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COMPARISON BETWEEN THE COVERED CODEND METHOD AND THE TWIN TRAWL METHOD IN BEAM TRAWL SELECTIVITY EXPERIMENTS

by

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ABSTRACT

This study compares the covered codend method and the twin trawl method for beam trawl selectivity experiments. The species involved are sole and dab. Several cover types and cover mesh sizes were tested. The twin beam trawl was also used to investigate the masking effect in the covered codend experiments. The conventional statistical model (Pope et al., 1975) is compared with the new model proposed by Millar and Walsh (1990) for analysis of the data from the twin trawl method.

Compared to the twin trawl method, the covered codend method with the larger mesh size covers yielded higher selection factors. The influence of the method on the selection range was less clear and varied according to the species and the cover type. Although there was evidence of masking with some of the covers, haul to haul variations made it impossible to adjust the data for this effect. The comparison of the conventional statistical model and the new model by Millar and Walsh for analyzing data from twin trawl selectivity experiments showed only slight differences in the estimated 50% lengths. The selection ranges obtained with the new model were somewhat smaller for sole but were substantially narrower for dab. The model by Millar and Walsh needs no manipulation of the raw data and should therefore be preferred over the conventional model for this type of experiments.

Introduction

Double rigged beam trawlers (figure 1) tow two nets simultaneously, and thus under the same conditions, and are therefore very suitable for comparative fishing experiments. It is surprising that little advantage has been made of this feature in beam trawl selectivity experiments. In his review of codend selectivity measurements for North Sea species Wileman (1988) reports on a total of 676 hauls made to study codend selectivity for sole in beam trawling. Only in a few occasions, totalling 149 hauls, the selection parameters were estimated by the parallel haul technique in which the experimental codend is rigged to one net and a small meshed reference codend to the other one. The reference codend gives the length distribution of the population. The escapement at each length class is given by substraction of the catches in the experimental codend from those in the reference codend.

Pope et al. (1975) state that the alternate haul method, of which the parallel haul method is a variant, usually gives higher estimates of the 50% length than the covered codend method. Beam trawl selectivity experiments in which both the covered codend and the parallel haul methods are used and may thus be compared, are scarce. Fonteyne and M'Rabet (1988) used the covered codend method as well as the parallel haul method to estimate the selection parameters for sole of diamond and square mesh codends in the Belgian coastal beam trawl fishery. The covered codend technique yielded selection factors of 2.7 for both mesh shapes, whereas by parallel hauls 3.1 and 2.9 were obtained for the diamond and square mesh codend respectively. Van Beek et al. (1981) used the covered codend and the parallel haul method to estimate the selection parameters of sole. No significant differences between the selection factors, 3.2±0.1 and 3.3±0.2, were noticed, but the methods were applied to two different sole stocks, respectively the Irish Sea sole stock and the North Sea sole stock.

The aim of the present investigations was to test whether the covered codend method and the parallel haul method give the same results in beam trawl selectivity experiments. Special attention was paid to the masking effect in the covered codend method, for which several cover designs were tested. To compare the different configurations, use was made of a twin beam trawl. The data from the twin trawl method were analyzed by both the conventional statistical model (Pope et al., 1975) and the model proposed by Millar and Walsh (1990).

The species involved in this research are sole and dab. The numbers of fish of the other species caught were too low for proper analysis in all experiments.

Material and methods

Gear, vessel and fishing grounds

The twin beam trawl used in the experiments is illustrated in figure 2. The 8 m beam was divided in two by a third trawlhead. Nets (figure 3) with a headline length of 3.7 m were mounted to each half and rigged with chain matrices to enable fishing on rough grounds. The experiments were carried out aboard the research vessel 'Belgica' (50.9 m length over all, 1154 kW, 765 GT). As this vessel is not equipped with derrick booms, only one gear was towed over the stern. Six cruises were made in the period February 1990 - March 1991 on fishing grounds located in the southern North Sea (table 1). The experiments were carried out under the same conditions as in commercial fishing. The average towing speed was 4 knots, the mean tow duration was 2 hours.

Codends and covers

The test codend was identical to the one used in the commercial beam trawl fishery. This codend is made of polyethylene yarns, has a circumference of 100 meshes (selvedges included) and a length of 50 meshes. The nominal mesh opening was 80 mm. The belly of the codend is protected by polyethylene ropework shafers.

Several cover types (full covers), illustrated in figure 4, were used in the covered codend experiments. The characteristics are given in table 2. The stretched lengths and widths of the covers are 1.6 and 1.4 times the length and width of the codend. Underwater observations made by Stewart and Robertson (1985) on small mesh codend covers used on a four panel trawl showed that covers 1.5 times the length and width of the codend are unlikely to obstruct the codend meshes. The type 1 cover has the same width all the length through, and is rigged to the tapered part of the net to ensure a maximum opening of the cover. The type 2 cover is tapered at the front and rigged to the net at the same row of meshes as the codend. These two covers were made of polyethylene yarns. This material is chosen for its buoyancy so that the cover will lie away from the codend when fishing. The nominal mesh opening was 60 mm, the smallest available in this material. The type 3 cover has the same shape as type 2 but the mesh opening is only 40 mm. This cover was made of polyamide. To assure that the codend and the cover remain apart when fishing, 6 small floats (1 kg floatability each) were attached to the upper panel of the cover. As with the experimental codends the underside of the covers was protected by rope chafers.

Experimental procedure

At the start of each cruise and prior to the proper selectivity experiments some hauls were made with both nets rigged with identical 80 mm codends to ensure that there was no clear difference in catching efficiency between both nets. To compensate for possible smaller, unnoticed variations however, the codends or codend configurations were regularly switched from one side to the other and the data of all hauls within one experiment were pooled. During the covered codend experiments the experimental 80 mm mesh codend and the cover were rigged to one net. To estimate the masking effect an uncovered 80 mm codend was fixed to the other net. In the twin trawl method experiments one net had the experimental codend, the other one the small mesh reference codend.

After each haul the fish in each codend or cover were sorted by species, weighed and measured to the nearest cm. The bycatch composition was noted. To estimate their weight the bycatches were boxed, the average weight per box being 30 kg. Catches in damaged codends or cover were excluded from further analysis. At regularly intervals 25 top panel codend and cover meshes were measured with an ICES mesh gauge operated at a pretension of 4 kg.

Data analysis

COVERED CODEND EXPERIMENTS

The combined catches of all hauls in each experiment were used to calculate the selection parameters. It was assumed that the selection curve may be represented by the logistic curve (Pope et al., 1975). The curve was fitted by maximum likelihood and the fitting was tested by the chi-square test also described by Pope et al. (1975). The level of significance was set at 0.05. If the expected number of fish in any class was less than 5, neighbouring classes were pooled and the number of degrees of freedom for the chi-square test were decreased accordingly.

The mesh size of the 60 mm cover in the covered codend experiments is sufficiently near the mesh size of the test codend (80 mm) to enable some fish within the selection range of the codend to escape from the cover. Consequently the number of fishes in the cover, especially at the lower length classes, will be underestimated. This may reduce the expected 50% length and increase the selection range. To compensate for this, the expected retention ratios for the cover were calculated for each length class represented, the observed number of fish in the cover were corrected accordingly and new retention points for the test codend were calculated. The retention ratios for the cover were calculated from the logistic equation, specified by

$$p_l = \frac{1}{1+e^{-(a+bl)}} \qquad (1)$$

in which p_l is the retention ratio at length l and a and b are the parameters of the logistic.

After transformation of (1) into logits

$$\ln\left(\frac{p_l}{1-p_l}\right) = a+bl \ ,$$

a and b can be calculated :

$$b = \frac{2\ln 3}{L_{75}-L_{25}} \qquad\qquad a = bL_{50}$$

in which L_{25}, L_{50} and L_{75} are the 25, 50 and 75% retention lengths respectively. $L_{75}-L_{25}$ is the retention range, whereas

$$L_{50} = \text{selection factor} * \text{mesh opening.}$$

The selection parameters used in these calculations were taken from Wileman (1988):

sole : selection factor : 3.2
       selection range : 3.8 cm
dab : selection factor : 2.1
       selection range : 2.3 cm (otter trawl).

TWIN TRAWL EXPERIMENTS

In twin trawl selectivity experiments, as in alternate haul or trouser trawl experiments, the number of fish above the selection range caught in the test codend often exceeds the number of fish in the small mesh reference codend, leading to retention percentages over 100%. This may be due to sampling variation but also to a difference in catching efficiency between both gears (Pope et al., 1975; Millar and Walsh, 1990). To compensate for this the retention ratio at each size may be adjusted by the ratio of the number of large fish in the two codends (Pope et al., 1975). Retention percentages still surpassing 100% must be fixed at 100% to calculate the selection curve parameters. Millar and Walsh (1990) developed a new statistical model to analyze trawl selectivity data from trouser trawl, twin trawl or alternate haul studies. Their model allows for possible differences of split of fish into the two codends. The split proportion is estimated and the hypothesis of an equal split is tested. Both the conventional method proposed by Pope and the method proposed by Millar and Walsh have been applied to our data from the twin trawl experiments.

To fit the logistic selection curve with the method by Millar and Walsh use was made of the FORTRAN program TTRAWL.FOR written by Millar and Cadigan (1991). Our computer program SELPAR was used for fitting the logistic curve by maximum likelihood.

Results and discussion

SOLE - covered codend method

The selection curves for the covered codend experiments with the type 1, 60 mm mesh cover are represented in figure 5. The chi-square value (table 3) indicates a significant difference (0.05 level) between the expected and observed retention points. The selection factor, 2.8, is well below the average value of 3.2 derived by Wileman (1988) from previous experiments. The selection range is much higher than the average, 6.8 cm instead of 3.8 cm. This can partly be explained by the selection of the 60 mm cover in the lower length classes. The retention points corrected for the selection by the cover and the corresponding selection curve are drawn in figure 5. Up to 25 cm the original retention points are altered, but particularly the lowest length classes are affected. The result of the adjustment is an increase of the expected 50% retention length from 23 to 23.75 cm and of the selection factor from 2.8 to 2.9 (table 3). The new selection range is 1.2 cm narrower. There is however still a significant difference between the observed and expected retention ratios. This is mainly due to the low retention ratios at 33 and 36 cm. It is interesting to note that fitting the curve by eye yields about the same selection parameters (table 3).

The masking effect could be judged by comparing the catch of the covered codend on one net with the catch of an identical, but uncovered codend on the other one. The length distributions, presented in figure 6, of the catches (4 valid hauls combined) in the covered and uncovered codend clearly illustrate the masking effect in the length classes below 32 cm. This effect decreases with increasing fish body length. The total number of soles caught by the covered codend exceeded the number caught by the uncovered one by 80 %. An attempt was made to correct the retention points by applying a correction factor to the number of fish retained in the covered codend. This correction factor reflects the ratio between the number of fish in the covered codend and the number of fish in the uncovered codend, averaged over the length classes with more or less equal masking effect. This correction factor was 3.5 for length classes up to 28 cm, 1.3 for the length classes from 29 to 31 cm and 1 (or no correction) from 32 cm on. The total catch 'codend plus cover', was not changed as it represents the population density. Figure 7 illustrates the drastic effect of this correction on the selection curve. The 50% length shifts from 23 cm to 28.54 cm and results in a new selection factor of 3.5 (table 3). The selection range decreases with 1.4 cm. However, the observed retention points do not succeed each other as smoothly as before, especially in the region of the 50% retention length. This may indicate that the corrections made are not adequate. Probably the magnitude of the masking effect varies from haul to haul and the application of correction factors derived from a small number of hauls to a more extensive experiment is not realistic.

The experiments with the type 2, 60 mm mesh cover yielded a 50% retention length of 23.9 cm and a selection factor of 2.9 (table 3). There was no significant difference (5% level) between the observed and the expected retention percentages. The expected 50% length shifts from 23.8 to 24.6 cm when the data are corrected for the selection by the cover (figure 8) and the selection factor increases with 0.1. The effect on the selection range is a narrowing by 1 cm. The masking effect of the cover was less clear than in the experiment with the type 1 cover. The number of soles caught in the covered codend was even 16 % lower than the number in the uncovered one. The length frequency distributions (figure 9) of the covered and uncovered codend catches show that this difference was randomly distributed over all length classes.

Compared to the covered codend experiments with the 60 mm mesh covers, the experiments with the 40 mm cover yielded the high 50% retention length of 27 cm, resulting in a selection factor of 3.4. The selection range had the extreme high value of 10.87. The selection curve is shown in figure 10. There is no uniform difference between the length distributions of the covered and uncovered codend catches of 12 combined hauls in figure 11. About 13% more soles were caught with the covered codend. The classes lower than 30 cm were most affected by the presence of the cover. In the ranges above 30 cm however some more fish were caught by the uncovered codend.

SOLE - twin trawl method

The length distributions of the codend catches in the twin trawl experiment are presented in figure 12. From 29 cm on the number of soles in both codends were more or less equal, though the 80 mm codend retained on average 1.075 more larger fish than the 40 mm reference codend. The differences for each length class between the numbers of fish caught in each codend are however not systematic and it remains an open question whether they are due to a difference in catching efficiency or to sampling variations.
The selection curves are shown in figure 13. The conventional statistical method returned a 50% length of 26 cm, resulting in a selection factor of 3.2. The selection range was 4 cm. To cope with the larger 80 mm codend catches for the higher length classes an adjustment was made by dividing the retention ratios by the factor 1.075 mentioned above. The 50% retention length shifted to 26.46 cm, the selection factor became 3.3. The selection range for the corrected data was 0.5 cm larger. The high chi-square values are due to the high retention ratios at the end of the selection curve, obtained from a small number of fish.
The results from the model by Millar and Walsh were close to those from the conventional method. With the assumption of a 50:50 split the same 50% length (26 cm) was obtained as with the conventional model applied to the unadjusted data. Due to the somewhat steeper selection ogive (figure 13), the

selection range was 0.24 cm smaller. The split estimated statistical model indicated a 54:46 split (large/small mesh codend). The expected 50 % length raised by 0.65 to 26.62 cm. Again, the difference from the 50% length obtained with the conventional model, applied to the adjusted data, was marginal (0.2 cm). The selection range was increased by 0.34 cm, but was 0.4 cm smaller than with the conventional model. Both the 50:50 split and the 54:46 split models showed no significant differences between the observed and expected retention percentages. It should be mentioned that the likelihood ratio test showed that the 54:46 split was not significantly different from the 50:50 split (p=0.072).

Of all experiments carried out the twin trawl method yielded selection factors that were closest to the averages (SF = 3.2, SR = 3.8) of previous selectivity experiments on sole (Wileman, 1988).

DAB - covered codend method

The results of the experiments with the type 1, 60 mm mesh cover are summarised in table 4, whereas the selection curves are given in figure 14. The 50% retention length obtained from the original data is 15.8 cm, the selection range is 5.4 cm. Correcting these data for the selection in the cover leads to a slight increase of the 50% length (16.1 cm) and of the selection factor from 1.94 to 1.98. The selection range decreases to 4.7 cm. Data on the codend selection of dab are rather scarce. Rauck (1980) obtained a selection factor of 2.1 with beam trawls, but he gives no value for the selection range. The mean selection range for dab in otter board trawling (Wileman, 1988) is 2.3 cm.

Figure 15 illustrates that masking by the cover is obvious for length classes up to 23 cm. For each length class correction factors equal to the ratio of the number of dab in the uncovered codend to the number in the covered codend have been applied to the numbers retained in the covered codend. The result of this adjustment can be seen in table 4 and figure 16. As for sole there is a drastic increase, over 4 cm, in the 50% retention length. Again there is a decrease of the selection range with 1.4 cm.

The type 2, 60 mm mesh cover gives higher 50% retention lengths, resulting in a selection factor of 2.1 (table 4). Figure 17 and table 4 indicate only slight changes if the data are corrected for the selection by the cover. With this cover masking occurs at several fish lengths, but as for sole there is no clear pattern (figure 18). This may be due to the low number of fish in this experiment.

The selection curve obtained with the 40 mm cover is shown in figure 19. Due to the small number of fish in the higher length classes the retention points in this region are underestimated. This may have influenced the values of the selection factor (2.3) and the selection range (5.9 cm) which are rather high in this experiment (table 4). The length distributions of the covered and uncovered codends in figure 20 indicate that the masking effect is limited, the total number of fish in the covered codend being only 6% higher than the number in the uncovered one.

DAB - twin trawl method

The length distributions of the 80 mm mesh test codend and the small mesh reference codend catches in the twin trawl experiment are given in figure 21. No difference was observed between the catching efficiency of both gears: the length classes above 21 cm (100% retention) totalled 195 and 193 fish for the 80 mm and 40 mm mesh codends respectively. The selection curves are shown in figure 22. The conventional model produced a 50% length of 18.9 cm and a selection factor of 2.4, the highest noticed during the present experiments. The model by Millar and Walsh, assuming a 50:50 split, displayed a 50% length of 18.38 cm and a selection range of 2.57 (table 4). This selection range is 1.5 cm narrower than the value obtained with the conventional model and indicates a steeper selection curve (figure 22). Given the fact that the Millar and Walsh model resulted in a better fit of the selection curve to the observed value, the results from this model should be retained. Although from the observed data there is no indication for a difference in catch efficiency of both gears, the p-estimated model reveals a 46:54 (large/small mesh codend) split. This split is however not significantly different from the equal split (p=0.171). The split model leads to a further but small decrease of both the 50% length (17.97 cm) and the selection range (2.33 cm). As with the 50:50 split model, the 46:54 model yielded expected retention points that were not significant different from the observed values.

Conclusions

1. Method

The twin gear experiments yielded higher 50% retention lengths and selection factors than the covered codend method with 60 mm mesh covers, for both sole and dab. The influence on the selection range was less clear and varied according to the species and the cover type.

The differences in 50% retention lengths between the type 3, 40 mm mesh cover and the twin gear experiments were less pronounced and resulted in selection factors differing 0.1-0.2 for sole and 0.0-0.1 for dab. The selection range obtained with the 40 mm cover was extremely large, especially for sole.

2. Cover type

The selection factors obtained with the 60 mm mesh type 2 cover were slightly larger than with the type 1 cover, the selection ranges were lower. The 40 mm mesh polyamide cover gave larger selection factors than the 60 mm mesh polyethylene covers for both species, but the selection ranges were very wide.

The selection curves of the cover and the codend may overlap if the cover mesh size is too large and this will result in an underestimate of the 50% retention length and the selection factor and in an overestimate of the selection range. It is however possible to compensate for this effect if the retention ratios of the cover for the length classes involved are taken into account.

3. Masking

The masking effect was most pronounced with the 60 mm mesh, type 1 polyethylene cover. Probably the magnitude of the masking effect varies from haul to haul, which makes it difficult to compensate for this source of bias. The use of floats with the polyamide cover seems to restrict the masking effect to an acceptable level.

4. Twin trawl data analysis

When analyzing data from twin trawl selectivity experiments using the conventional statistical model, problems arise when for lengths above the large mesh selection range more fish are caught in the large mesh codend and the retention percentage thus exceeds 100%. An adjustment procedure is required to equalize the catches. The model developed by Millar and Walsh (1990) needs no manipulation of the raw data and should therefore be preferred over the conventional method. The split proportion is estimated and the hypothesis of an equal split is tested. The two methods showed only slight variations in the estimated 50% lengths. The selection ranges obtained with the new model were somewhat smaller for sole but were substantially narrower for dab.

Acknowledgements

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Table 1 - Cruise data

Ref No	Date	Fishing grounds	Experiments	No of hauls
90/03	19-23.2.90	Baie de la Seine Falls	Control of catching efficiency Covered codend, type 1/60mm cover, masking effect	5 13
90/05	5-9.3.90	Outer Gabbard, Falls	Control of catching efficiency Twin trawl method, 60 mm ref codend Covered codend, type 1/60mm cover, masking effect	6 7 3
90/14	29.5-1.6.90	Outer Gabbard, Galloper	Control of catching efficiency Covered codend, type 2/60mm cover, masking effect	6 6
90/21	17-19.9.90	Galloper	Control of catching efficiency Covered codend, type 2/60 mm cover, masking effect	3 2
91/02	28.1-7.2.91	Southermost Rough, Flamborough Hd Gd, Little Inner Silver Pit, Smiths Knoll, Outer Gabbard, Galloper	Control of catching efficiency Covered codend, type 3/40 mm cover, masking effect	3 17
91/06	4-8.3.91	Galloper, Outer Gabbard, Inner Gabbard	Control of catching efficiency Twin trawl method, 40 mm ref codend	2 18

Table 2 - Codend and cover constructions

Type	Dimensions	Material	Mesh length/ mesh opening
Codend	50 meshes long x 100 meshes round or 4.5m x 9m	PE, twisted 2xR4130tex	90/80 mm
Cover type 1 (figure 4)	112 meshes long x 180 meshes round or 7.84m x 12.6m	PE, braided R6000tex	70/60 mm
Cover type 2 (figure 4)	100 meshes long x 180 meshes round or 7m x 12.6m	PE, braided R6000tex	70/60 mm
Cover type 3 (figure 4)	162 meshes long x 292 meshes round or 7.3m x 13.14m	PA, braided R3180tex	45/40 mm

Table 3 - Selection data for sole

Corrections	No of hauls	Mesh opening (mm)	No of fish in codend	No of fish in ce+cover/ ref codend	L_{50} (cm)	SF	SR (cm)	χ^2	df	$P(\chi^2)$
Covered codend method, cover: type 1 - 60 mm mesh opening										
	6	81.28	287	396	23.01	2.83	6.84	52.7	21	<0.001
Cov. selection			287	459	23.75	2.9	5.66	64.9	21	<0.001
Fitted by eye			287	396	24.0	3.0	5.8			
Masking effect			162	396	28.54	3.5	5.41	56.5	21	<0.001
Covered codend method, cover: type 2 - 60 mm mesh opening										
	6	81.96	136	171	23.86	2.91	5.41	19.3	18	0.374
Cov. selection			136	193	24.56	3.00	4.44	25.3	18	0.117
Covered codend method, cover: type 3 - 40 mm mesh opening										
	12	79.01	359	794	27.01	3.42	10.87	32.3	24	0.120
Twin gear method										
	14	80.35	646	1376	25.99	3.24	4.03	19616.4	24	<0.001
Catching eff.					26.46	3.29	4.53	7025.8	24	<0.001
Millar & Walsh, 50:50 split					25.97	3.23	3.79	25.1	24	0.400
Millar & Walsh, 54:46 split					26.62	3.31	4.13	21.8	23	0.533

L_{50} = 50% retention length; SF = selection factor; SR = selection range; df = degrees of freedom

Table 4 – Selection data for dab

Corrections	No of hauls	Mesh opening (mm)	No of fish in: codend	No of fish in: ce+cover/ ref codend	L_{50} (cm)	SF	SR (cm)	χ^2	df	$P(\chi^2)$
Covered codend method, cover: type 1 – 60 mm mesh opening										
	6	81.28	445	794	15.76	1.94	5.41	18.3	18	0.436
Cov. selection			445	894	**16.09**	1.98	4.65	10.8	18	0.903
Masking effect			190	794	19.94	2.45	4.06	59.2	18	<0.001
Covered codend method, cover: type 2 – 60 mm mesh opening										
	6	81.96	222	370	17.18	2.10	3.58	22.2	13	0.052
Cov. selection			222	401	17.34	2.12	3.26	20.9	13	0.075
Covered codend method, cover: type 3 – 40 mm mesh opening										
	10	79.01	460	960	18.21	2.31	5.90	55.6	20	<0.001
Twin gear method										
	14	80.35	374	856	18.87	2.35	4.06	534.8	18	<0.001
Millar & Walsh, 50:50 split					18.38	2.29	2.57	26.5	20	0.150
Millar & Walsh, 46:54 split					17.97	2.24	2.33	24.6	19	0.174

L_{50} = 50% retention length; SF = selection factor; SR = selection range; df = degrees of freedom

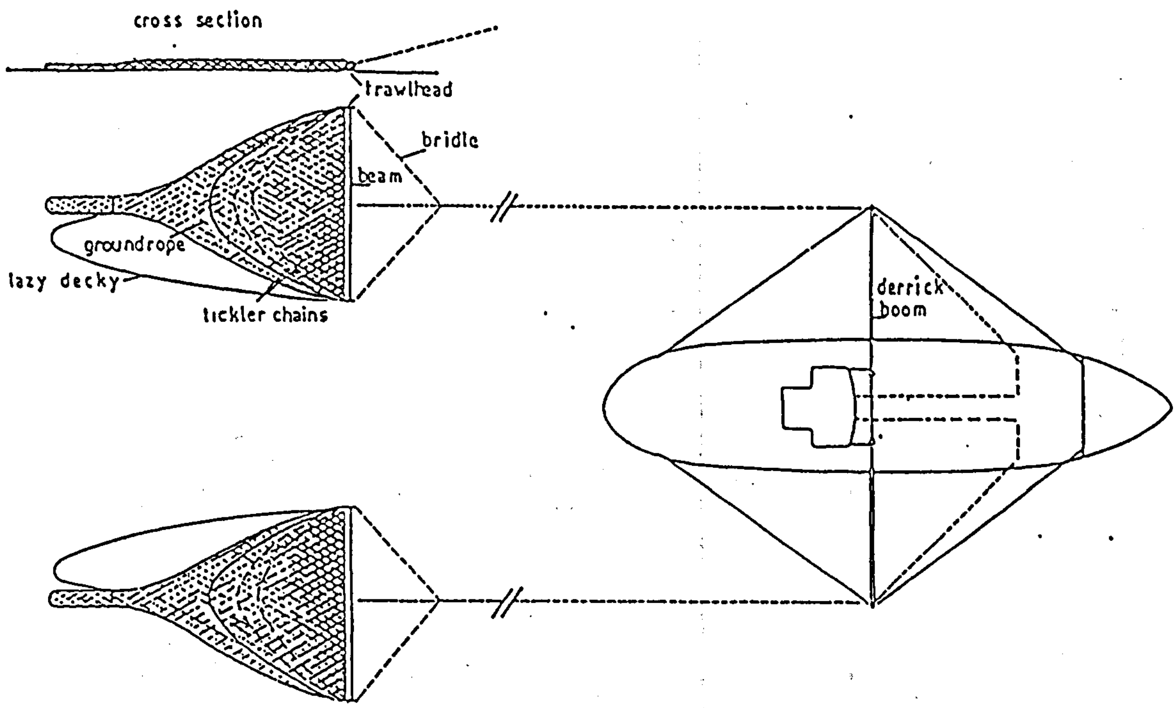


Figure 1 – Double rig beam trawling.

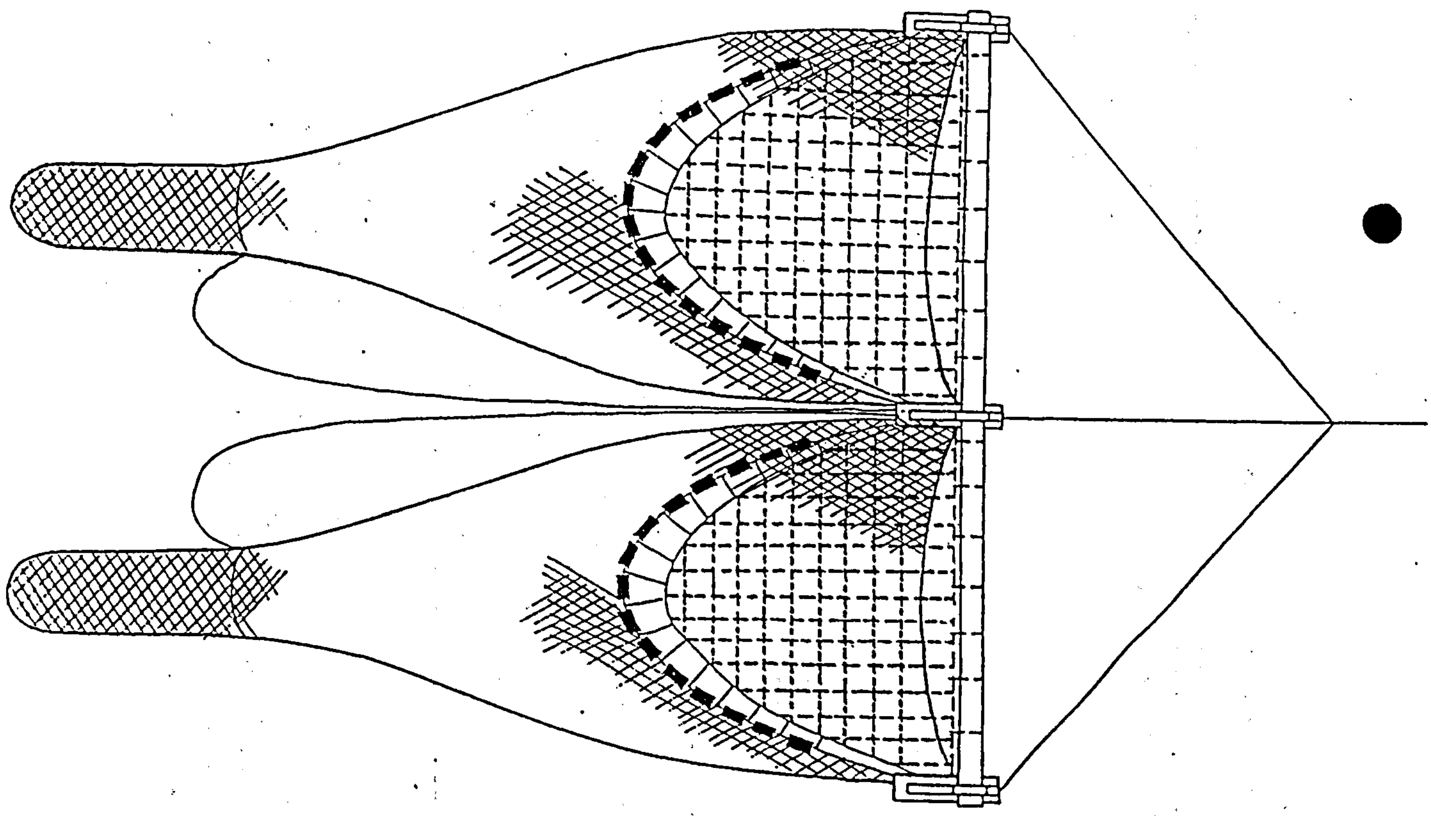


Figure 2 – Twin beam trawl.

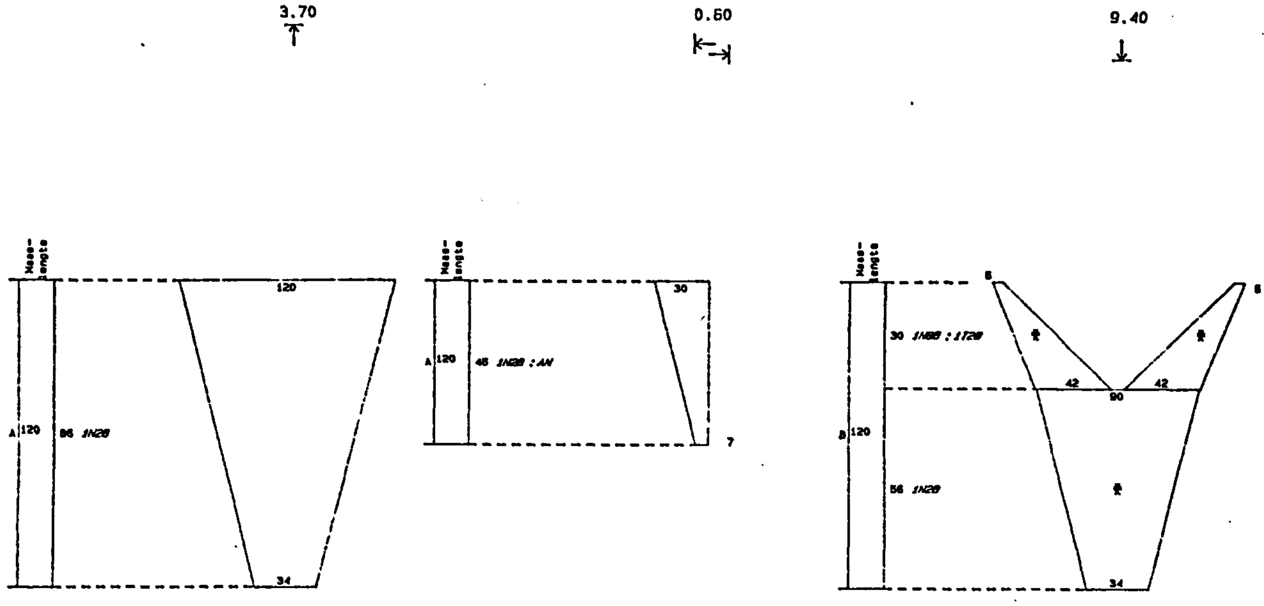
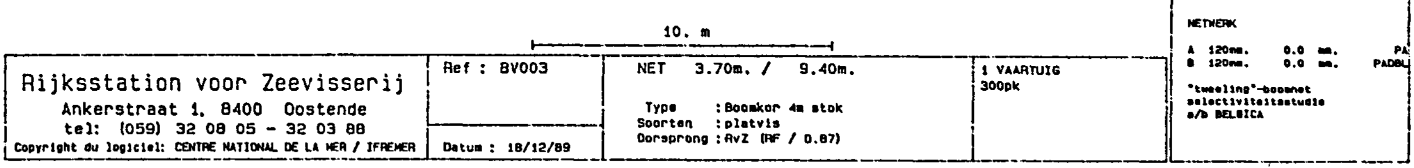


Figure 3 — Net plan.



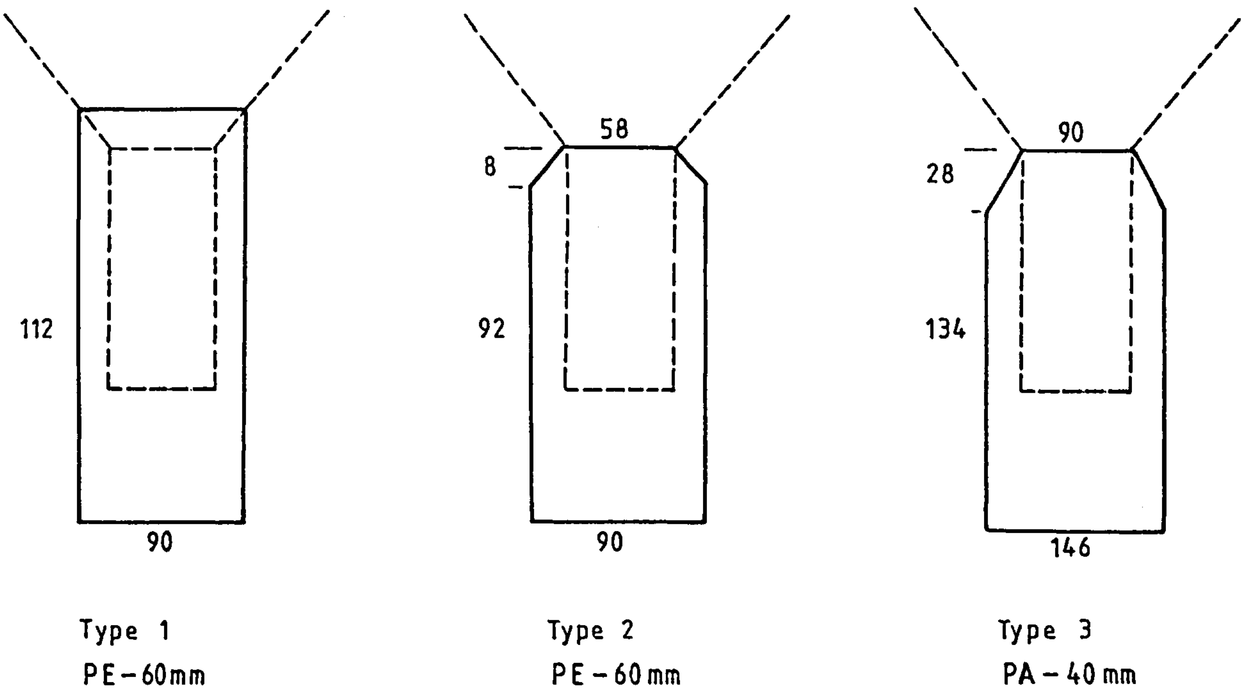


Figure 4 — Cover types.

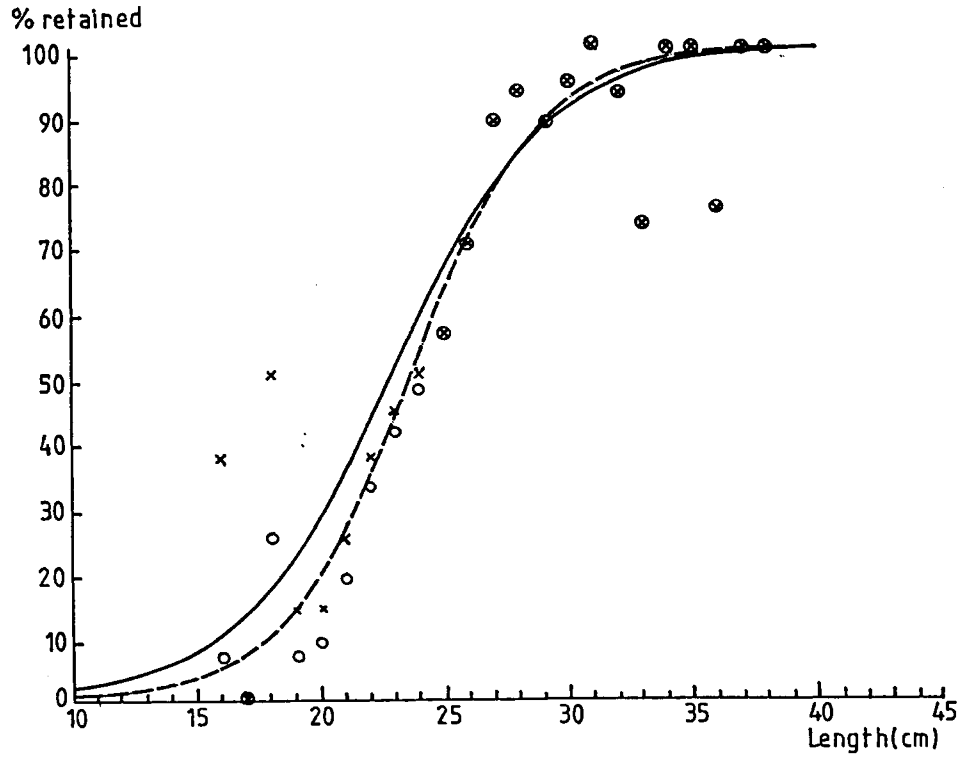


Figure 5 – Selection curves for sole, covered codend method – cover : type 1, 60 mm mesh opening.

× ——— observed retention points
o ---+-- retention points corrected for selection by the cover.

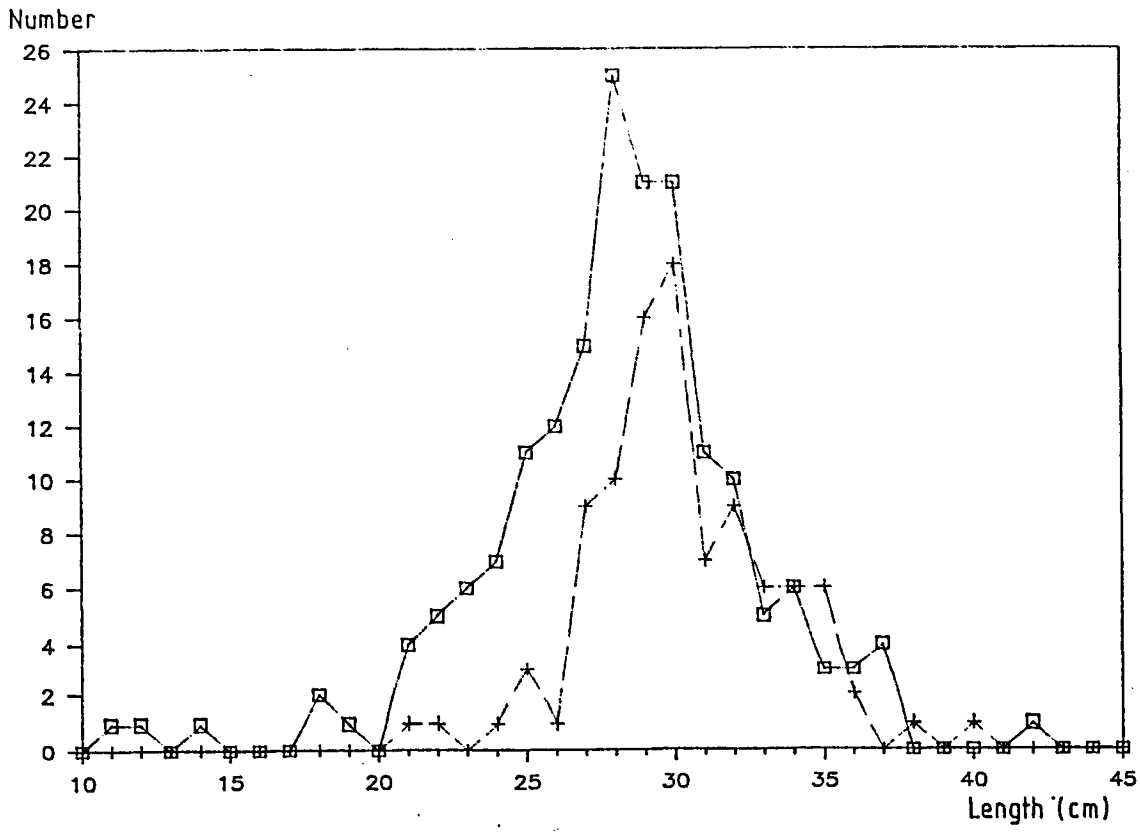


Figure 6 — Length distributions of the sole catches in the covered (□) and uncovered (+) codends.
cover: type 1, 60 mm mesh opening.

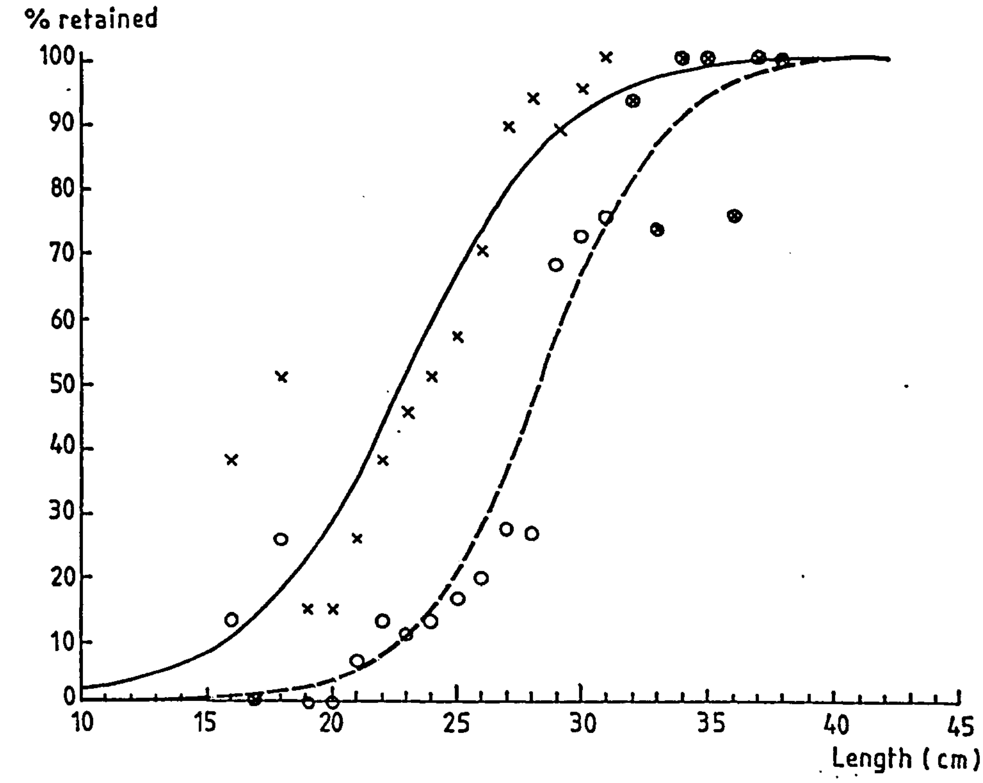


Figure 7 – Selection curve for sole corrected for the masking effect

× ——— original retention points
○ – – – retention points corrected for the masking effect.

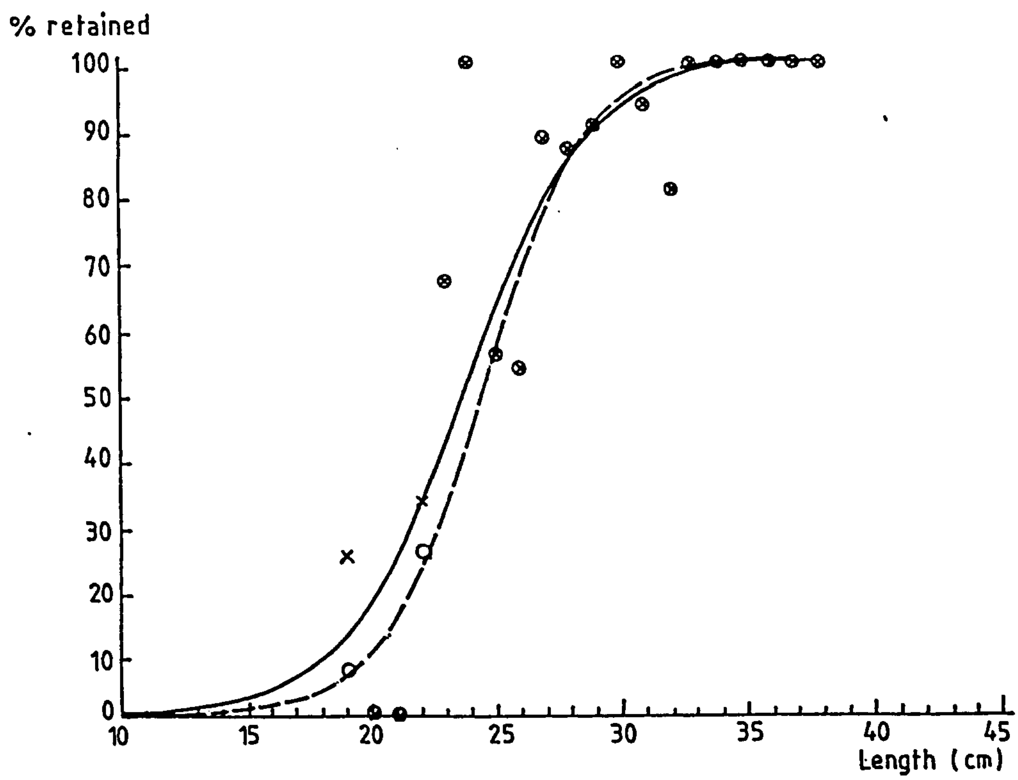


Figure 8 – Selection curves for sole, covered codend method – cover : type 2, 60 mm mesh opening.

× ——— observed retention points.
○ – – – retention points corrected for selection by the cover.

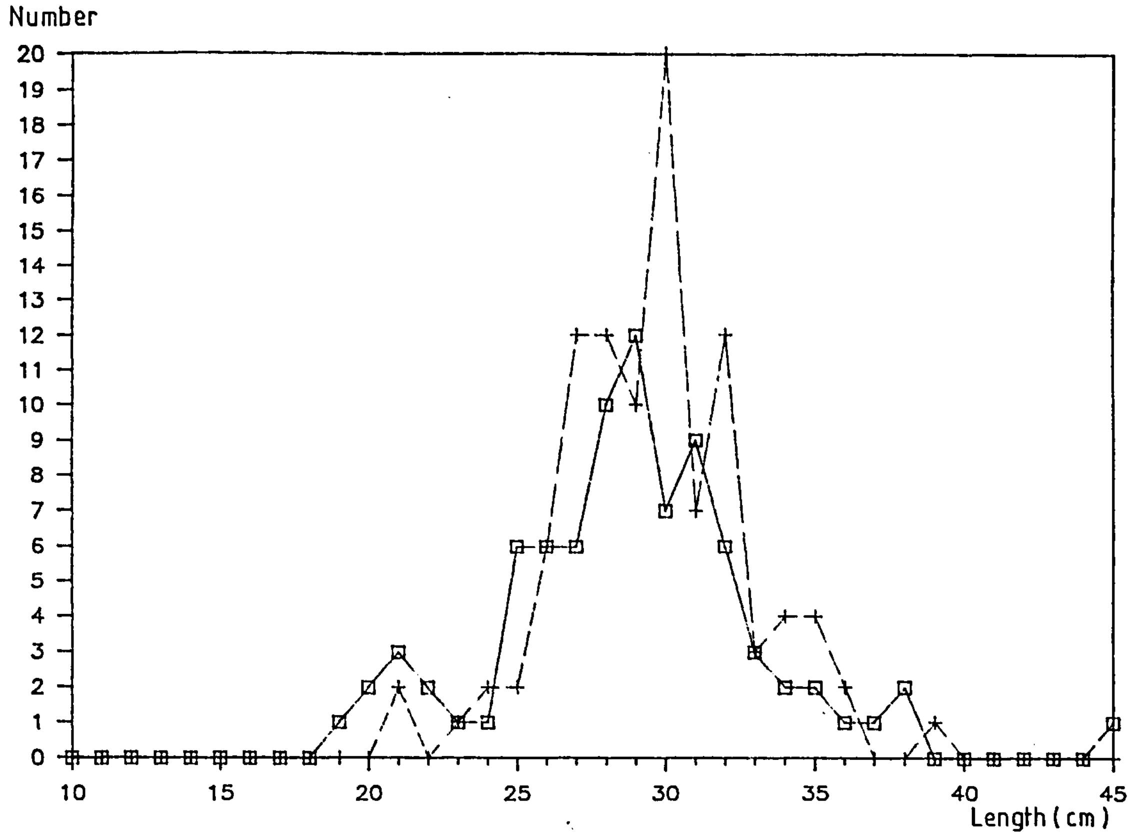


Figure 9 — Length distributions of the sole catches in the covered (□) and uncovered (+) codends.
cover: type 2, 60 mm mesh opening.

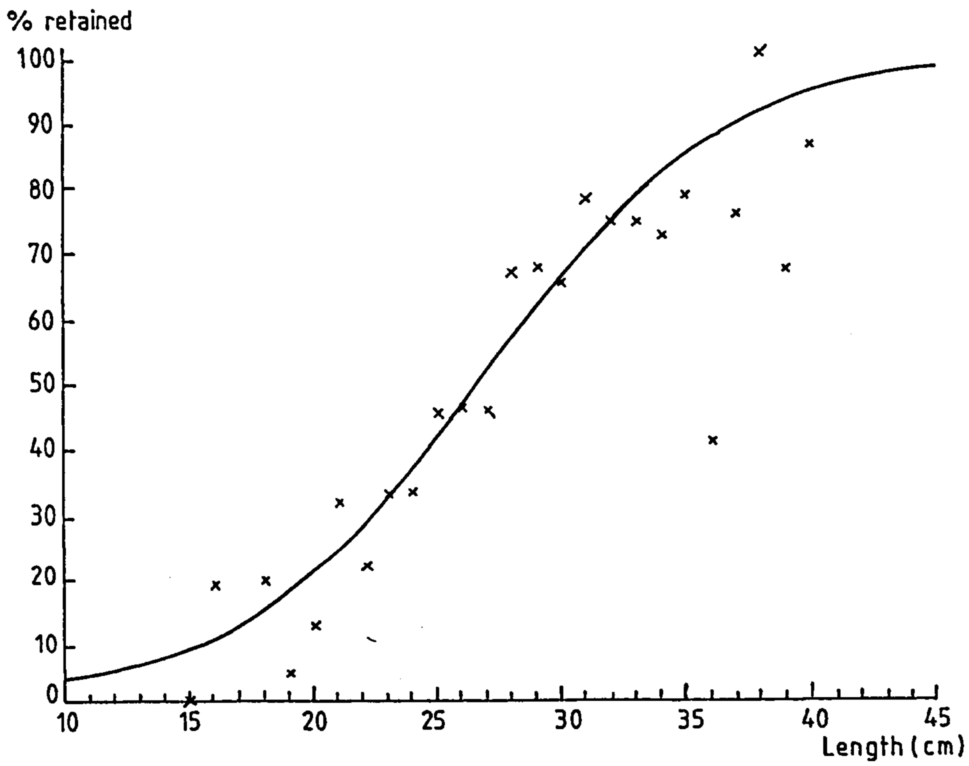


Figure 10 — Selection curve for sole, covered codend method.
cover: type 3, 40 mm mesh opening.

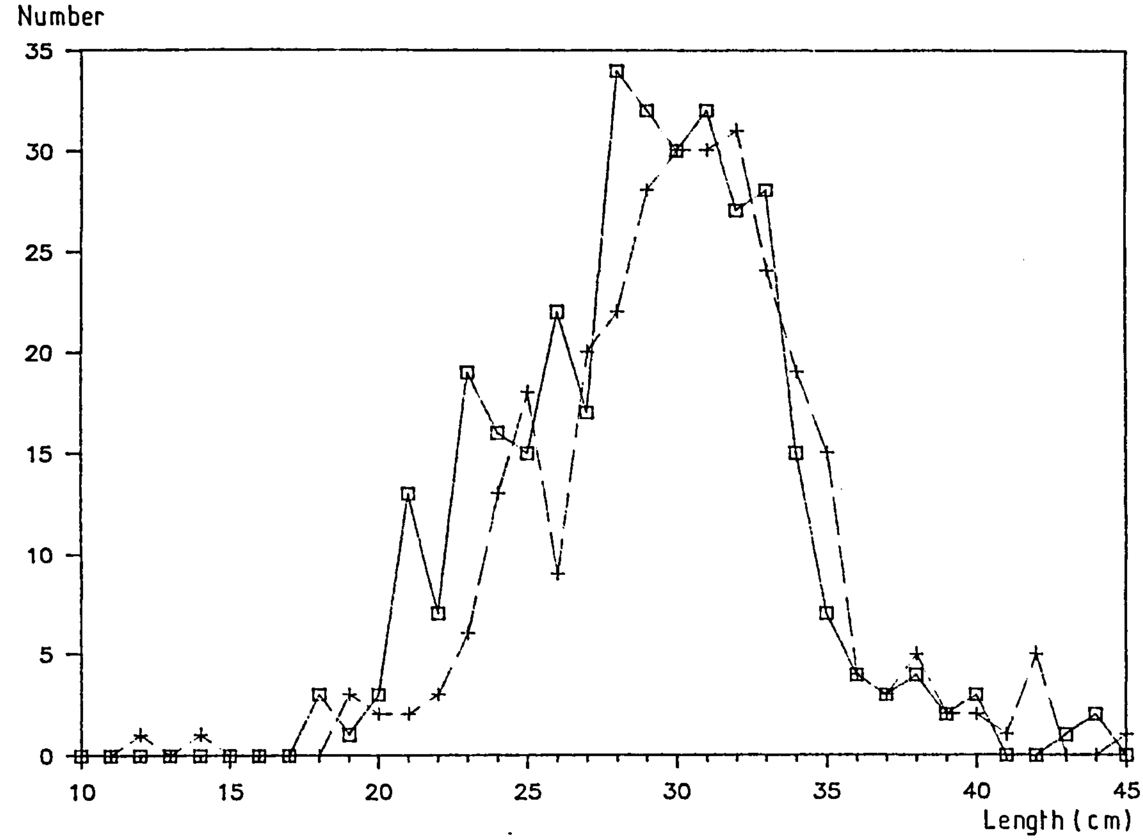


Figure 11 _ Length distributions of the sole catches in the covered (□) and uncovered (+) codends.
cover: type 3, 40 mm mesh opening.

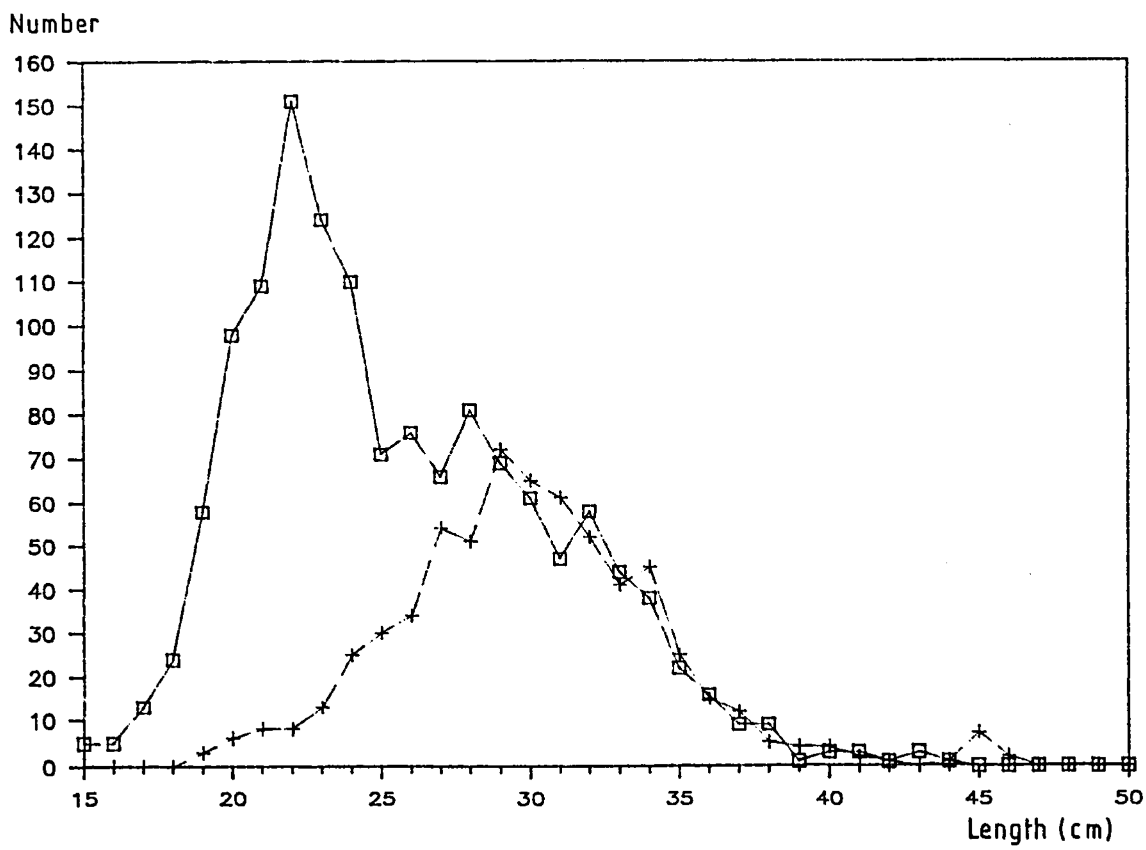


Figure 12 _ Length distributions of the sole catches in the 40 mm (□) and the 80 mm (+) codends.

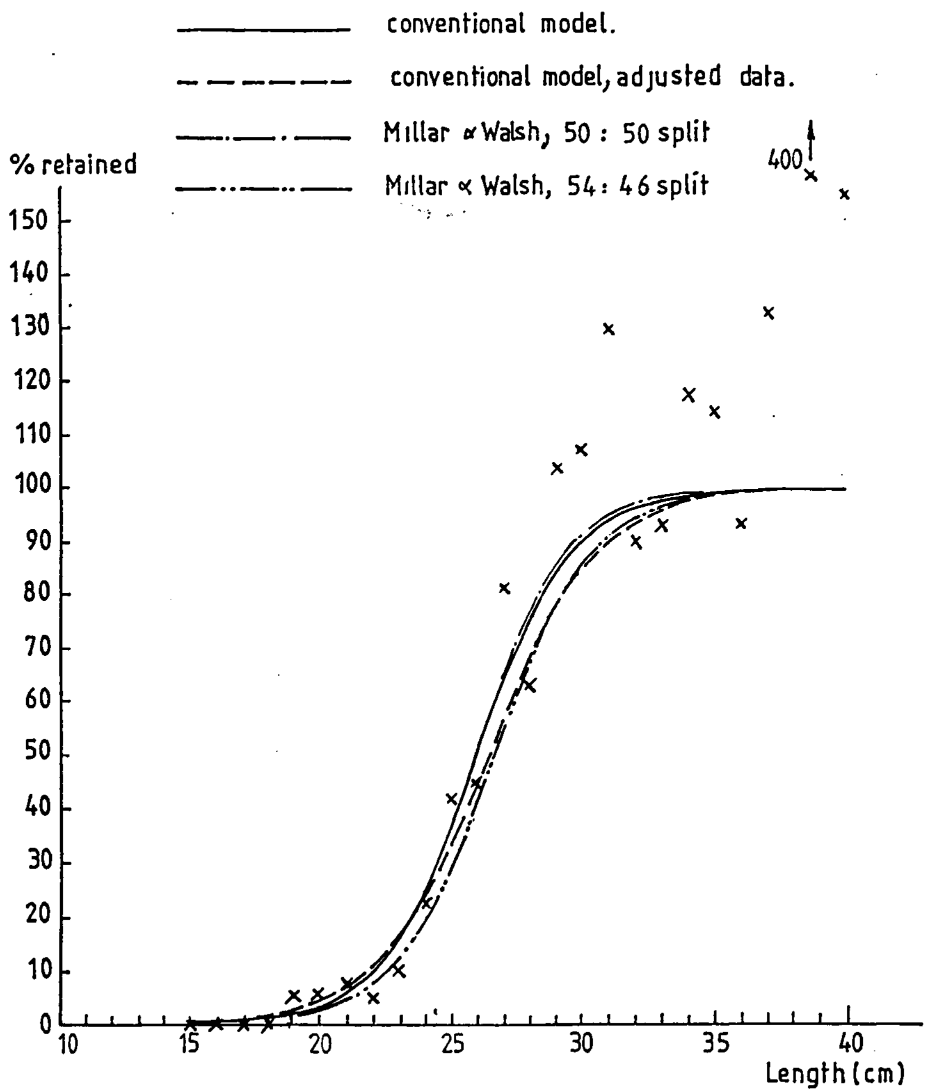


Figure 13 _ Selection curves for sole, twin trawl method.

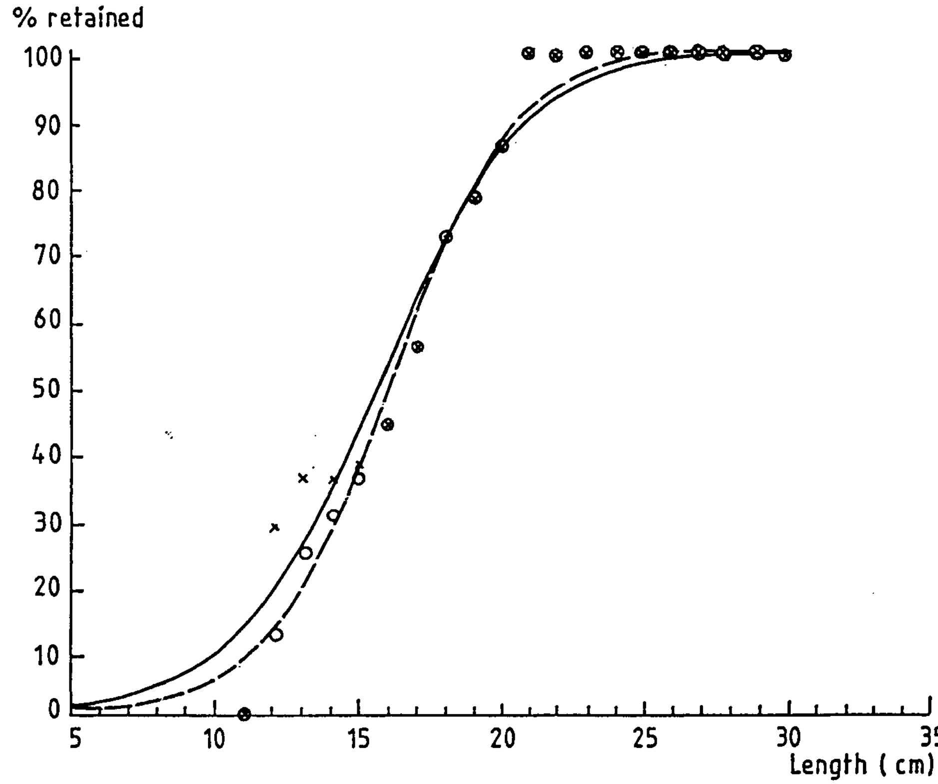


Figure 14 _ Selection curves for dab, covered codend method – cover : type 1, 60mm mesh opening.

× ——— observed retention points
o – – – – retention points corrected for selection by the cover.

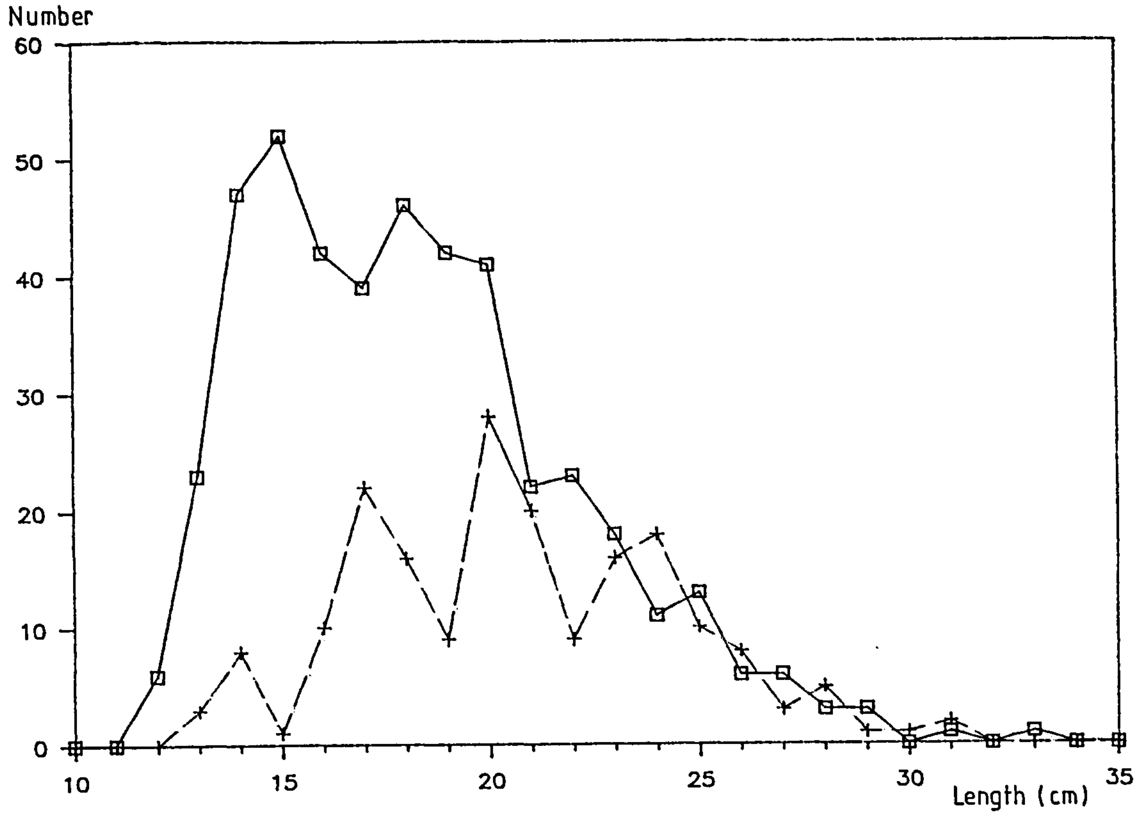


Figure 15 _ Length distributions of the dab catches in the covered (□) and uncovered (+) codends
cover: type 1, 60 mm mesh opening.

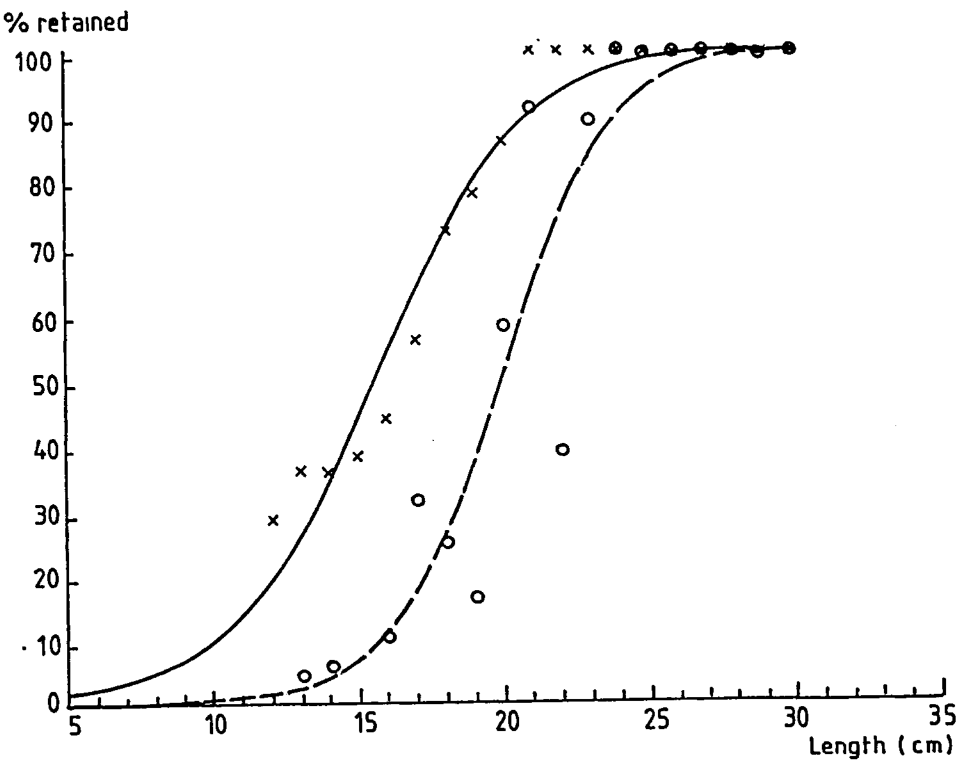


Figure 16 — Selection curves for dab corrected for the masking effect.

× ———— original retention points

o – – – – – retention points corrected for the masking effect.

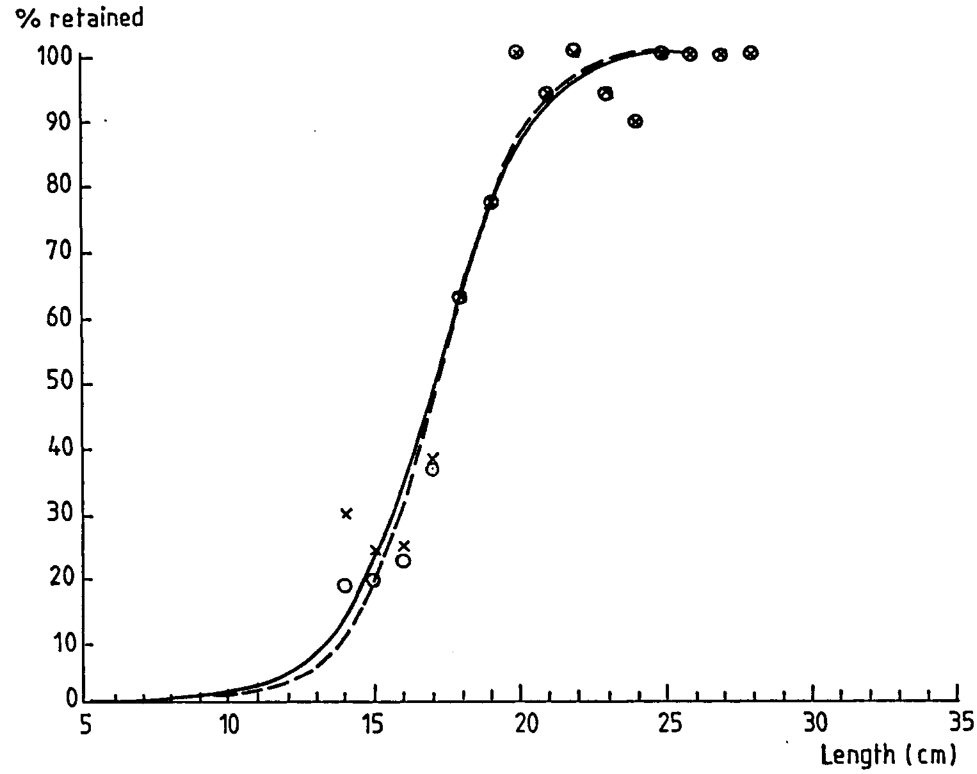


Figure 17 — Selection curves for dab, covered codend method
cover : type 2, 60 mm mesh opening.

× ——— observed retention points.

O - - - - retention points corrected for selection by the cover.

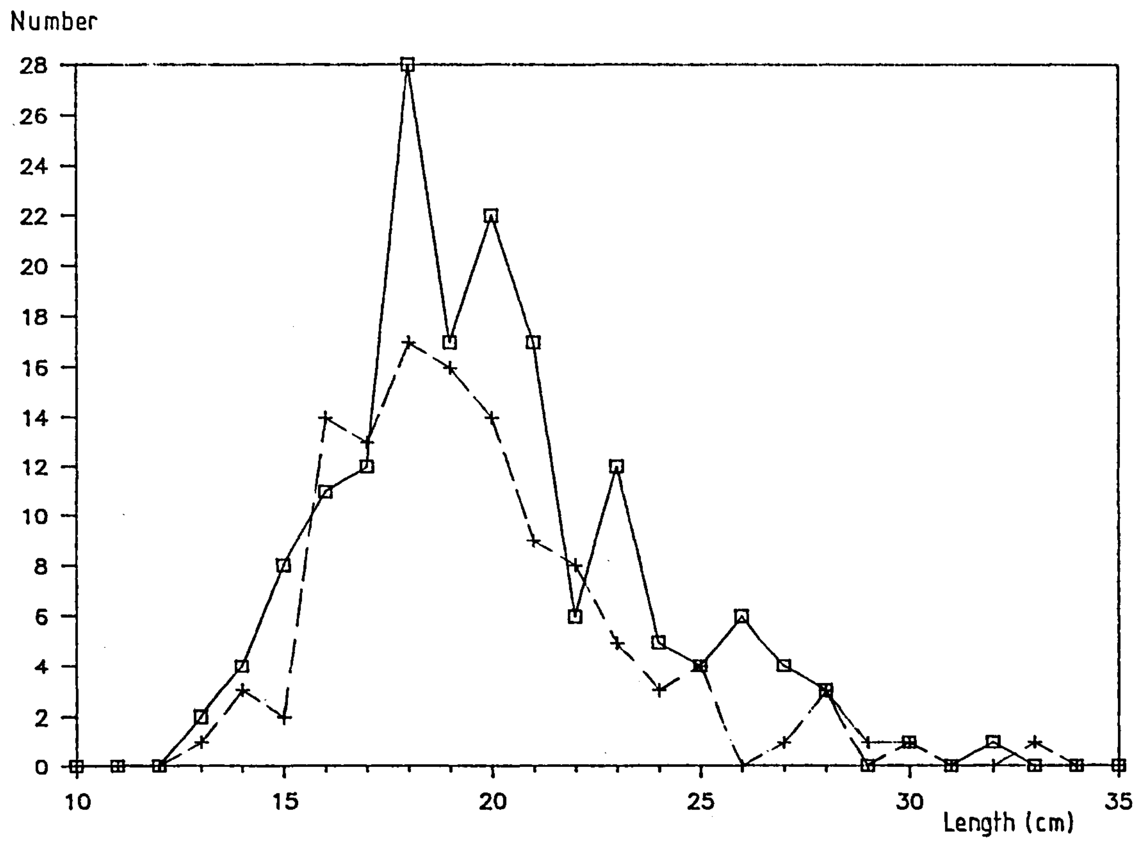


Figure 18 — Length distributions of the dab catches in the covered (□) and uncovered (+) codends.
cover: type 2, 60mm mesh opening.

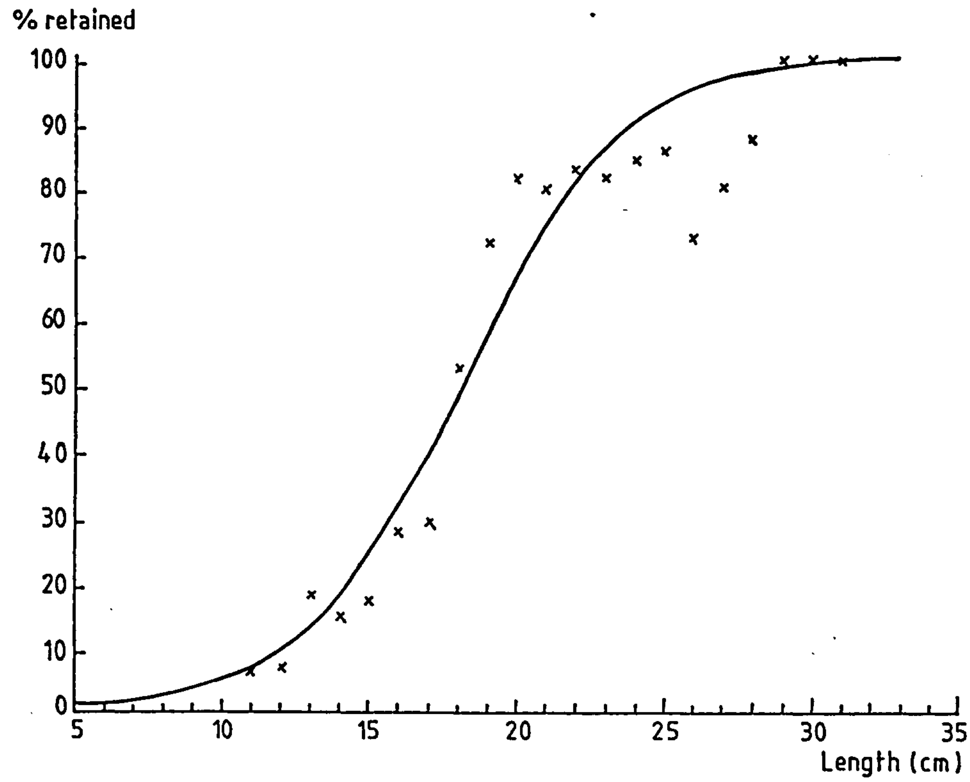


Figure 19_ Selection curve for dab, covered codend method.
cover : type 3, 40 mm mesh opening.

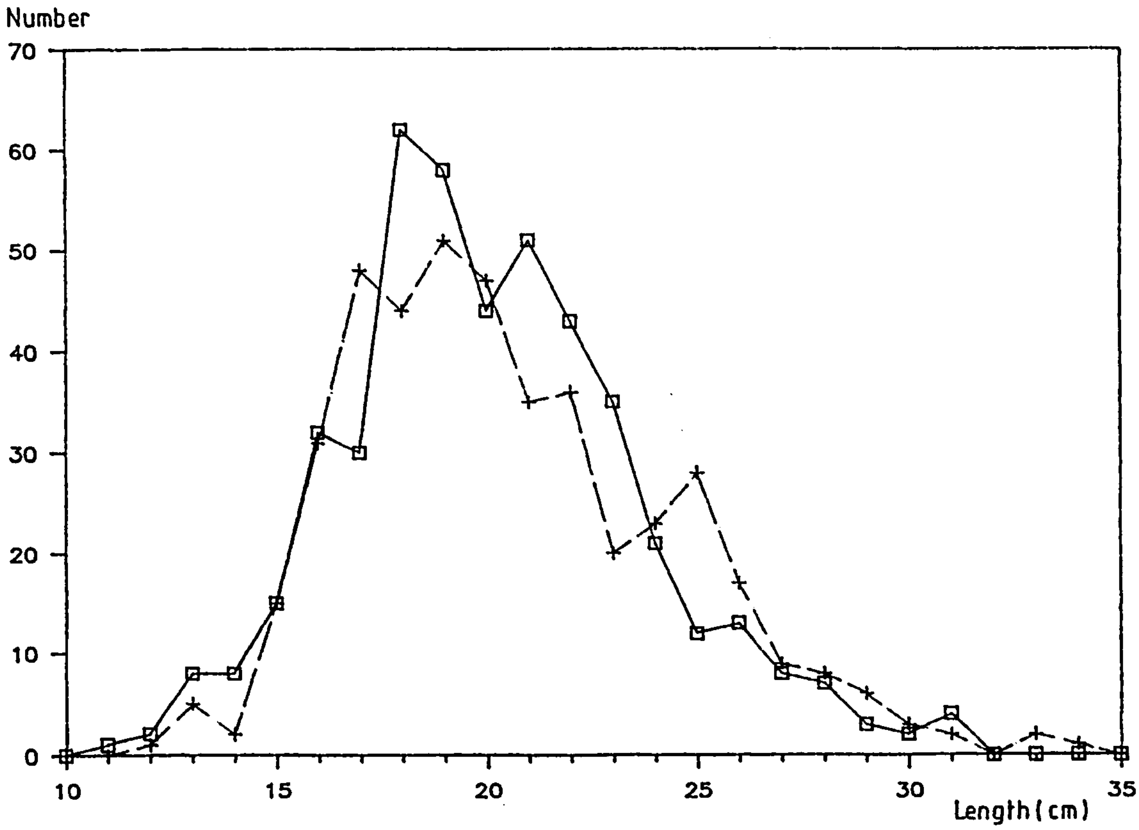


Figure 20_ Length distributions of the dab catches in the covered (□) and uncovered (+) codends.
cover : type 3, 40 mm mesh opening.

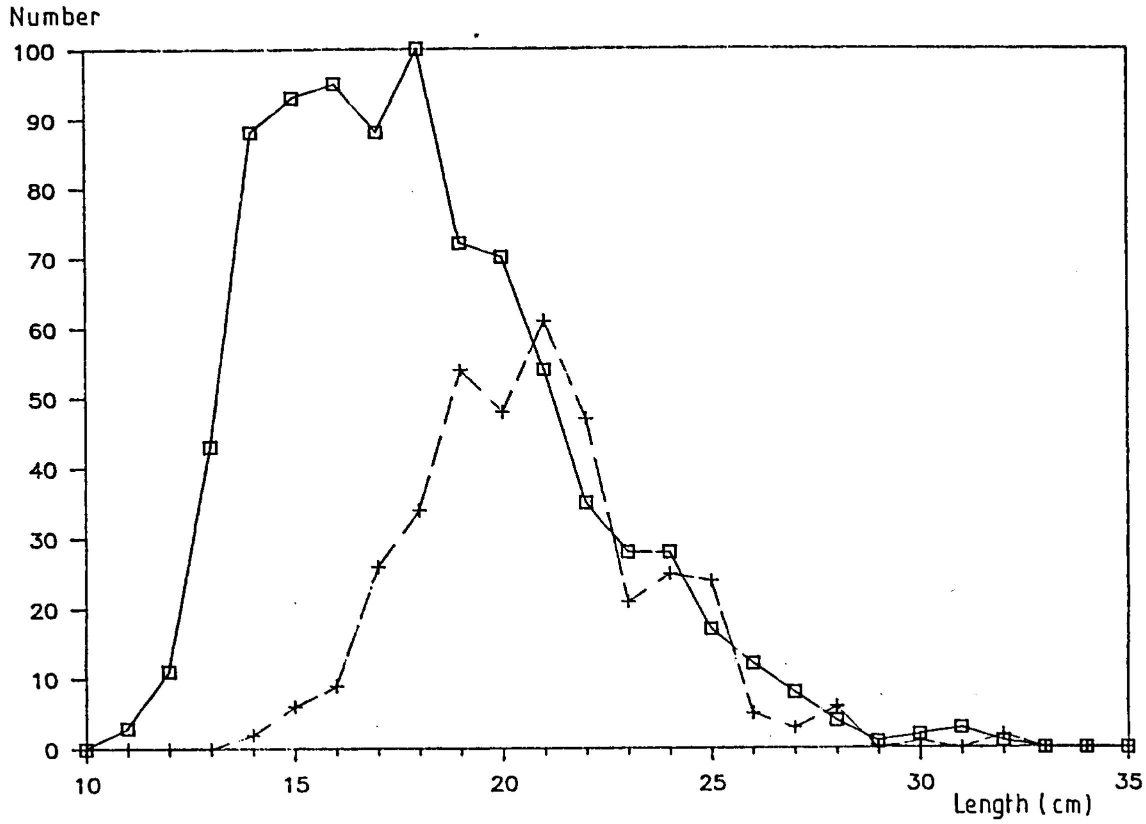


Figure 21 — Length distributions of the dab catches in the 40 mm (□) and 80 mm (+) codends.

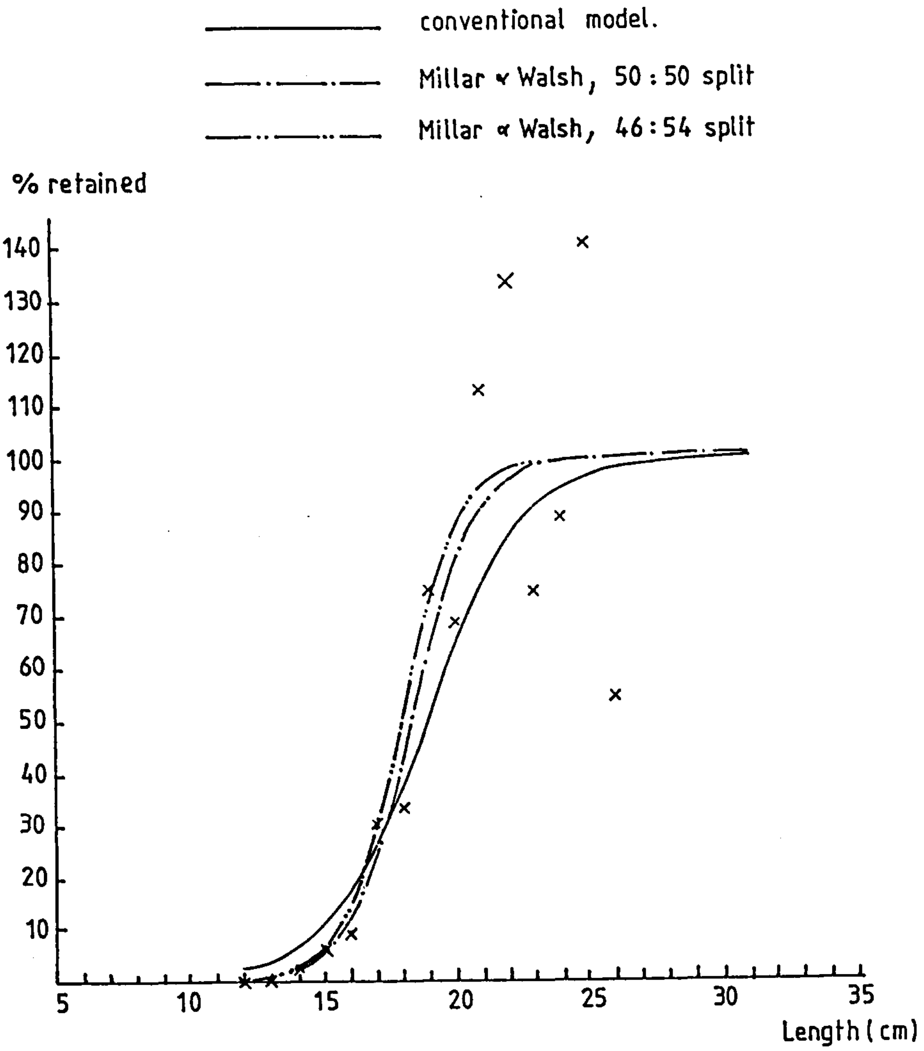


Figure 22 — Selection curves for dab, twin trawl method.