made of the comparative fishing with the two 120 mm codends in water depths between 60 and 80 m.

The cover was of the totally enclosing type, and made from 60 mm braided, 3 mm polyethylene; 1.5 times the width and 4 m (40%) longer than the codend. The cover was mounted two mesh rows up on the extention piece, and was enclosing the square mesh codend while fishing with trouser trawl.

When doing the trouser-trawl method a 6.8 m long vertical separation net (60 mm) was mounted from the entrance of the two codends and forwards (Figure 2). The extention piece was divided into two equal halves, thus splitting the catch and minimizing the effect of different mesh size/form, well in front of the two codends. The following comparisons were made with this method:

a) diamond mesh codend (120 mm) - small mesh codend,

b) square mesh codend (120 mm) - small mesh codend, and

c) diamond mesh codend - square mesh codend, both 120 mm.

The same comparison as above were done on the second trip, this time with 135 mm codends.

The vessel used on the first trip was the M/Tr "Kågsund" (41.7 m OAL, 1250 HP) equipped with "Cotesi No. 3" trawl and Vee otterboards. The vessel on the second trip was the M/Tr "Persfjord" (46.5 m OAL, 1500

HP) equipped with a similar type of trawl ("Alfredo No. 3") and Vee otterboards. Both boats used a heavy bottom bobbin gear, with max. 24" rubber rollers.

Duration of tows ranged from 1/2 to 2 hours onboard "Kågsund", and from 2 to 6 hours onboard "Persfjord". All the comparisons of length distribution of fish from diamond and square mesh codend were made with the trouser trawl method.

RESULTS

The codend made of knotless material used on the first trip had an approximate cylindrical shape with nearly maximum opening of the square meshes. The particular twisted knotless material used, however, proved to be poorly suited for codend experiments. The material was very soft, and the junctions between the bars were sliding when pressure was applied inside a mesh. It was difficult to make reliable mesh size measurements using the ICES-gauge. The effective mesh size during fishing was most probably different from that measured on deck. The nominal mesh size of 120 mm, as well as the average measured mesh size, are therefore used in the calculations.

The RCTV-observation made during the trials with the covered codend showed poor performance of this method. After some filling up of the cover, the load from the catch caused the cover to squeeze the main codend. The fish that had escaped from the main codend were obstructed to go aft in the cover, and were partly accumulated between the cover and the main codend, just outside the escaping zone. Due to these circumstances, this method was given up in favour of the trouser-trawl method, which was used on the second trip as well.

The vertical separation net in front of the parallel codends appeared to perform well. While the opening areas of the two codends were different in the junction extension piece - codends, there was no visible difference between the two forward halves of the extention piece. Fish entering this area tried to keep up with the trawl by

"burst-swimming", and it appeared to be a coincidence in which half of the extension piece the fish finally did enter.

The selection results from the first trip with 120 mm codends and small mesh codends are given in Table 1 and in Figure 3 and 4. Two valid hauls for each codend were combined and plotted to show the retention percentages for different length classes of fish, and the best fit line through the points was drawn by eye.

The square mesh codend gave higher selection factors (S.F.) and 50% retention lengths both for cod and haddock. The selection range for cod in the two codends was about equal. Due to very few haddock with length greater than l_{50}, no selection range could be established for this species.

Comparing the covered codend method (1 haul) and the trouser-trawl method, the latter gave the highest selection factor, and the lowest selection range for cod.

The trouser trawl trials with the diamond and square mesh codends gave, however, no significant difference in length distribution between the two codends, in spite of the difference in S.F. for the two codends (Figure 5 and 6).

The results from the second trip, when 135 mm codends (diamond and square) were compared with small mesh codends, are given in Table 1. The retention points for cod (Figure 7) are based on two valid hauls for each type of codend and the selection curves are drawn as described above. Again the square mesh codend gave higher S.F. and l_{50} for cod.

Due to very few haddock greater than 50 cm no selection curves are drawn, but the retention values indicate, however, that fewer small sized haddock (40-50 cm) are caught in a square mesh codend (Figure 8).

A comparison of the length distributions for haddock from the two 135 mm codends (Figure 9), shows that in the size group 32-42 (undersized) the square mesh codend caugth only 25% of that in the diamond one. This

gave a significant difference in mean length of 1.2 cm (P = 0.002) for the material as a whole (Table 2).

Also for cod the length distribution went in favour of the square mesh codend (Figure 10). The catch of fish below l_{50} (diamond mesh codend) was 50% less in the square mesh codend. This difference decreased with increasing fish length. For fish above 70 cm, the catches in the two catches were quite similar, as expected when the separation net in the extension piece worked satisfactory.

This gave a significant difference (at P = 0.05) in mean length for all the valid hauls (Table 2) except for one, which contained 40% redfish (Sebastes marinus L.) in volum. In this haul, heavily meshing of red fish occured in the aft part of the square mesh codend, and a dramatic drop in selection occured. Bycatch of 2-4% redfish (in volum), however, did not show any influence on the selection.

During this second cruise we experienced some practical problems when handling catches from 2 tons and upwards in each codend. Heaving up on the stern ramp the catch is thoroughly packed aft in the codends. Applying the "dumper", the catch will slide rigth down the diamond codend due to meshes opening across. The square mesh codend, with a given circumference and no such elasticity, and almost to be lifted off deck before emptying started. This problem was especially experienced when this codend was meshed with redfish.

DISCUSSION

Ideally, codend material used for selection experiments should have very good knot-setting and a mesh size that remaines constant throughout the experiments, thereby reducing one of the variables to deal with. Twisted knotless material (two strands) as used during the first trip did·not fullfil this requirements at all. Perhaps other braided knotless material may have proven better. On the other hand, knotted netting, as used on the second trip, proved to have both better knot-setting and more stable mesh size.

In the aft part of the square mesh codend of knotted material the meshes remained square shaped due to load both lengthwise and across. In the front the meshes partly became rectangular due to load only lengthwise.

Based on RCTV-observations, the evaluation of the covered codend method and trouser-trawl method went in favour of the last one. As both the main codend and the cover are being filled up, the cover is squeezing the main codend more and more, and most probably altering its selectivity. This may be one of the reasons for the decreasing S.F. with increasing catches observed when doing the covered codend method, a phenomena that was not apparent in the data from alternate haul experiments (ICES 1964).

Based on the same kind of observations as above, Stewart and Robertson (1985) found that covers 1.5 times the width and length of the main codend could be used with some confidence, nothing, however, was said about catch size.

The trouser-trawl method has earlier rightly been criticized; due to e.g. unequal flow into two codends with different mesh size (Pope et al. 1975).

If a splitting device as described above is used, such effects will be minimized. In addition, after the introduction of the "Auto-trawl" system, this whinch compensates for effects like wind and tide, and prevents the trawl from being towed asymetrically, even fishing by the two codends is secured.

It appears difficult to give any conclusion regarding the S.F. for knotless netting, due to uncertainty in effective meshsize. The trend is that the square mesh codend gives a higher l_{50} than the diamond one.

Parallel fishing with the two 120 mm codends did not give any difference in length distribution, neither for cod nor haddock. This

may be caused by a longer hauling time (2 hours) compared with the tows made to establish S.F. and l_{50} for cod and haddock. Beverton (1964) indicates that increased towing duration tends to give an increase in S.F., provided that the catch is not increasing proportionally. The fact that the diamond mesh codend was undulating very much up and down as well as sideway, and thereby constantly whirling the fish around, could have lead to an increase in S.F.

Comparing the S.F. of the 120 and 135 mm codends is difficult due to the reason mentioned above. The main trend is, however, that S.F. does not decrease with increasing mesh size in square mesh codend, a finding corresponding to that reported by Robertson and Stewart (1986).

The parallel fishing with 135 mm codends was done just like commercial fishing, both regarding depth, fishing area, towing duration, and rigging of the codends. This gave far less small and undersized cod and haddock in the square mesh codend than in the conventional one.

The heavily meshing of redfish in the square mesh codend on one occasion was a new experience, and it remains to be seen what effect longterm fishing without cleaning the codend will have on the selectivity.

Handling problems of square mesh codends was not expected, and it may be necessary to modify these codends for use on stern trawlers, e.g. by introducing diamond mesh in the lower half of the codend.

REFERENCES

BELTESTAD, A. 1977. Selectivity experiments with topside chafers and round straps. Coun.Meet.int.Coun.Explor.Sea, 1983, B:38.

BEVERTON, R.H. 1963. Escape of fish through different parts of a codend. Comm.Nthw.Atlant.Fish., Spes.Publ.(5): 9-11.

BEVERTON, R.H. 1964. The selectivity of a flap-type topside chafer. Redbook ICNAF; 1964(3): 132.

BRANDT, A. von, 1960. Selection of redfish. ICES Comp.Fish.C'ttee., Pap. (10): 5 p.

MARLEN, B. von, J.B. van DUYN and D.J.C. BLIJKER, 1985. An intro- duction of direct observation techniques using a remotely controlled television vehicle on bottom trawls with square mesh codends. Coun.Meet.int.Coun.Explor.Sea,1985, B:34.

POPE, J.A., A.R. MARGETTS, J.M. HAMLEY & E.F. AKYUIZ, 1975. Manual of methods for fish stock assessment, part III. Selectivity of fishing gear. FAO Fish.Tech.Paper No. 41: 1-65.

PRIESTLY, R., WARDLE, C.S. & HALL, C.D., 1985. The Marine Laboratory Remote Controlled Fishing Gear Observation Vehicle. Coun.Meet. int.Coun.Explor.Sea, 1985, B:10.

ROBERTSON, J.H.B. 1983. Square mesh codend selectivity experiments on whiting (Merlangius merlangus (L)) and haddock (Melanogrammus aeglefinnus (L)). Coun.Meet.int.Coun.Explor.Sea, 1983, B:25, 1-13 (Mimeo).

ROBERTSON, J.H.B. & STEWART, P.A.M., 1986. An analysis of length selection data from comparative fishing experiments on haddock and whiting with square and diamond mesh codends. Scottish Fisheries Working Paper No. 9/86.

STEWART, P.A.M. & J.H.B. ROBERSTON, 1985. Small mesh codend covers. Scottish Fisheries Reasearch Report No. 32.

Table 1. Selectivity results for square and diamond mesh codends of 120 mm knottless, twisted material, and 135 mm knotted braided material.

	Method	Codend	50 % retention length (cm)	Selection factor	Selection range (cm)
COD	Covered codend	Square 136.8 mm (120 mm knottless material)	48.9	3.6 (4.1)	7.3
	Trouser trawl	Square 136.8 mm (120 mm knottless material)	54.0	4.0 (4.5)	5.0
		Diamond 135.8 mm (120 mm knottless material)	49.2	3.6 (4.1)	4.7
		Square 134.6 mm (135 mm knotted material)	60.2	4.5	9.5
		Diamond 136.4 mm (135 mm knotted netting)	56.0	4.1	8.7
HADDOCK	Covered codend	Square 136.8 mm (120 mm knottless material)	44.5	3.3 (3.7)	
	Trouser trawl	Square 136.8 mm (120 mm knottless material)	49.C	3.6 (4.0)	
		Diamond 135.8 mm (120 mm knottless material)	47.0	3.5 (3.9)	
		135 mm knotted material	-	-	

Table 2. Catch and mean length of cod and haddock in diamond and square mesh codends.

| Haul no. | COD | | | | | | HADDOCK | | | | | | | |
| | Diamond mesh codend | | | Square mesh codend | | | | Diamond mesh codend | | | Square mesh codend | | | |
	Measured	Total	I	Measured	Total	I	P	Measured	Total	I	Measured	Total	I	P
13	348	566	60.6	388	388	61.5	0.044	112	112	46.2	15	15	48.6	0.266
15	267	620	58.3	294	294	60.9	0.000	162	162	48.6	14	14	55.0	0.001
16	441	441	57.6	285	285	59.2	0.011	39	39	48.0	14	14	59.4	0.454
22	289	871	58.9	279	554	58.2	0.120	218	218	44.5	148	148	45.3	0.043
23	263	1092	55.6	360	694	59.4	0.000	227	227	42.9	154	154	46.4	0.000
24	329	329	56.9	279	279	58.4	0.015	173	173	45.0	37	37	45.8	0.595
Total	1937	3919	57.4	1835	2494	59.1	0.000	931	931	45.3	382	382	46.4	0.002
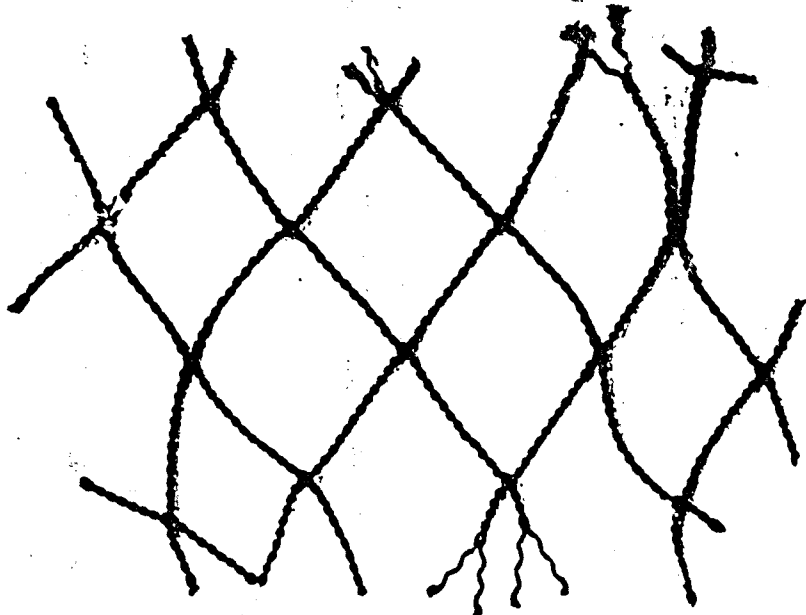
Tot. no.	64/59 #	64/59 bars
Free meshes/bars	60/37 #	60/37 bars
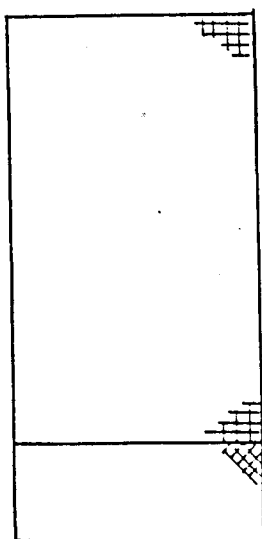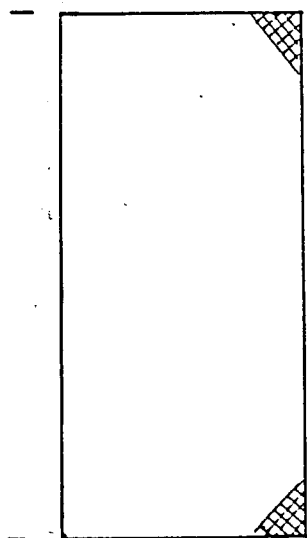
Fig. 1A. Knotless material used during the selectivity experiement
(not to scale).

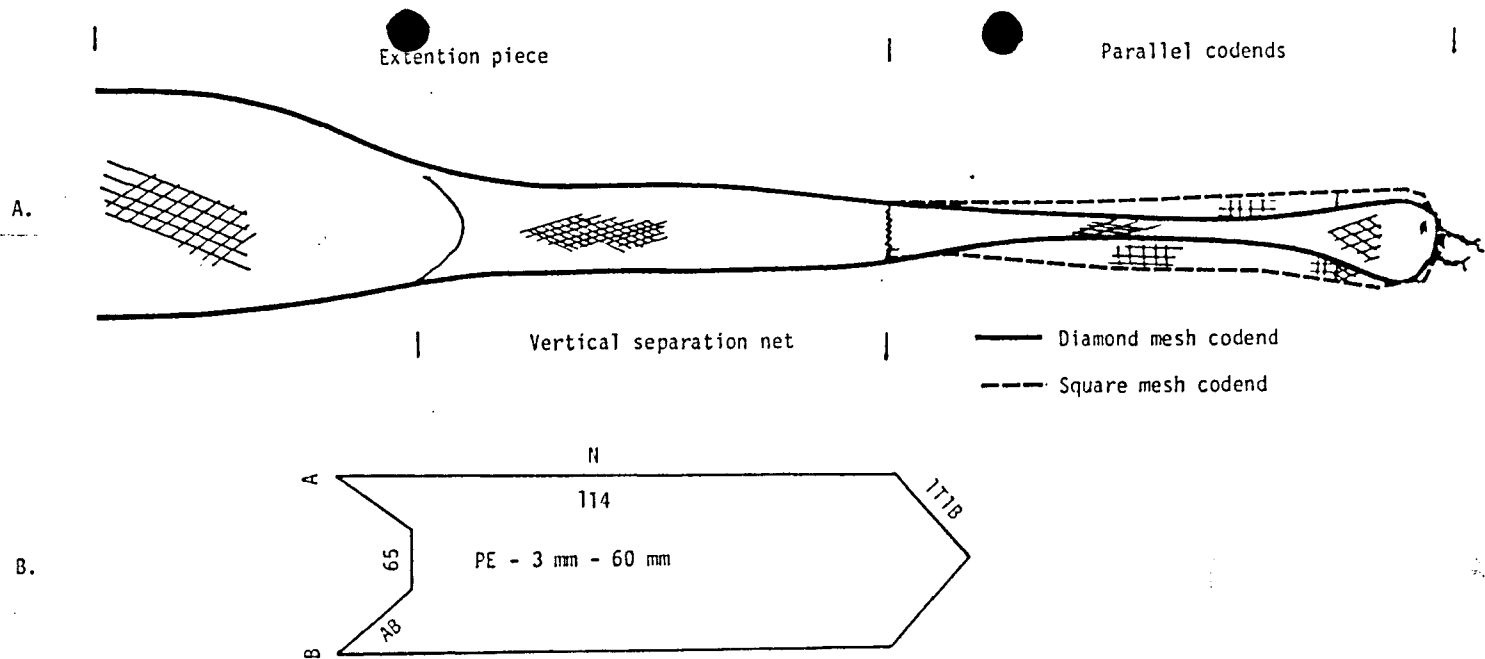B. Schematic drawing of the codends (Knotless material/knotted material).

A.

Extention piece

Parallel codends

Vertical separation net

——— Diamond mesh codend

- - - - Square mesh codend

B.

A

N

114

1T1B

65

PE - 3 mm - 60 mm

AB

B

Figure 2 A. Schematic drawing (from videotape) of the extention piece with separation net and codends.

B. Vertical separation net.
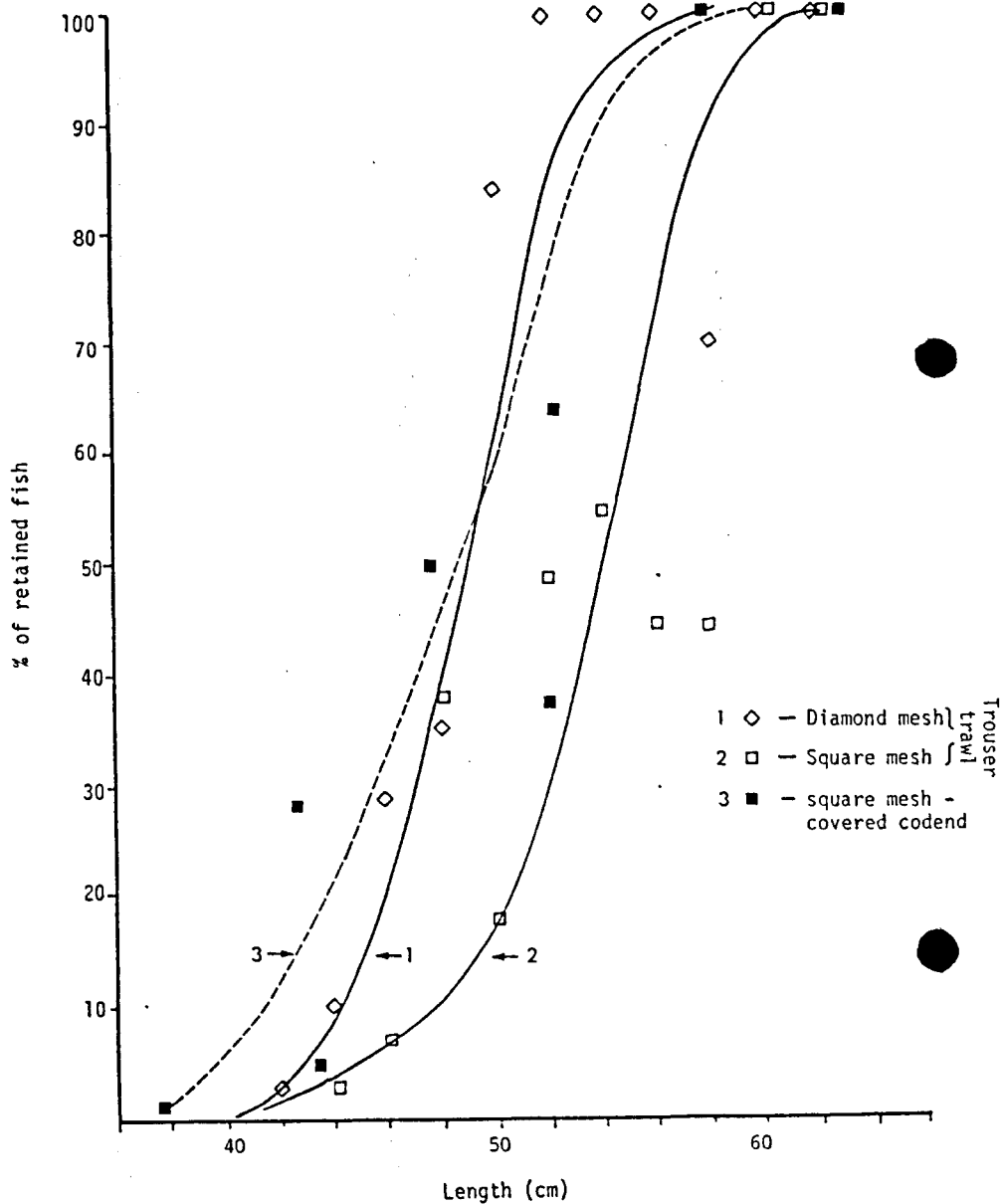
Figure 3. Selection curves for cod using the 120 mm twisted knotless codend material.
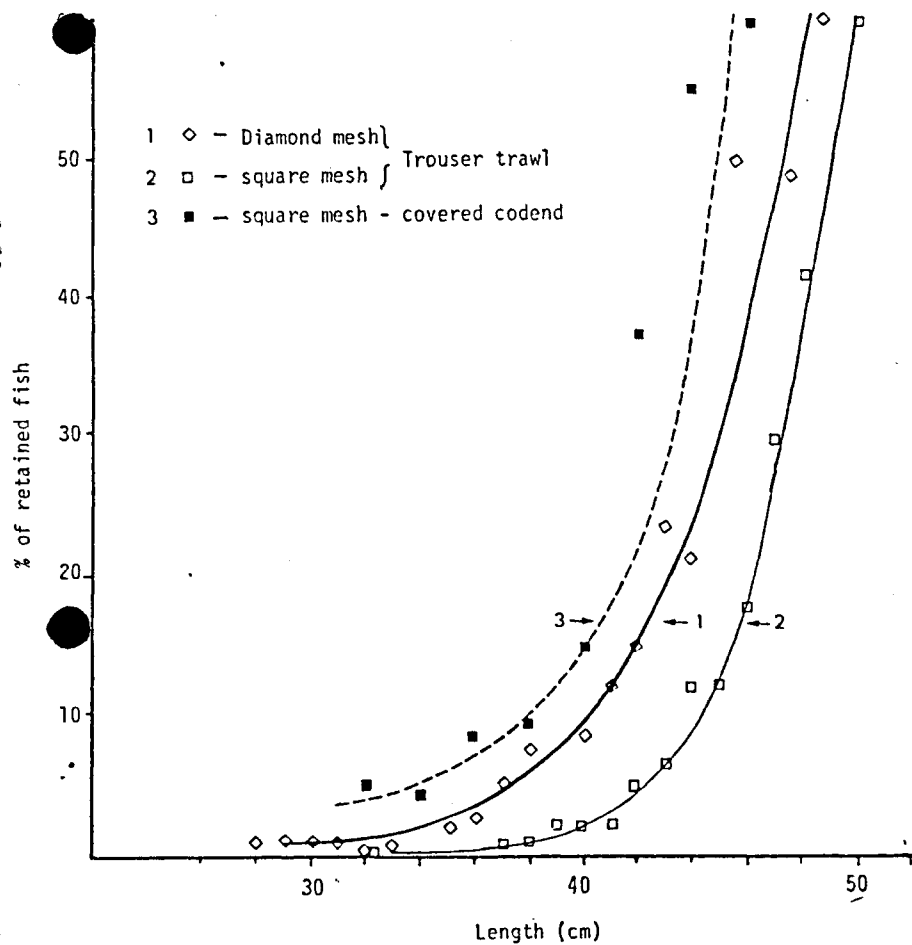
Figure 4. Selection curves for haddock using 120 mm twisted knotless codend material.
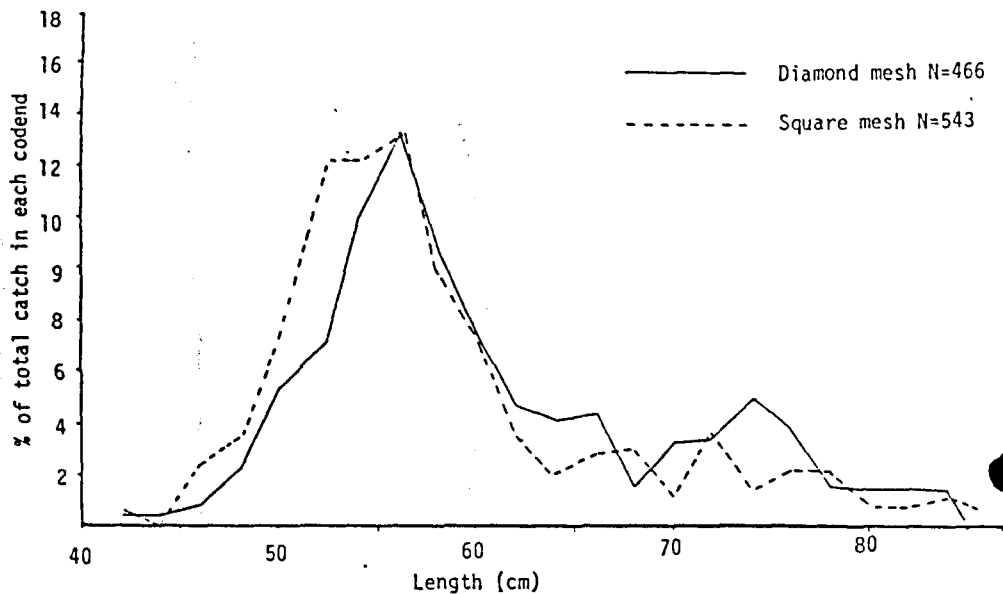
Figure 5. Length distribution of cod in the 120 mm diamond and square mesh codends.
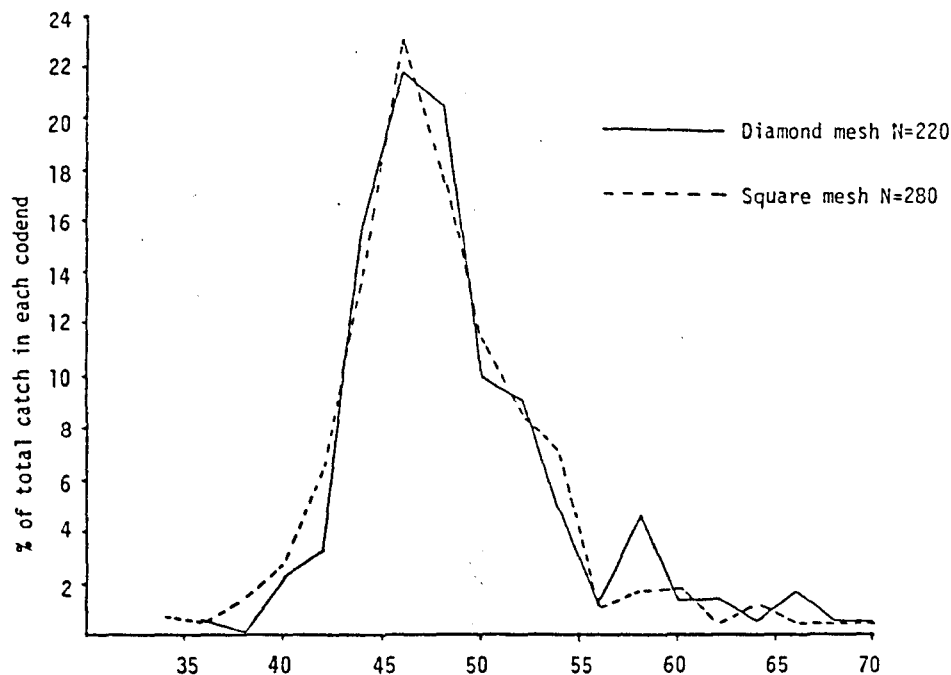
Figure 6. Length distribution of haddock in the 120 mm diamond and square mesh codends.
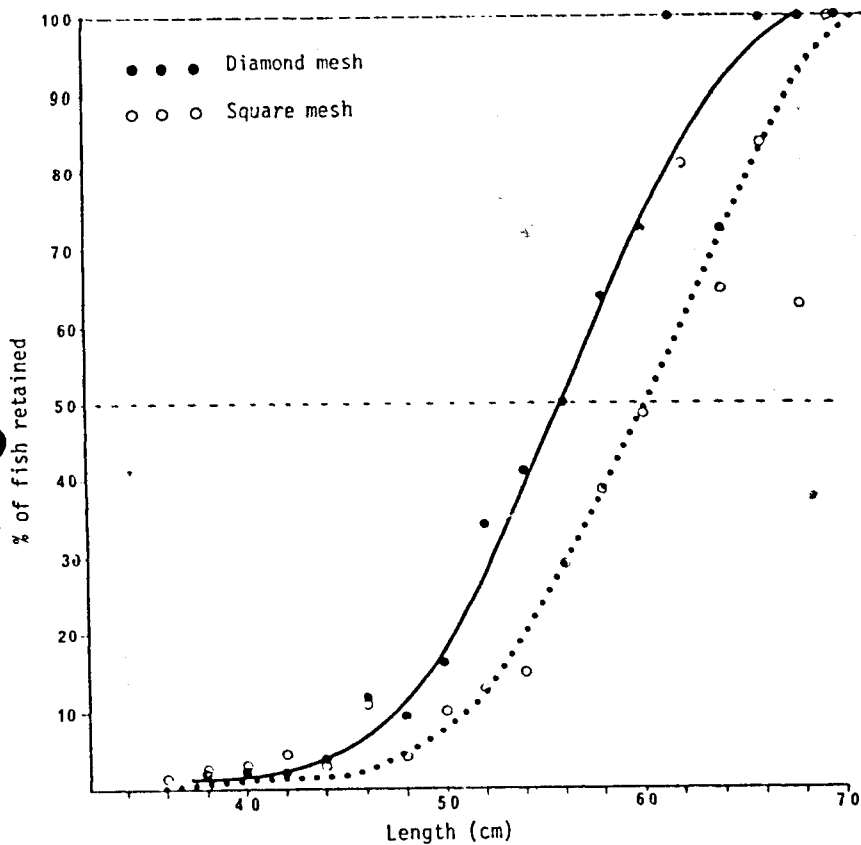
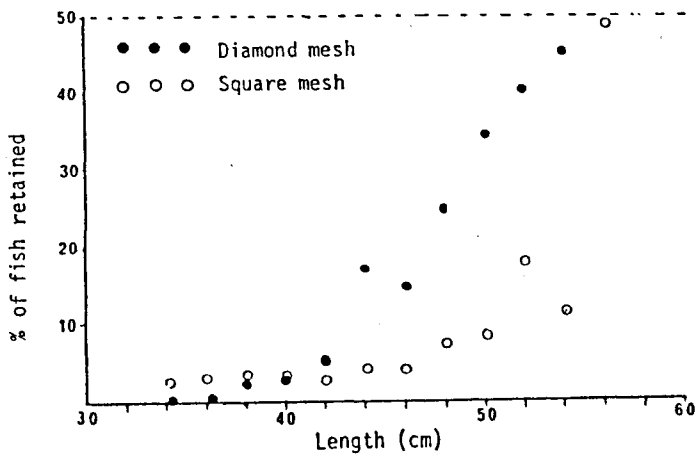Figure 7. Selection curve for cod in 135 mm diamond and square mesh codends.

Figure 8. Retaining-points for haddock for different lengthgroups in 135 mm
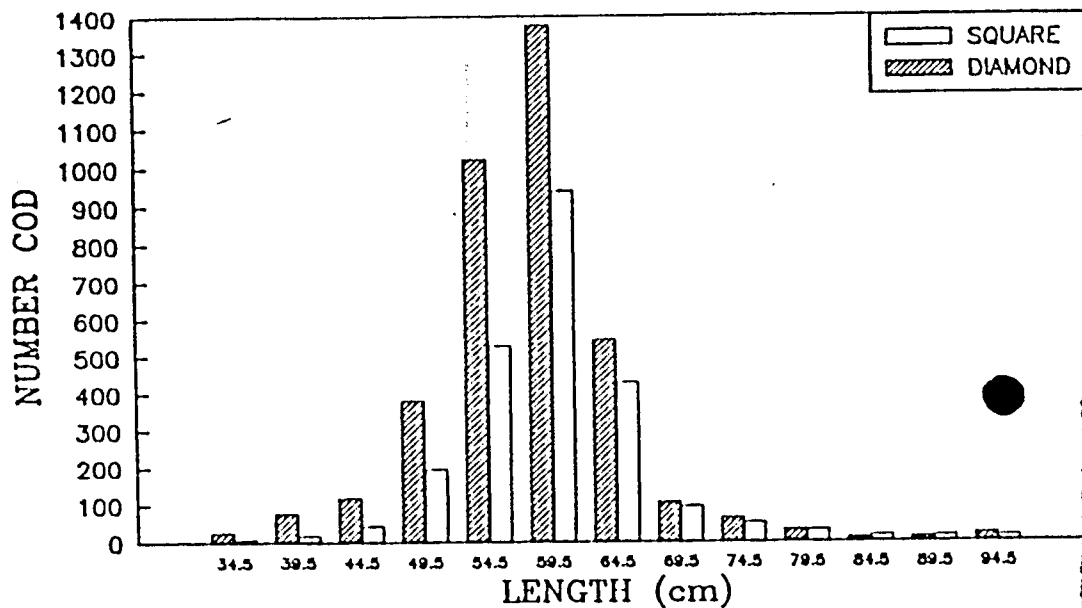diamond and square mesh codends.

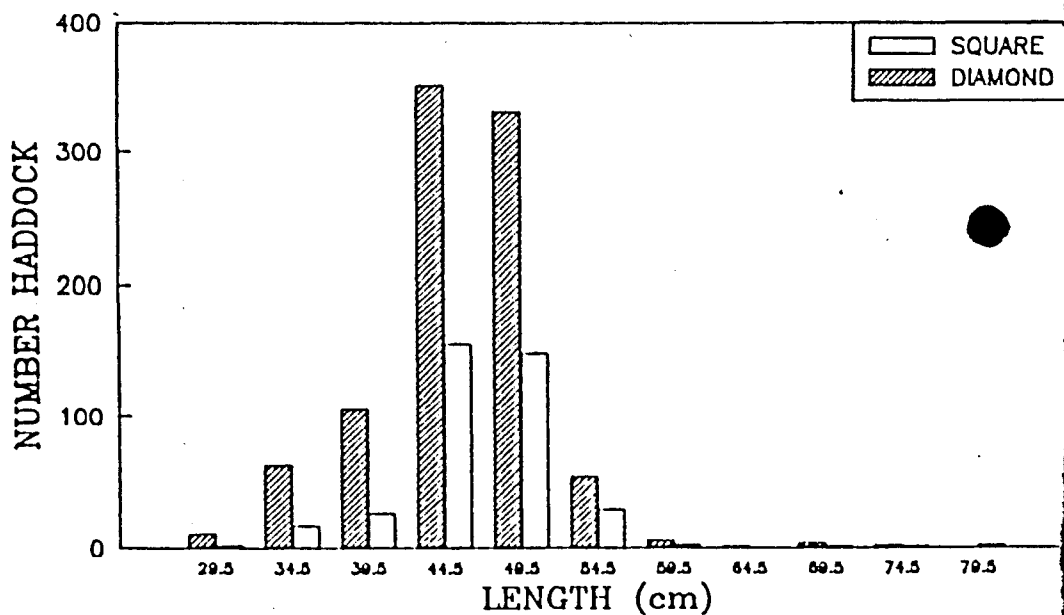Figure 9.   Length distribution of cod in 135 mm diamond and square mesh codends.

Figure 10.   Length distribution of haddock in 135 mm diamond and square mesh codends.