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Report of the Mesh Selection Working Group, 1959-1960

INTRODUCTION

In 1958 a comparative mesh selection experiment was undertaken in which research vessels from Holland, West Germany and Scotland took part. This experiment was performed in the North Sea and had as one of its primary aims the comparison of mesh selection results obtained by different vessels using different gears but otherwise using common experimental techniques. The intensive work carried out previously by member countries of the International Council for the Exploration of the Sea (ICES) and also of the International Commission for the North-west Atlantic Fisheries (ICNAF) had brought into prominence the wide variability in mesh selection experiment results and pointed to the need for a critical evaluation of the many factors contributing to such variation.

A second co-ordinated experiment was undertaken in 1959 in the Arctic, research trawlers from West Germany, Norway, England, U.S.S.R. and Scotland taking part. Among the aims of this experiment were measurement of selectivity of Arctic cod by the trawls in common use in that fishery, the measurement of the selectivity of trawls made of synthetic twines and an evaluation of the effect on results of experimental technique and other variables.

When a preliminary report on the 1959 International Arctic mesh experiment was presented to the Comparative Fishing Committee at the forty-seventh meeting of the International Council in 1959 it was resolved..."That a meeting be held..... of one representative of each of the countries concerned in the International Arctic mesh selection experiment, together with others concerned in the 1958 and 1959 experiments, in order to assess the results of the Arctic experiment more fully, particularly for the purposes of the international cod stock assessment, and to introduce further standardisation in such experiments whilst trying to extract the maximum information from them for the Liaison Committee (it is hoped that the latter will include further information on the problem of the use of cod-end covers in relation to alternating haul experiments, and on synthetic and other twine characteristics in relation to "light trawls"). To ensure the maximum international value from such a meeting it is also recommended that other countries be encouraged to send a representative". Later these terms of reference were extended to include a survey of trawl and seine cod-end mesh selection and a summary of selectivity data for the ICES area collected in the period since the preparation of the report of the Ad Hoc Committee established at the Fourth Meeting of the Permanent Commission, September 1955.

COPENHAGEN MEETING, 1959

A mesh selection working group was convened in Copenhagen, December 7 - 12, 1959. The representatives who took part were:-

Ch. Gilis	Belgium
K.P. Andersen	Denmark
Ag. J.C. Jensen	Denmark
A.R. Margetts	England
A. von Brandt	Federal Republic of Germany
M. Roessingh	Holland
G. Saetersdal	Norway (Convenor)
J.A. Pope	Scotland

G. Otterlind	Sweden
E. Akyuz	FAO

Unfortunately, Dr. A.I. Treschev, U.S.S.R., who had planned to participate was ill and could not attend, but a report was received during the meeting containing the relevant U.S.S.R. data.

The following programme was adopted for the work of the group:-

A. To work up the results of the Joint Mesh Selection Experiments, 1959.

B. To review previous results of mesh selection experiments from Arctic waters.

C. To review the results of the 1958 International Mesh Selection Experiments.

D. In the light of these and other available results:-

(i) To discuss and arrive at agreed values for the selection factors of Arctic cod and haddock and possibly redfish.

(ii) To discuss selection results obtained from the two methods alternate hauls/covered cod-ends.

(iii) To discuss standardisation of trawl mesh selection methods, notably:-

1. Standardisation of covers.
2. " " haul duration.
3. " " towing speed.
4. " " mesh measurements.
5. " " fish measurements (length and girth)
6. " " description of net twines.

(iv) To discuss the definition of "light trawl".

(v) To summarize in a draft tabular form all European trawl selectivity data published since the summary prepared by the Ad Hoc Committee in 1955. This draft table would then be circulated to all members of the Comparative Fishing Committee for checking and could be presented in a revised and complete form at the ICES meeting, 1960.

(vi) To discuss the methods of analysing mesh selection data.

E. To report to the Chairman of the Comparative Fishing Committee on the work of the Group.

The discussions were based mainly on processed data prepared in advance of the meeting by some of the participants. These data were:-

A summary of the results of the 1959 International Experiments (Margetts).

Report of the 1958 International Experiments (Pope and Roessingh).

A review of types of synthetic fibres used in net materials (von Brandt).

Suggestions for standardisation of description of net twines (von Brandt).

A description of the net twines used in the 1959 International Experiments (von Brandt).

An account of U.S.S.R. trawl selectivity data (Treschev).

A list of European trawl selectivity data published since the Ad Hoc Committee's summary (Saetersdal).

In addition to these grouped and processed data use was also made of the basic data from the 1959 International Experiments. Papers and reports from the Biarritz and Lisbon meetings and from the annual meetings of the Comparative Fishing Committee during later years were also considered, especially when discussing agenda item D (iii).

A considerable time was spent in analysing and discussing the 1958 and 1959 International Experiments. A report to the Chairman of the Comparative Fishing Committee of ICES included a summary of the main data from the 1959 International Experiment, a condensed report of the 1958 experiment, and a review of the discussions and views of the group on the various agenda items except D (vi), which was omitted through lack of time. It was recommended that the full reports of these Experiments should be published in ICES publications, and the group also commended the usefulness of such a workshop in research work of international character; it was felt that the opportunity of meeting and working together had saved a considerable amount of time and work for all the representatives taking part in the International Comparative Fishing Experiments.

COPENHAGEN MEETING, 1960.

At the Forty-Eighth meeting of the International Council in 1960 it was resolved that the report of the International Mesh Selection Working Group to the Chairman of the Comparative Fishing Committee with its appendices, summarising all selectivity data for the ICES area, should be published in a special number of Rapp. Cons. Explor. Mer, after appropriate revision, amplification and editing. It was further decided that, in order to prepare the above report for publication and to resolve certain problems still outstanding in the analysis and interpretation of the data it contains, the countries concerned in the two international mesh experiments be invited to send a representative to a meeting in Copenhagen in mid-December 1960, and that other member countries and FAO be invited to send observers.

The second Mesh Selection Working Group was convened in Copenhagen, December 6 - 13, 1960. The representatives taking part were those attending the first group (though Saetersdal, Jensen and Otterlind were able to be present for only part of the time) together with H. Bohl (Federal Republic of Germany), Dr. A.I. Treschev and V.E. Blinov (U.S.S.R.) and for a short time B.B. Parrish (Scotland). Mr. Pope was Convenor.

The programme of work adopted was:-

1. Consideration of methods of analysing mesh selection data.
2. Further analysis of the 1958 and 1959 International Mesh Experiment data.
3. Review of tables of European mesh selection results.
4. Review of present status of knowledge and recommendations for future mesh selection research.
5. Standardisation of experimental techniques.

All of these items except No. 4 were discussed. The compilation of

tables of mesh selection experiment results proved to be an arduous task and although by the end of the Working Group meeting these tables were in the main complete, it was then not possible to summarise briefly the extensive array of results; this has been done, at least in part, by Messrs Pope and Margetts since the Working Group meeting.

The Report is divided into four parts. Parts I and II are the reports of the 1958 and 1959 International Experiments respectively, each being the responsibility of the participants in the particular experiment. Part III is a tabular summary of available cod-end mesh selection data for the ICES area. Part IV deals with general considerations of trawl and seine cod-end mesh selection and its measurement.

SCOPE OF THIS REPORT

PART 1. THE 1958 INTERNATIONAL COMPARATIVE FISHING EXPERIMENT.

by

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INTRODUCTION

Although agreement had been reached by 1956 (Ad Hoc Committee Report, 1957) on the values to be assigned to the selection factors of some species for cod-ends of certain material, such values were the average of a range of observations, the range in most cases being quite large. While it was generally recognised that a good deal of variation is to be expected in mesh selection results, it was felt that not all the variability should be ascribed to random causes, as the averages over quite large experiments still exhibited considerable variation.

For a given species and cod-end mesh size eight major groups of factors affecting mesh selection results may be listed. These are:-

1. Netting material and construction
2. Vessel characteristics and rigging of gear
3. Towing speed
4. Duration of tow
5. Catch size
6. Fish shape
7. Local conditions
8. Experimental techniques

An experiment was carried out in June 1958 to throw light on the effect of the second of the above groups of factors. Three research vessels, the 'Willem Beukelsz' from Holland, the 'Anton Dohrn' from the Federal Republic of Germany, and the 'Explorer' from Scotland took part. By working at the same time and on the same ground the effects of 6 and 7 above were minimized. In addition, the experimental techniques were to be standardised by

(a) using the covered cod-end technique
(b) using covers of the same design and same material (namely, cotton)
(c) towing for the same duration (1 hour on all occasions)
(d) using cod-ends of the same material and mesh size
(e) measuring mesh sizes with the same type of gauge
(f) measuring all fish in the same way (namely, total length to the nearest cm, using intervals like 24.5 - 25.4 cm, 25.5 - 26.4 cm, etc).

In actual fact complete standardisation was achieved only in items (a), (c), and (f).

The speeds of the vessels during towing were not the same for all ships, being approximately $3\frac{1}{2}$ kn. for the 'Willem Beukelsz', 4 kn. for the 'Anton

Dohrn' and 4½ kn. for the 'Explorer'.

In the time available it was not possible to investigate thoroughly as many problems as wished, and the experiment, although conceived on an ambitious scale, clearly could not provide answers to many important problems. In particular, comparisons between ships were confined to tests with one standard cod-end only, to allow a greater variety of cod-end materials to be tested during the period.

GEAR

The experiment was undertaken in two parts, the first covering the period 2 - 7 June inclusive (Period 1) and the second covering the period 10 - 17 June inclusive (Period 2). The 'Willem Beukelsz' did not participate in the experiment after 12 June.

The 'Willem Beukelsz' and 'Anton Dohrn' both used a herring trawl while 'Explorer' used a whitefish trawl. Except for some slight modifications to the groundropes the trawls used by the 'Willem Beukelsz' and the 'Anton Dohrn' remained the same during both Periods 1 and 2. The 'Explorer's' trawl was irreparably damaged at the end of Period 1 and a new trawl was used during Period 2. These trawls were identical except for differences in the wings which are not thought in any way likely to have materially affected cod-end mesh selection. The full specifications of all trawls used are given in Table 1.

Four different cod-ends were used by each vessel during each period. The cod-end materials and braiding are listed in Table 2. The double manila cod-ends were all manufactured to the same specification by a Dutch firm and these were used as standards for providing between-ship comparisons.

In all cases only the upper half of the cod-ends was covered. The covers were of cotton netting, the mesh sizes varying from ship to ship, being 19 mm for the 'Explorer', 24 mm for the 'Willem Beukelsz' and 38 mm for the 'Anton Dohrn'. All covers extended about 1½ metres beyond the cod-lines. The undersides of the cod-ends used by the 'Willem Beukelsz' and the 'Explorer were in addition fitted internally with small-mesh cotton netting to prevent any possible escapes from the undersides. The cod-ends used aboard the 'Anton Dohrn', although not so fitted, had large protective hides and netting attached externally to their lower halves which in all probability were sufficient to mask escapes from the undersides.

The mesh sizes of the cod-ends were measured at frequent intervals, approximately 50 meshes being measured on each occasion. These were taken in a randomly selected longitudinal line from the cod-line forward to prevent bias in the average arising from any trend in mesh size along the cod-end. Unfortunately, it was not found possible to standardise methods of mesh measurement at all times, although this was intended. The standard gauge which was to be employed was the Scottish longitudinal pressure gauge (for a description see Parrish, Jones & Pope, 1956). In its original form this gauge could not accurately measure mesh sizes below about 60 to 62 mm, and as several of the cod-ends used had meshes of smaller size than this other gauges capable of measuring smaller sizes had to be used. All cod-ends used aboard the 'Explorer' were measured with the Scottish gauge, while cod-ends aboard the 'Willem Beukelsz' and the 'Anton Dohrn' were normally measured using ICNAF-type spring-loaded, wedge gauges exerting vertical pressures of approximately 4 kilograms, the type used aboard the 'Willem Beukelsz' being very slightly modified from the original design (for a description of the ICNAF gauges see von Brandt & Bohl, 1959).

The average mesh sizes had, therefore, to be adjusted from the available readings. This was done by comparing observations made on several occasions on the standard cod-ends. Measurements made by one person using the same gauge on these showed them to be of almost identical mesh size. Measurements made with the different gauges on the three standard cod-ends were therefore compared, as shown in Table 3. Taking the Dutch measurements as standard, conversion factors of 0.98 for the Scottish figures and 1.02 for the German figures are obtained. Support for these conversion factors was given from some parallel measurements made aboard the 'Explorer' which gave a conversion factor for 'Explorer'/'Anton Dohrn' of 1.06, in good agreement with the figure 1.04 shown in Table 3. The standardised mesh sizes are shown in Table 4.

Properties of the cod-end materials ascertained from tests on samples of the different twines are summarised in Table 5. These tests were made at the Institut für Netzforschung, Hamburg and the Nederlands Visserij-Proefstation, Utrecht.

EXPERIMENTAL PROCEDURE

During Period 1 hauls were made in an area some 20 miles north-east of St. Abbs Head on the south-east coast of Scotland in a depth varying between 60 and 80 metres. Whiting (Gadus merlangus L.) were plentiful on this ground throughout the period but haddock (Gadus aeglefinus L.) were too scarce to provide useful selection material. An examination of the length frequency distributions of whiting taken by the three vessels on this ground showed a tendency for the 'Explorer' to catch fewer small whiting (less than 25 cm) than the other vessels (Bertelsen et al., 1958).

During Period 2 work was carried out some 12 - 16 miles east of Peterhead on the Scottish east coast; the depth in this area varies between 70 and 110 metres. Again during this period 'Explorer' tended to catch fewer small whiting (less than 25 cm) that the other vessels, a tendency also found in the case of haddock (Bertelsen et al., 1958).

In both periods four hauls, each of one hour's duration, were made daily by each vessel, all cod-ends being used once each day. The order of use of the cod-ends was randomized according to a pre-arranged plan, each vessel using the standard double manila cod-end at the same time. Shooting and hauling were done more or less simultaneously and the vessels towed along parallel courses. The distance between the courses varied from haul to haul but were usually of the order of half a mile. All hauls were made during daylight and the weather throughout was calm.

METHOD OF FITTING SELECTION CURVES

Selection curves were fitted to the data from individual hauls. It was assumed that the true selection curves were of the logistic form

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

where p is the proportion of fish escaping at a length of l cm and a and b are parameters to be estimated from the data. The method of estimating a and b was by maximum likelihood as described by Berkson (1957).

In some cases it was not possible to fit curves, either because of small catches or because the size of fish taken did not cover all or at least a large part of the selection range, and in these cases the hauls were rejected. In other cases the retention points calculated from the original observations in

1 cm length intervals were too erratic to allow good fits and the points were first recalculated, grouping the data in length intervals of 2 cm. This always led to a reduction in the scatter. Increase of the grouping interval does not bias the estimate of the 50% retention length but does increase the estimate of the selection range. No corrections for grouping were applied, however, as they are laborious and in most cases would have resulted in little change in the values obtained without correction.

In general the observed points deviated in the region of low retentions (less than 10%) from what would be expected if the logistic curve is used to represent the true selection curve. Such variation in selection data is far from uncommon (see, for instance, Buchanan-Wollaston, 1927; Boerema, 1958). The curves were therefore fitted in each case to the data over the 90% - 10% range and good fits obtained in this range.

The 50% retention lengths, which are given by $-a/b$, were obtained from the fitted parameters. Selection factors, using the standardised mesh sizes shown in Table 4, were calculated. The individual selection factors and their standard errors are given in Table 6 and averages for each cod-end for each period are listed in Table 7. These averages are in all cases unweighted averages.

The selection ranges were obtained by first calculating the 75% and 25% retention lengths which, like the 50% length, are simple functions of the parameters a and b. Individual values of the selection range are shown in Table 8 and unweighted averages in Table 9. The number of fish in the cod-end and cover separately are also listed in Table 8.

RESULTS

The cod-end materials used in this experiment consisted of two major groups, those made from natural fibres (manila and hemp) and those made from synthetic fibres (Perlon, nylon, Trevira, Terylene, Courlene and Nymplex). The synthetic fibres may be further grouped into polyamides (nylon and Perlon), polyesters (Trevira and Terylene) and polyethelenes (Courlene and Nymplex). This provides a useful framework within which the selection results may be compared. Whiting and haddock are considered separately.

WHITING

The data for the standard double manila cod-end allow the fullest analysis. In addition to the fact that these cod-ends were made from the same material their average mesh sizes, as already noted, were closely similar on all three ships. Selection factors for the 'Willem Beukelsz' and the 'Anton Dohrn' for this cod-end were much more variable in period 1 than in period 2, ranging from 3.0 to 3.9 for the former vessel and 3.3 to 3.9 for the latter in the first period as against 3.5 to 3.7 and 3.6 to 3.9 respectively in the second period. The average values of the selection factors for both the 'Willem 'Beukelsz'and the 'Anton Dohrn' were slightly greater in period 2 than in period 1, but the differences are not statistically significant.

The change in average selection factor from period 1 to period 2 for the 'Explorer' amounted to $+0.6 \pm 0.124$ (d.f. = 24) and this difference is statistically significant. There appears to be no simple explanation for this large change nor for the quite large differences between ships in period 1.

The average catches of whiting in the cod-end and the cover combined for the standard cod-end were

	Period 1	Period 2
'Willem Beukelsz'	416	522
'Anton Dohrn'	1,357	1,203
'Explorer'	265	939

while the average catches in the selection range were

	Period 1	Period 2
'Willem Beukelsz'	134	228
'Anton Dohrn'	186	353
'Explorer'	55	345

It may be that, while there is no association between size of catch and selection factor, variation in selection factor is greater when catches are small.

In general, the selection ranges, given in Table 8, are more homogeneous, greatest variation being found in the selection curves for the 'Explorer' in the second period.

Double hemp cod-ends were used by the 'Willem Beukelsz' and the 'Anton Dohrn'. These cod-ends, although both were of hemp and double braided, were made from twines of different construction. The main properties of the twines are listed in Table 5. The estimated selection curves are in all cases very good fits to the observations, although the value of 10.8 cm for the selection range for one of the hauls by the 'Willem Beukelsz' may be somewhat high due to the grouping employed in the analysis. There is some evidence that the material used by the 'Willem Beukelsz' gave rise to higher selection ranges than that used by the 'Anton Dohrn', but the haul-to-haul variability is too high and the number of observations too few to place any great reliance on this. There is no evidence of any real difference in the selection factors obtained by the two vessels.

It will be seen from Table 5 that the hemp used aboard the 'Anton Dohrn' had a higher runnage than that used aboard the 'Willem Beukelsz' but was of almost the same flexibility.

Like the hemp cod-ends, the single manila cod-ends used aboard the 'Willem Beukelsz' and 'Explorer' were made from twines having different properties. The results for these cod-ends are reasonably consistent within ships, although the selection factors and selection ranges for the 'Explorer' tended to be higher in period 2 than in period 1. It can be seen from Tables 7 and 9 that the average selection factors and selection ranges were higher for the 'Willem Beukelsz' that the 'Explorer'. The single manila cod-end used on the 'Willem Beukelsz' had a higher runnage and was much more flexible than that used on the 'Explorer'.

One interesting finding from these results for the cod-ends of natural twine is that the selection factors for the single-braided cod-ends appear, in general, to be lower than those for the double-braided ones.

The polyamides nylon and Perlon used on the 'Explorer' and 'Anton Dohrn' respectively gave much more variable results in period 1 than in

period 2. Selection factors for both cod-ends were higher on average in period 2 than in period 1 although for neither cod-end does the difference between periods quite reach significance. The difference between the average selection factors for the two cod-ends in period 2, namely 0.6, has a standard error of $\pm$0.08 and so differs significantly from zero. In contrast to the selection factors the selection ranges were higher in period 1 than in period 2, but neither the difference between periods nor that between ships is significant.

Again it may be noted that the lower selection factors are given by the single-braided cod-end. In addition, as may be seen from Table 5, the nylon twine was very much less flexible that the Perlon.

Only three results were obtained for the Trevira cod-end. They give an average selection factor of 4.0 in period 1 as against the single value of 4.5 in period 2. The selection range is of the order of 6.0 cm for this cod-end. Selection factors and selection ranges for the Terylene cod-end used by the 'Explorer' were quite variable in both periods. The selection factors varied from 3.5 to 3.7 and 3.1 to 3.7 in the first and second periods respectively, while the selection ranges varied from 9.6 to 13.9 cm and 4.9 to 8.4 cm. The average selection factors for Terylene in period 1 and period 2 are 3.3 and 3.6 respectively and so are considerably lower than those for Trevira. Again the lower selection factors are given by the single-braided cod-end. There is a large difference in flexibility between the Terylene and Trevira twines, the Terylene being much less flexible.

The selection factors and selection ranges for the double Courlene cod-end, used by the 'Anton Dohrn' in the second period only, were very consistent, the difference between the highest and lowest values being only 0.2. The highest selection range observed, namely 6.9 cm, occurred in the haul with the smallest total catch of whiting. The selection factors and ranges for the Nymplex cod-end were more variable, a very high value for the selection range (14.7cm) occurring for one haul. This haul had a much larger catch than the others in the selection range, the number of whiting taken being 382 as against an average of 49 for the other four hauls. The largest total catch of whiting was, however, taken in the one haul in period 2. There is no significant difference between the selection factors for the Courlene and Nymplex cod-ends.

HADDOCK

Selection factors and selection ranges for the standard double manila cod-end are very consistent for both the 'Anton Dohrn' and the 'Explorer'. Both vessels gave an average selection factor of 3.2. While the average selection range for the 'Explorer' was lower than that for the 'Anton Dohrn' the difference is not significant.

The single nylon and double Perlon cod-ends gave average selection factors of 3.0 and 3.5 and average selection ranges of 3.6 cm and 4.2 cm respectively. Results for both cod-ends showed relatively little variation. It may be noted that the single-braided cod-end again gave lower selection factors, the difference being statistically significant.

Selection factors for Terylene were very consistent, giving an average value of 2.8. The average selection factor for Trevira was 3.7 and the difference between these two values is statistically significant. Selection ranges for the two cod-ends are generally quite similar. The single high selection range of 15.1 cm for Trevira occurred in a haul which had a much larger haddock catch in the selection range than the others: 609 fish as compared with an average of 56 for the other four hauls. As already pointed out the Terylene cod-end which gave the lower selection factors was a single-braided cod-end.

Results could be obtained from only two hauls with the Nymplex cod-end. These gave an average value of 2.9. The selection factors for Courlene, which were consistent and all greater than the Nymplex values, gave an average selection factor of 3.3 There was no real difference between the selection ranges, the average values being 4.5 cm for Courlene and 5.7 cm for Nymplex.

DISCUSSION OF RESULTS

The procedure of analysing individual haul data as presented here enables the haul-to-haul variability in selection to be measured. It was expected from previous experience that this component of variation would be quite high and this has been confirmed by the present data. However, this was not always true; in several series the selection factors in particular were very consistent. Highly variable data were not a feature of any particular ship. All three vessels gave some sets which were very variable and others which were very consistent.

One of the findings of this experiment has been that any variation produced by the forward parts of the gear and by the vessels themselves is not greater than that between hauls by the same vessel and gear. In this experiment the vessels taking part were of quite different sizes, their gross tonnage being

'Willem Beukelsz'	208
'Anton Dohrn'	999
'Explorer'	862

and the gear used by them differed not only in size but also in design, two of them being herring trawls while the other was a whitefish trawl.

This finding lends support to the practice at present adopted of combining results from various sources in order to arrive at average selection factors for cod-end materials.

Unfortunately it has not been possible from the data collected in the present experiment to determine what are the causes, if any other than random, which give rise to large variations in selection factor on the same ground for the same cod-end. A study of the selection factors and selection ranges in relation to the number of fish caught and the weight of catch has not revealed any association between these quantities. In this connection it should be mentioned that the weights of fish caught were not exactly recorded and indeed were only very roughly estimated on one of the ships. Also, complete details of all species taken in each haul were kept on only two of the ships.

The experiment has also indicated, in the case of whiting, a probable area difference in selection factor. In seven out of eleven cases the average selection factors were higher for the same cod-end in the second period than in the first. If real, this effect may have been due among other things to a difference in trawling depths in the two areas, or to a difference in the girth/length relationship, or to the effect of a change in catch composition. The latter change was not great being mainly confined to more haddock and fewer herring on the ground. Unfortunately no girth/length measurements were made during the experiment.

Even though differences between results from individual hauls are large, in most cases they do not obscure differences between the various groups of cod-ends. Thus, for instance, the unweighted average of six estimates of the whiting selection factor for the standard double manila cod-ends is 3.5. The unweighted averages for double hemp, double Perlon and double Trevira are respectively 3.7, 4.0 and 4.2. On previous evidence (see, for example,

Boerema, 1954; Margetts, 1956; von Brandt, 1956) the natural material hemp and the synthetic group of polyamides have been classed as 'light' materials (that is, cod-ends made from these materials have higher selection factors than those made from manila) and the present results substantiate this classification. Since the 1958 experiment further results have indicated that the polyester group also falls in the same class of 'light' trawl materials (see, for example, Saetersdal, 1960; Pope, unpublished data). In the 1958 experiment the same distinction between manila on the one hand and hemp, Perlon and Trevira on the other may be seen from Table 7.

The double-braided cod-ends belonging to the polyethylene group (Courlene and Nymplex) give average selection factors which are lower than those for the other double-braided cod-ends of synthetic material.

In addition to these results the experiment indicates a difference in selectivity between single-and double-braided cod-ends, lower selection factors being usually found for the single-braided cod-ends. In the case of manila the selection factors for whiting averaged over both periods are:

	'Willem Beukelsz'	'Explorer'
Single manila	3.4	3.0
Double manila	3.5	3.4

Similarly, the average selection factors for single nylon and double Perlon are

	Whiting	Haddock
Single nylon	3.7	3.0
Double Perlon	4.0	3.5

while those for single Terylene and double Trevira are

	Whiting	Haddock
Single Terylene	3.6	2.8
Double Trevira	4.2	3.7

Further evidence that single-braided cod-ends give lower selectivity than double-braided ones was found subsequent to the 1958 experiment by Pope & Hall (1960) who gave a probable explanation for this phenomenon.

In conclusion it is appropriate to mention what, in retrospect, appear to have been the major shortcomings of the experiment. As stated at the beginning the number of strict between-ship comparisons was cut down in order to allow a wide variety of cod-ends to be tested. In fact probably too many different cod-ends were used and it might have been better to make more hauls with fewer cod-ends. With a haul-to-haul variance of selection factors of the order of at least 0.02 it requires a minimum of seven results for each of a pair of cod-ends in order to be 90% certain of detecting a real difference in their selection factors of $\pm$0.3 at the 5% level of probability. This number of results was obtained for only a few of the cod-ends in the 1958 experiment.

With regard to mesh measuring it is unfortunate that it was not possible to use exactly the same type of gauge on all ships, and in the circumstances rather more comparisons between gauges would have been desirable.

A more complete standardisation of the type of cover could have been achieved without too much difficulty. The type of cover used in the experiment has actually been criticised by Boerema (1958) who found that this type of top cover gave lower selection results than the usual cover adopted by Dutch workers, which envelops the whole cod-end and is kept free from it by cane supporting hoops. Any bias produced by the form of cover used in the 1958 experiment would likely be similar for all cod-ends and all ships and would largely disappear in making comparisons between cod-ends and ships.

Finally, fuller and more precise information might have been kept of the catch compositions and their weights and, for whiting at least, girth measurements might have been made for the purpose of establishing girth/length relationships.

Without some of these shortcomings more information would have been gained from the experiment, but they in no way invalidate the results found and reported here.

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Table 1. Specifications of trawls (in feet)

	'Explorer' (period 1)	'Explorer' (period 2)	'Willem Beukelsz'	'Anton Dohrn'
Headline	96	96	45	105
Groundrope	84	116	90	167
Bosom of groundrope	20	20	15	17
Top wings (mesh size)	41 (14 cm)	41 (14 cm)	12 (14 cm)	21 (15 cm)
Lower wings (mesh size)	45 (14 cm)	62 (14 cm)	45 (14 cm)	62 (15 cm)
Square (mesh size)	14 (14-10 cm)	14 (14-10 cm)	24½ (14 cm)	35½ (15 cm)
Belly (mesh size)	28 (14-11-9 cm)	28 (14-11-9 cm)	38½ (14-5 cm)	47 (14.5-5.5 cm)
Baitings (mesh size)	35½ (9 cm)	35½ (9 cm)	37 (14-5 cm)	47 (14.5-5.5 cm)
Lengthening pieces (mesh size)	10 (9 cm)	10 (9 cm)	23 (5 cm)	23 (5.5 cm)
Cod-end	29	29	16	23
Sweeps	180	180	-	118
Cables	-	-	90	-
Legs, upper	20	20	36	72
Legs, lower	36	20		
Floats	40	40	-	-
Kites	-	-	1	1

Table 2. Cod-end materials and braiding.

'Willem Beukelsz'	'Explorer'	'Anton Dohrn'	
Periods 1 and 2	Periods 1 and 2	Period 1	Period 2
Double manila	Double manila	Double manila	Double manila
Double hemp	Single manila	Double hemp	Double Courlene
Single manila	Single nylon	Double Perlon	Double Perlon
Double Nymplex	Single Terylene	Double Trevira	Double Trevira

Table 3. Mesh measurements of standard cod-ends (mm)

Date	'Willem Beukelsz'	'Explorer'	'Anton Dohrn'	'Willem Beukelsz'/ 'Explorer'	'Willem Beukelsz'/ 'Anton Dohrn'	'Explorer'/ 'Anton Dohrn'
3.6.58	68.2	71.2	66.4	0.96	1.03	1.07
4.6.58	67.8		67.5		1.00	
6.6.58	65.3	67.6	64.3	0.97	1.02	1.05
10.6.58	65.6		64.1		1.02	
12.6.58	65.8		65.2		1.01	
12.6.58	65.7	64.1	64.3	1.02	1.02	1.00
15.6.58		66.1	63.7			1.04
Mean conversion factor				0.98	1.02	1.04

Table. 4. Standardised average cod-end mesh sizes (mm)

Vessel	Cod-end	Period 1	Period 2
'Willem Beukelsz'	Double manila	66.8	65.7
	Double hemp	72.2	72.6
	Single manila	63.2	61.9
	Double Nymplex	78.8	79.6
'Anton Dohrn'	Double manila	67.1	65.5
	Double hemp	53.2	-
	Double Perlon	65.0	63.7
	Double Trevira	80.1	78.0
	Double Courlene	-	71.4
'Explorer'	Double manila	68.0	64.6
	Single manila	70.1	65.9
	Single nylon	70.8	68.0
	Single Terylene	86.8	82.5

Table 5. Cod-end twine properties

	Standard cod-end	'Anton Dohrn'				'Explorer'			'Willem Beukelsz'		
Material	Manila	Hemp	Perlon	Trevira	Courlene	Manila	Nylon	Terylene	Manila	Hemp	Nymplex
Construction	3 x 1 twisted (Nr. 50)	3 x 1 twisted (0,5/3)	8 x 1 plaited	8 x 3 plaited	twisted (7/16")	4 x 1 twisted	3 x 7 twisted	3 x 7 twisted	3 x 1 twisted	3 x 1 twisted	3 x 3 twisted
Runnage (m/kg)	262	174	210	385	200	156	136	127	232	373	933
Breaking strength (kg)											
wet, overhand knot	48	94	102	60	86	90	110	107	72	46	20.4
dry, unknotted	64	88	144	104	112	150	222	229	99	35	30.4
Breaking length (km)											
wet, overhand knot	12.6	16.4	21.4	23.1	17.2	14.0	15.0	13.6	16.7	17.2	19.0
dry, unknotted	16.6	15.3	30.2	40.0	22.3	23.3	30.2	29.0	22.9	13.3	28.1
Loss by wet knotting (%)	24	-	29	38	23	40	51	53	27	-	34
Flexibility (H) *	380	200	20	20	350	760	910	270	460	150	170
Diameter, mm (H)*	3.0	3.7	3.1	2.4	3.6	4.5	3.7	3.5	3.6	2.3	1.6
Preparation	unp.	unp	unp.	unp.	unp.	prep.	unp.	prep.	prep.	unp.	unp.
Analysis*	U	H	H	H	H	U	U	U	U	U	U

*H = Analysis in Hamburg, Institut für Netzforschung.

U = Analysis in Utrecht, Nederlands Visserij - Proefstation

Table 6. Selection factors and standard errors for individual hauls

(a) Whiting

Vessel	Cod-end		Period 1				Period 2			
'Willem Beukelsz'	Double manila	S.F.	3.9	3.0	3.3		3.5	3.7		
		s.e.	.031	.069	.090		.032	.107		
	Double hemp	S.F.	3.9	3.4	3.4		3.8			
		s.e.	.076	.114	.081		.087			
	Single manila	S.F.	3.5	3.3	3.4	3.2	3.4	3.4		
		s.e	.033	.095	.107	.061	.056	.046		
	Double Nymplex	S.F.	3.4	3.7	4.0	3.8	3.5			
		s.e.	.067	.103	.113	.134	.059			
'Anton Dohrn'	Double manila	S.F.	3.7	3.9	3.8	3.3	3.7	3.7	3.6	3.8
		s.e.	.030	.034	.078	.055	.041	.027	.027	.048
		S.F.	3.4	3.8			3.7	3.8	3.9	3.6
		s.e.	.045	.063			.031	.050	.043	.031
	Double hemp	S.F.	3.4	4.1						
		s.e.	.012	.022						
	Double Perlon	S.F.	4.2	3.4	3.9	3.8	4.1	4.5	4.0	4.3
		s.e.	.039	.058	.036	.059	.047	.070	.022	.044
		S.F.	4.3				4.3	4.1	4.2	4.1
		s.e.	.043				.055	.017	.035	.032
	Double Trevira	S.F.	3.9	4.1			4.5			
		s.e.	.058	.027			.133			
	Double Courlene	S.F.					3.8	3.7	3.9	3.8
		s.e.					.037	.031	.063	.042
		S.F.					3.8	3.8		
		s.e.					.038	.049		
'Explorer'	Double manila	S.F.	3.1	3.3	3.1	3.0	3.6	3.7	3.7	3.8
		s.e.	.086	.126	.108	.043	.023	.045	.029	.053
		S.F.					3.8	3.6	3.6	
		s.e.					.029	.028	.022	
	Single manila	S.F.	2.6	2.8			3.0	3.3	3.1	3.4
		s.e.	.049	.073			.053	.049	.037	.064
	Single nylon	S.F.	4.1	4.0	3.6	3.7	3.6	3.4	3.6	3.8
		s.e.	.196	.080	.125	.059	.062	.045	.038	.039
		S.F.					3.8	3.6	3.5	3.7
		s.e.					.063	.049	.019	.017
	Single Terylene	S.F.	3.8	4.2	3.5		3.2	3.1	3.7	3.1
		s.e.	.082	.149	.080		.057	.045	.072	.037

Table 6 (cont)

(b) Haddock

Vessel	Cod-end		Period 2			
'Willem Beukelsz'	Double Nymplex	S.F.	2.8	3.0		
		s.e.	.072	.112		
'Anton Dohrn'	Double manila	S.F.	3.3	3.2	3.1	3.2
		s.e.	.031	.025	.022	.019
		S.F.	3.3	3.1	3.3	3.1
		s.e.	.024	.020	.038	.033
	Double Perlon	S.F.	3.3	3.6	3.4	3.5
		s.e.	.049	.034	.035	.030
		S.F.	3.6	3.4	3.5	3.4
		s.e.	.049	.037	.042	.049
	Double Trevira	S.F.	3.7	3.8	4.0	3.6
		s.e.	.061	.080	.101	.067
		S.F.	3.5			
		s.e.	.093			
	Double Courlene	S.F.	3.2	3.4	3.4	3.2
		s.e.	.063	.070	.067	.022
		S.F.	3.3	3.2	3.3	3.2
		s.e.	.026	.035	.078	.053
'Explorer'	Double manila	S.F.	3.2	3.1	3.2	3.2
		s.e.	.042	.045	.025	.033
	Single nylon	S.F.	3.0	2.9	3.0	3.1
		s.e.	.039	.050	.032	.024
		S.F.	3.0			
		s.e.	.065			
	Single Terylene	S.F.	2.8	2.9	2.9	2.8
		s.e.	.103	.062	.073	.067
		S.F.	2.9	2.8		
		s.e.	.076	.046		

Table 7. Average selection factors

(a) Whiting

Vessel	Cod-end	No. of Hauls	Period 1	No. of Hauls	Period 2
'Willem Beukelsz'	Double manila	3	3.4	2	3.6
	Double hemp	3	3.6	1	3.8
	Single manila	4	3.4	2	3.4
	Double Nymplex	4	3.7	1	3.5
'Anton Dohrn'	Double manila	6	3.6	8	3.7
	Double hemp	2	3.8	-	-
	Double Perlon	5	3.9	8	4.2
	Double Trevira	2	4.0	1	4.5
	Double Courlene	-	-	6	3.8
'Explorer'	Double manila	4	3.1	7	3.7
	Single manila	2	2.7	4	3.2
	Single nylon	4	3.8	8	3.6
	Single Terylene	3	3.8	4	3.3

(b) Haddock

Vessel	Cod-end	No. of Hauls	Period 2
'Willem Beukelsz'	Double Nymplex	2	2.9
'Anton Dohrn'	Double manila	8	3.2
	Double Perlon	8	3.5
	Double Trevira	5	3.7
	Double Courlene	8	3.3
'Explorer'	Double manila	4	3.2
	Single nylon	5	3.0
	Single Terylene	6	2.8

Table 8. Selection ranges and number of fish in selection range for individual hauls

$n_{c.e.}$ = number of fish in cod-end

n_{cr} = number of fish in cover

(a) Whiting

Vessel	Cod-end		Period 1				Period 2			
'Willem Beukelsz'	Double manila	S.R.	3.6	5.4	5.8		3.0	7.8		
		$n_{c.e.}$	107	48	27		85	89		
		n_{cr}	63	66	33		132	150		
	Double hemp	S.R.	9.5	10.8	4.9		5.5			
		$n_{c.e.}$	111	209	25		33			
		n_{cr}	109	161	22		35			
	Single manila	S.R.	4.1	6.3	4.9	3.5	4.3	4.8		
		$n_{c.e.}$	113	43	25	16	85	179		
		n_{cr}	102	45	16	13	115	140		
	Double Nymplex	S.R.	4.3	14.7	5.0	6.0	3.8			
		$n_{c.e.}$	24	196	16	18	32			
		n_{cr}	26	186	20	28	31			
'Anton Dohrn'	Double manila	S.R.	4.1	3.9	4.0	5.9	4.4	3.8	4.2	4.6
		$n_{c.e.}$	184	118	50	82	156	261	195	114
		n_{cr}	195	98	64	93	237	418	201	180
		S.R.	3.8	4.4			3.7	3.5	5.1	3.7
		$n_{c.e.}$	64	54			130	43	134	137
		n_{cr}	54	62			252	69	122	175
	Double hemp	S.R.	2.6	2.9						
		$n_{c.e.}$	600	222						
		n_{cr}	885	231						
	Double Perlon	S.R.	3.8	7.8	4.5	5.4	4.5	4.6	3.4	4.4
		$n_{c.e.}$	80	165	159	73	87	53	213	120
		n_{cr}	79	217	164	80	105	70	287	140
		S.R.	4.9				4.4	4.1	3.7	3.8
		$n_{c.e.}$	108				60	427	121	128
		n_{cr}	124				63	536	103	151
	Double Trevira	S.R.	6.5	5.4			5.7			
		$n_{c.e.}$	59	269			16			
		n_{cr}	88	359			24			
	Double Courlene	S.R.					3.7	6.9	4.0	4.4
		$n_{c.e.}$					87	132	135	70
		n_{cr}					96	135	252	80
		S.R.					4.2	6.6		
		$n_{c.e.}$					78	215		
		n_{cr}					83	235		

Table 8 (cont)

Vessel	Cod-end		Period 1				Period 2			
'Explorer'	Double manila	S.R.	4.6	5.1	3.9	3.0	2.3	3.7	3.9	6.0
		$n_{c.e.}$	28	26	14	46	97	110	193	133
		n_{cr}	37	20	16	34	121	155	206	190
		S.R.					3.7	3.6	3.3	
		$n_{c.e.}$					175	192	230	
		n_{cr}					198	226	191	
	Single manila	S.R.	2.3	3.4			3.1	4.2	2.2	4.2
		$n_{c.e.}$	17	22			28	102	69	112
		n_{cr}	25	21			26	76	82	100
	Single nylon	S.R.	7.9	6.6	12.6	6.5	4.3	4.1	4.0	4.1
		$n_{c.e.}$	28	46	106	93	79	58	133	114
		n_{cr}	32	49	117	93	129	56	223	159
		S.R.					4.8	3.4	5.3	4.3
		$n_{c.e.}$					96	38	544	351
		n_{cr}					151	70	621	444
	Single Terylene	S.R.	9.9	13.9	9.6		4.9	7.5	8.6	6.4
		$n_{c.e.}$	72	117	77		32	175	109	196
		n_{cr}	91	212	83		45	226	159	319

(b) Haddock

Vessel	Cod-end		Period 2			
'Willem Beukelsz'	Double Nymplex	S.R.	4.7	5.7		
		$n_{c.e.}$	23	28		
		n_{cr}	31	45		
'Anton Dohrn'	Double manila	S.R.	3.3	3.6	3.2	3.6
		$n_{c.e.}$	106	208	236	391
		n_{cr}	129	220	206	377
		S.R.	4.4	2.4	3.8	2.5
		$n_{c.e.}$	351	190	96	82
		n_{cr}	344	156	103	66
	Double Perlon	S.R.	4.8	3.0	4.4	4.1
		$n_{c.e.}$	103	90	154	283
		n_{cr}	102	125	179	473
		S.R.	4.5	3.6	4.1	4.8
		$n_{c.e.}$	137	124	123	117
		n_{cr}	235	139	178	131
	Double Trevira	S.R.	5.1	3.7	6.5	5.7
		$n_{c.e.}$	51	16	33	28
		n_{cr}	37	11	24	26

Table 8 (cont)

Vessel	Cod-end		Period 2			
'Anton Dohrn'	Double Trevira	S.R.	15.1			
		$n_{c.e.}$	229			
		n_{cr}	380			
	Double Courlene	S.R.	4.9	4.3	6.5	4.3
		$n_{c.e.}$	77	45	138	255
		n_{cr}	107	79	239	426
		S.R.	3.4	3.4	6.0	3.2
		$n_{c.e.}$	149	181	76	36
		n_{cr}	238	403	137	54
'Explorer'	Double manila	S.R.	2.4	2.8	2.2	3.6
		$n_{c.e.}$	32	49	121	140
		n_{cr}	32	41	84	113
	Single nylon	S.R.	3.4	3.1	3.7	3.4
		$n_{c.e.}$	63	81	135	217
		n_{cr}	73	48	121	199
		S.R.	4.4			
		$n_{c.e.}$	70			
		n_{cr}	54			
	Single Terylene	S.R.	5.9	7.4	7.3	8.1
		$n_{c.e.}$	37	83	73	206
		n_{cr}	62	127	139	344
		S.R.	7.1	5.6		
		$n_{c.e.}$	93	78		
		n_{cr}	167	135		

Table 9. Average selection ranges.

(a) Whiting

Vessel	Cod-end	No. of hauls	Period 1	No. of hauls	Period 2
'Willem Beukelsz'	Double manila	3	4.9	2	5.4
	Double hemp	3	8.4	1	5.5
	Single manila	4	4.7	2	4.6
	Double Nymplex	4	7.5	1	3.8
'Anton Dohrn'	Double manila	6	4.4	8	4.1
	Double hemp	2	2.8	-	-
	Double Perlon	5	5.3	8	4.1
	Double Trevira	2	6.0	1	5.7
	Double Courlene	-	-	6	5.0
'Explorer'	Double manila	4	4.2	7	3.8
	Single manila	2	2.8	4	3.4
	Single nylon	4	8.4	8	4.3
	Single Terylene	3	11.1	4	6.8

(b) Haddock

Vessel	Cod-end	No. of hauls	Period 2
'Willem Beukelsz'	Double Nymplex	2	5.2
'Anton Dohrn'	Double manila	8	3.4
	Double Perlon	8	4.2
	Double Trevira	5	7.2
	Double Courlene	8	4.5
'Explorer'	Double manila	4	2.8
	Single nylon	5	3.6
	Single Terylene	6	6.9

PART II. THE 1959 INTERNATIONAL ARCTIC TRAWL MESH SELECTION EXPERIMENT

by

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PROGRAMME

The overall aim of the experiment was that with several vessels from several different countries trawling together on the same ground at the same time, variations in mesh selection would be studied. Within this broad outline were four more precise aims:-

1. To establish more firmly the selectivity of the type of trawl cod-end used in Arctic fisheries, i. e., double-braided manila.
2. To compare the two methods used in mesh selection experiments, alternate hauls and covered cod-ends.
3. To study between-ship differences in selection.
4. To measure the selectivities of some man-made fibres.

It was intented to obtain thorough information on cod and perhaps also some on haddock.

Four countries (Norway, Federal Republic of Germany, U. S. S. R. and England) each arranged to devote a full ship's cruise to the experiment, and a fifth (Scotland) would include some selectivity work in a cruise to the selected fishing area at the same time.

Participating ships would each use an agreed standard trawl, the standard agreed upon being that as used by the Federal Republic of German trawlers and the research ship 'Anton Dohrn' and made by a particular net-maker in Hamburg. The cod-ends were to be of manila with mesh sizes 110 mm and 140 mm, and of commonly used synthetics with mesh size 140mm, the cod-end covers to be of a standard design, made of polyethylene with mesh size about 70 mm. The main work of the experiment would be based upon the manila cod-ends on the Hamburg trawl; by fixing a cover to one of the 110 mm and one of the 140 mm cod-ends and changing cod-ends after each haul, it was hoped to be able to make many repetitions of the sequence of four cod-ends, and thus simultaneously perform alternate haul and covered cod-end experiments. Duration of haul would be standardised. Synthetic cod-ends on the manila trawls and perhaps also other trawls with the manila cod-ends would be used as opportunity allowed.

THE EXPERIMENT

In the event all five ships ('Johan Hjort', 'Anton Dohrn', 'Tunets', 'Ernest Holt' and 'Explorer') of the five participating countries (Norway, Federal Republic of Germany, U.S.S.R., England and Scotland respectively) took part in the experiment, although 'Explorer' was engaged primarily upon other work, yet managed to include some covered net hauls in her programme when working near some of the other participants. All vessels were comparable in size and fishing power, 'Tunets' being a chartered commercial Arctic trawler, 'Ernest Holt' a research trawler little modified from a standard Arctic trawler, and 'Anton Dohrn', 'Johan Hjort' and 'Explorer' research vessels designed to trawl effectively. Unfortunately, the timing of the ship's cruises meant that the ships could not all be together for all or even most of the total duration of the experiment. 'Johan Hjort' was present throughout; for a short while all four of the main participants were together, and at other times there were always one or two ships with 'Johan Hjort'. Table 10 summarises the dispositions of the ships. It will be seen from this table that the work was spread over several different fishing grounds between south-west of Bear Island and West Spitsbergen; it was an unfortunate feature of the experiment that changes of fishing ground had to be made, but the nature of the fishing necessitated such changes. The fishing was generally rather erratic and localised, with catches ranging from heavy to very light; few fish other than cod and occasionally a few haddock were caught. At each of the grounds fished yields were at first encouraging but were not maintained, so that there came a time when results no longer justified staying on that ground. For the first eight days 'Anton Dohrn' and 'Johan Hjort' were at south-west Spitsbergen on Hornsund ground where yields were good, but too frequent damage to gear on rough ground and encroachment of ice caused them to move south and join up with 'Ernest Holt' and 'Tunets' to the south of Spitsbergen on the Stø rfjord ground where yields were uneven and mostly poor. 'Anton Dohrn' then had to leave the experiment. Results were not satisfactory again until 'Johan Hjort' and 'Ernest Holt' were at West Spitsbergen where, however, a further three grounds had to be tried, while 'Tunets' persisted for a week with moderate results to the south-west of Bear Island. Thus the experiment fell broadly into three phases, the first with 'Anton Dohrn' and 'Johan Hjort' at Hornsund, the second with 'Johan Hjort' and 'Ernest Holt' at West Spitsbergen and the third with 'Tunets' at Bear Island.

Nor was the achievement in the way of standardising meshes at 110mm and 140 mm as successful as hoped for. Despite the attempt made to obtain the same mesh size in each paired set of cod-ends and in the comparable pairs on the various ships, the manufacturing variation of mesh size was very appreciable; thus 'Anton Dohrn' fished with cod-ends at 116 mm and 123 mm, 'Johan Hjort' at 110 mm and 130 mm, 'Tunets' at 105 mm and 128 mm and 'Ernest Holt' at 100 mm and 120 mm plus a very slightly different shaped cod-end at 137 mm.

Table 11 and Figures 1 and 2 contain details of the constructions and some of the properties of the twines used.

The cod-end covers were of 70 mm mesh Nymplex polythene over the upper sides only of the cod-ends, without hoops or such-like, with a bag overhanding the distal ends of the cod-ends by 4-6 feet, and of width half as slack again as the cod-end; the inside of the undersides of the cod-ends were blinded with 70 mm single netting. Cod-ends were fitted with underside chafers (bull-hides) and were worked with splitting straps.

Fish were measured to the nearest centimetre overall length when laid naturally on a measuring board without the tail fin being smoothed down to give a maximum measurement.

Selection factors were determined by reading the 50% selection point off the selection curve fitted to the points by eye.

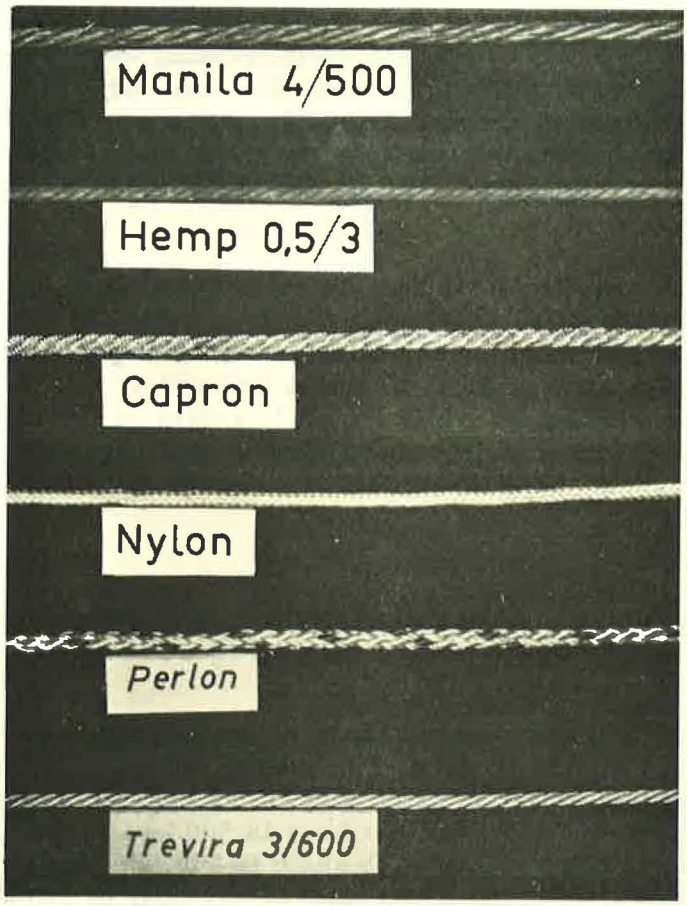

Figure 1 Cod-end materials used in 1959 International Arctic Trawl mesh experiment. The numbering 4/500 indicates 4 strands (ply) each running 500 m per kg, 0.5/3 indicates 3 strands each 0.5 km per kg, and 3/600 indicates 3 strands each 600 m per kg.

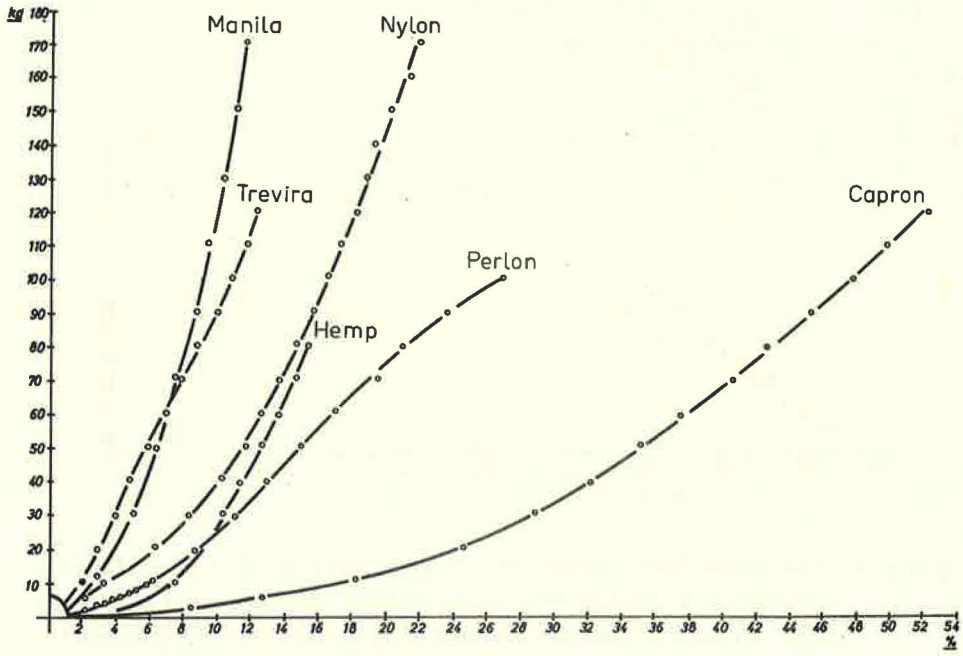

Figure 2 Load-elongation curves of cod-end materials used in 1959 International Arctic trawl mesh experiment.

RESULTS

In covered cod-end experiments, when numbers of fish caught are big enough, selectivity can be measured even from single hauls. Thus, especially in such an experiment where factors such as fishing ground and catch quantity vary between hauls, there will be advantages in treating hauls separately whenever possible, but that would mean printing a vast array of data sheets, so here something of a compromise is reached by some grouping of hauls for the purpose of determining selectivity, the original data sheets or copies of them being lodged at the Fisheries Laboratory, Lowestoft, where they are available on request.

It is simplest to consider first just the selection of Cod (1) by the series of different materials; Manila(.1), Hemp(.2), Polyamide(.3) and within these groups to subdivide firstly by ships and then further by experimental technique e.g. 1.1.2.1. refers to cod caught in a manila cod-end by the 'Johan Hjort' using covered cod-end technique, while 1.1.3.2. refers to cod caught in a manila cod-end by the 'Ernest Holt' using alternate haul technique.

COD

1.1. Manila

1.1.1. 'Anton Dohrn', at Hornsund, south-west Spitsbergen, mostly by one-hour hauls, made ten effective hauls with covered 123 mm manila cod-end, and twelve with uncovered 116 mm manila cod-end.

1.1.1.1. The covered hauls showed selection factors ranging, haul by haul, from 2.7 to 3.9. Catches also varied considerably and selectivity appeared to vary inversely with the catch size in the cod-end (Table 12). The hauls have been grouped by catch size per hour in 500 kg intervals (Table 13), which give the three selection curves a, b and c in Fig. 3; these show selection factors of 3.5, 3.0 and 2.8 for the mean catches per hour of 340 kg, 860 kg and 1800 kg respectively. By lumping all ten covered hauls together the selection factor was 3.2 (curve d).

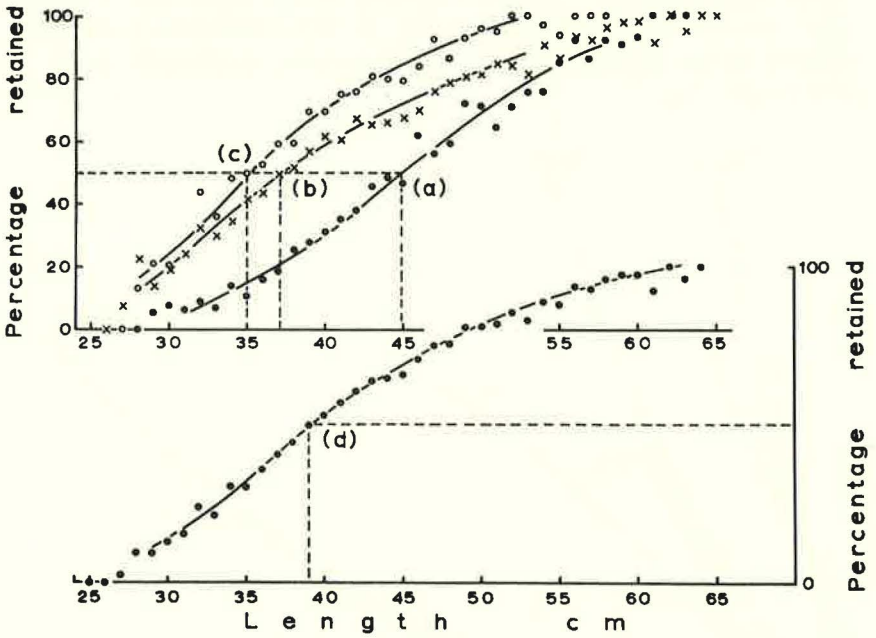

Figure 3 Cod selection curves for 'Anton Dohrn' 123 mm double manila cod-end at Hornsund, 1959, by covered cod-end. (a), (b) and (c) hauls grouped by catch sizes, respectively 340 kg/hr, 860 kg/hr and 1800 kg/hr. (d) all hauls grouped together. (Table 13).

1.1.1.2. The uncovered 116 mm hauls alternated with the covered 123 mm. By taking the total catch in cover and cod-end of all covered hauls as representing the population of fish available, a first comparison with the length distribution of fish in the uncovered net indicates that selection did not operate after 46 cm. The uncovered net catch of length 46 cm and above was 1.71 times that of the covered net catch, so the whole length frequency of the covered catch was raised by factor 1.71 before being used as the denominator in calculating the selection of the 116 mm cod-end. The alternate haul method thus gives a selection factor of 3.4 for all hauls lumped together (Table 14, Fig. 4). It was scarcely possible to separate bigger catches from smaller by the 116 mm uncovered cod-end for calculating separate selectivities at various catch sizes. At Stø rfjord, 'Anton Dohrn' did not use the manila cod-end.

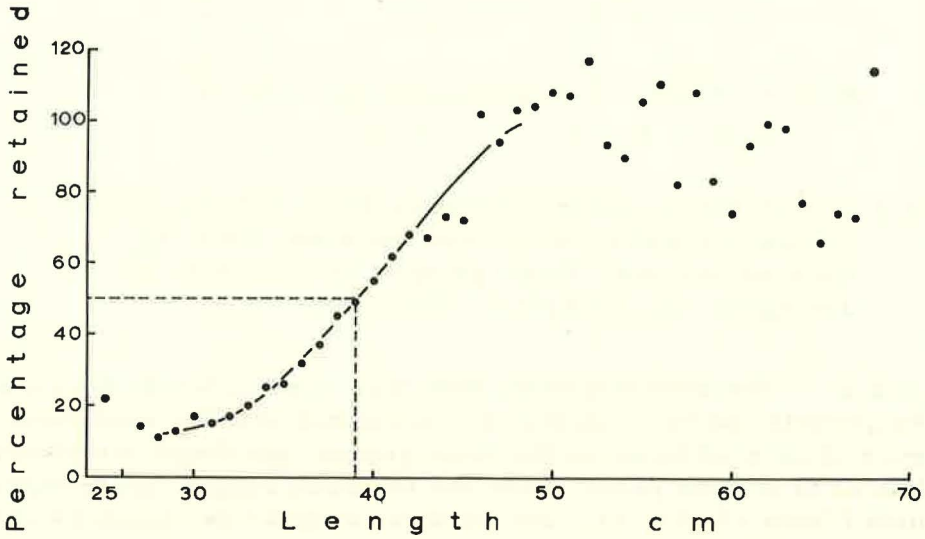

Figure 4 Cod selection curve for 'Anton Dohrn' 116 mm double manila cod-end at Hornsund, 1959, by alternate hauls (Table 14).

1.1.2 'Johan Hjort', in company with 'Anton Dohrn', at Hornsund made seven effective covered 128 mm manila cod-end hauls (two of them in deep water and five in shallow), four effective covered 103 mm cod-end hauls, six effective uncovered 110 mm cod-end hauls, and seven effective uncovered 127 mm cod-end hauls. At Stø rfjord, in company with 'Anton Dohrn', 'Ernest Holt' and 'Tunets', the only effective 'Johan Hjort' hauls were three with the covered 126 mm cod-end, and similarly at Bear Island in company with 'Ernest Holt', a fourth with the same gear being added later when alone. At West Spitsbergen, in company with 'Ernest Holt', Johan Hjort' made nine effective hauls with the covered 129 mm cod-end, six effective uncovered 129 mm cod-end hauls and six effective uncovered 110 mm hauls (Table 15, Fig. 5).

1.1.2.1. With hauls grouped by grounds and by 500 kg per hour catch intervals the covered cod-end selection factors ranged between 3.1 and 3.8 (Table 16). At first inspection there appeared to be some between-grounds differences in selectivity. Fish catches varied a lot between grounds but the length/girth relationship of cod did not vary appreciably between grounds. When, within grounds, the data were examined in relation to catch size it appeared that, as with 'Anton Dohrn', selectivity varied inversely with catch size, and that the apparent between-ground differences were largely eliminated.

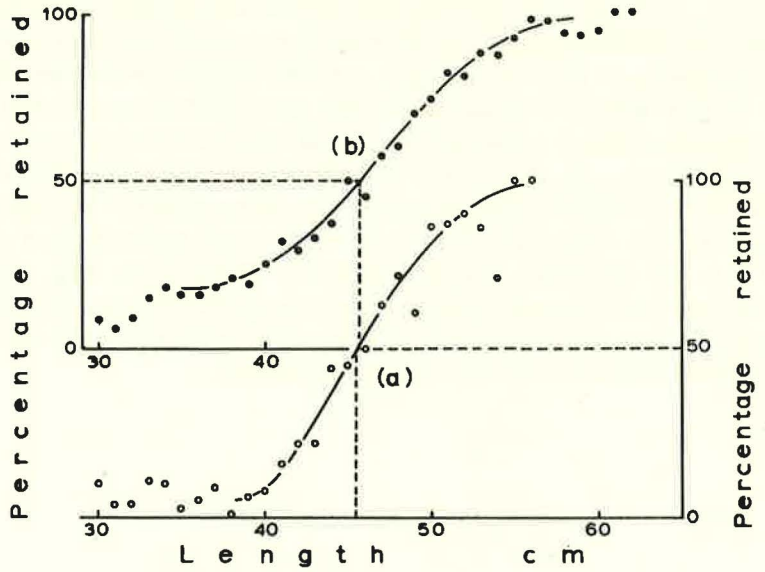

Figure 5 Cod selection curves for 'Johan Hjort' 129 mm double manila cod-end at Isfjord and Bellsund, 1959, by covered cod-end. Hauls grouped by catch size (a) 160 kg/hr, (b) 750 kg/hr. (Table 15).

1.1.2.2. The alternate hauls with uncovered cod-ends have also been grouped by grounds and by catch size and compared with the total catch in cod-end and cover of covered hauls on the same ground, the length distributions being adjusted so as to achieve parity above the selection ranges before calculating the 50% points (Table 17, Fig. 6). The numbers of hauls and numbers of fish were rather few to establish well defined selection, so that no great reliance can be placed on each of the calculated 50% points (witness the fact that the selection factor was altered by 0.15 when a small-meshed uncovered cod-end catch was used for the comparison instead of the covered cod-end catch). Nevertheless the calculated selection factors, ranging between 3.55 and 4.2, were generally well above those obtained from covered hauls. The selectivities, as determined by the alternate haul method, did not appear to be associated with catch size.

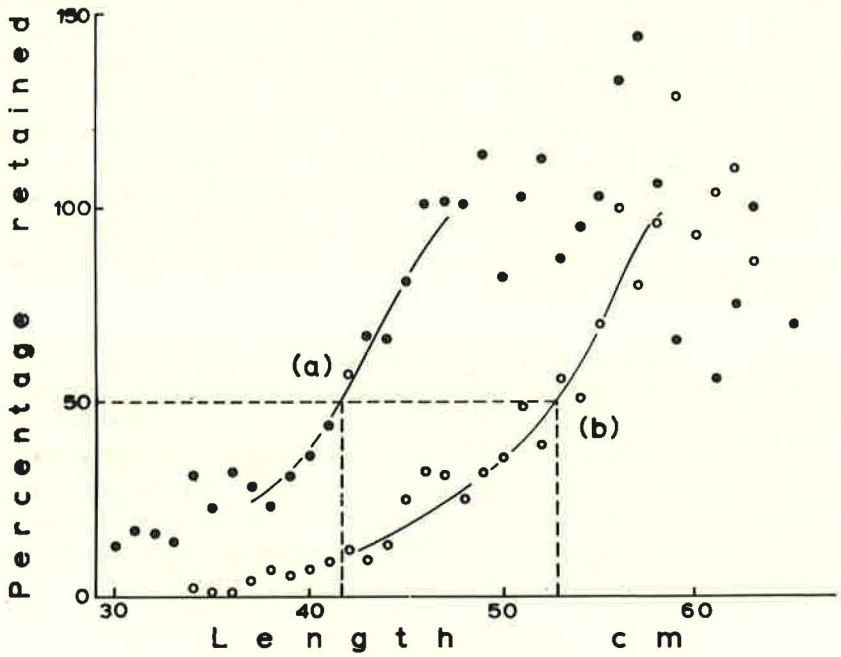

Figure 6 Cod selection curves for 'Johan Hjort' double manila cod-end at Isfjord and Bellsund, 1959, by alternate hauls; (a) 110 mm at 850 kg/hr, (b) 129 mm at 140 kg/hr. (Table 17).

1.1.3. 'Ernest Holt' joined in the experiment at Størfjord, fishing there with 'Anton Dohrn', 'Johan Hjort' and 'Tunets'. But the results obtained there by 'Ernest Holt' were not satisfactory, largely because of poor catches and faulty rigging of the cover which interfered with escapes of small fish from the cod-end. At Bear Island this latter was rectified, but catches were poor and only one covered haul was truly effective (Tables 18 and 19, Fig. 7). More useful results were obtained at West Spitsbergen. The intended 110 mm cod-end was in fact of such small mesh size that it was useless for covered net hauls with the length distributions of the fish as they were, and another cod-end of 137 mm double manila was introduced. The lengths of fish on Bellsund and Isfjord grounds were similar, but there were differences between these and Prince Charles Foreland Bank, so these two areas were treated separately.

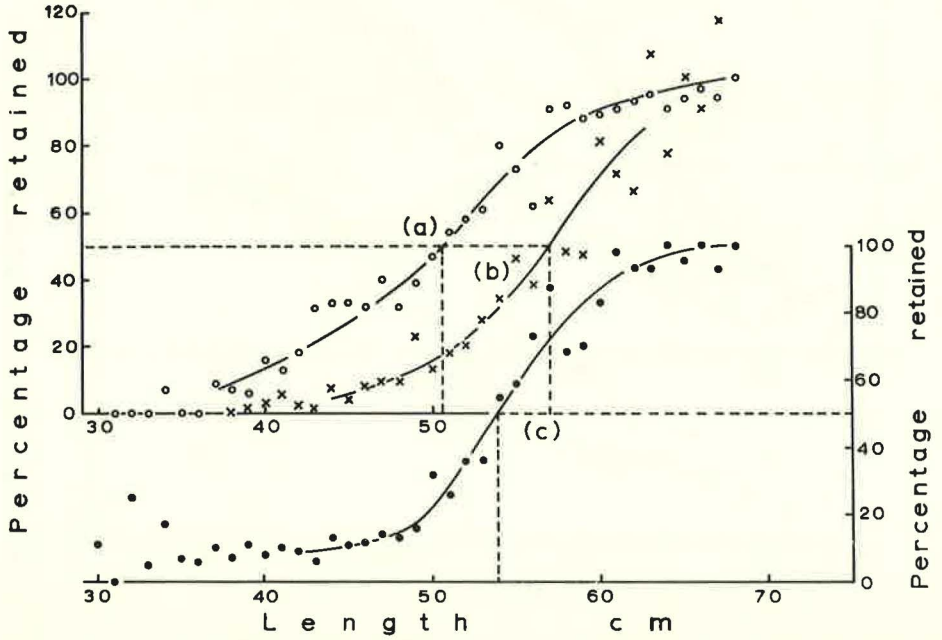

Figure 7 Cod selection curves for 'Ernest Holt' at Prince Charles Foreland Bank, 1959; (a) 137 mm double manila by covered cod-end (Table 18), (b) 137 mm double manila, by alternate hauls (Table 20), (c) double nylon by covered cod-end (Table 27).

1.1.3.1. Within areas the covered hauls by each cod-end were grouped in 500 kg catch weight intervals. The grouped data are in Table 18 and the results are summarised in Table 19. Haul numbers were few; on Foreland Bank the selectivity, with factor 3.7, seemed to be higher than that elsewhere at West Spitsbergen (factor 3.4); there was no obvious dependence of selectivity upon catch size; in fact, if there was no difference due to fishing ground, rather the opposite to the association observed by 'Anton Dohrn' and 'Johan Hjort' applied.

1.1.3.2 Only at West Spitsbergen and Foreland Bank were the data sufficient for comparison of uncovered and covered hauls, and even for this data from different fishing grounds had to be combined (Table 20). The selectivities calculated ranged between 3.8 and 4.2, that for the 137 mm cod-end being 4.0 or 4.2 according to which figures were taken as representing the fish available for selection. Even allowing for errors both in the alternate haul and in the covered cod-end selectivity estimates, the alternate haul selectivities seem to be consistently higher than the covered cod-end selectivities.

1.1.4. 'Tunets' joined the experiment at Stø rfjord and there made a series of hauls, alternating a covered double manila 128 mm cod-end with a covered double manila 105 mm cod-end. 'Tunets' did not accompany the other vessels to West Spitsbergen, but remained working at West Bear Island with hemp and Kapron covered cod-ends.

1.1.4.1. The results from fifteen hauls with each manila cod-end have been combined and are shown in Table 21, the selection curves from which are shown in Fig. 8. Catches were on the whole consistently rather small. The selection factor was 3.4 for both cod-ends.

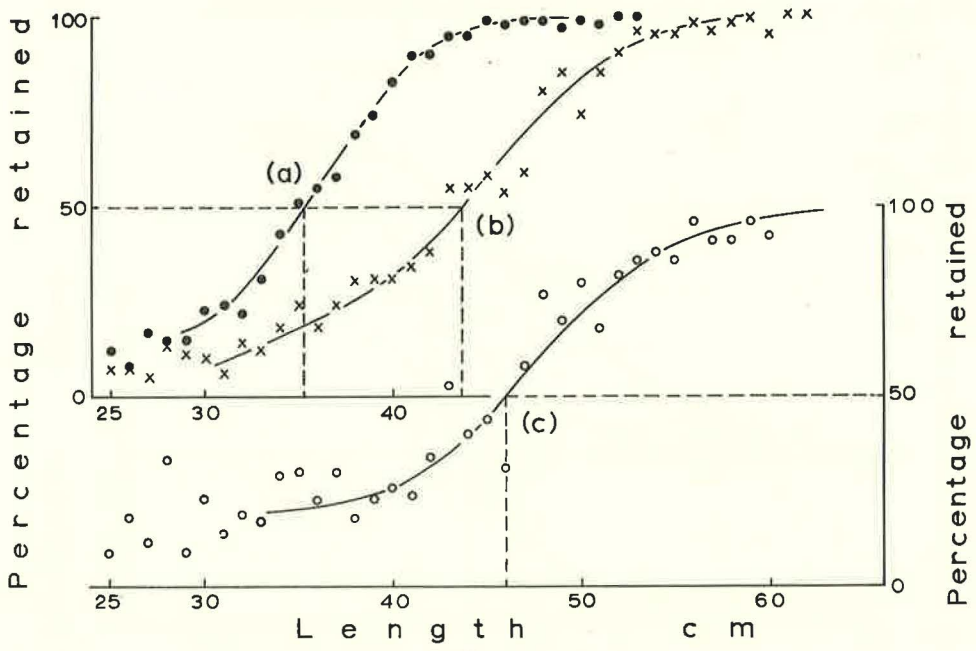

Figure 8 Cod selection curves for 'Tunets', 1959, by covered cod-end; (a) and (b) respectively 105 mm and 128 mm double manila at Stø rfjord (Table 21), (c) 108 mm Kapron at Bear Island (Table 26).

1.1.5 'Explorer' was working to the west of Bear Island, using a trawl typical of British Arctic trawlers with a covered 109 mm cod-end, while the joint experiment was in progress at Stø rfjord, Bear Island and Spitsbergen. Four hauls were effective (Table 22), the predominant two of which were at a rate of fishing of about 1,000 - 1,400 kg per hour. The selection factor for 109 mm double-braided manila was 3.5.

1.2. Hemp and flax

1.2.1. 'Anton Dohrn' made ten hauls with a 136 mm covered hemp cod-end at Stø rfjord. Catches were uniformly light at a level below 500 kg per hour. The calculated selection factor from these hauls was 3.5 (See Table 23).

1.2.2. 'Tunets' made ten hauls with 109 mm flax cod-ends on the Hamburg trawl at Bear Island. Selection was mainly in the range of fish sizes where there were few fish (Table 24) and consequently the lower half of the selection curve was indistinct and the exact position of the 50% point uncertain; the probable selection factor is about 3.6.

1.3. Polyamide fibres

Nylon, Perlon and Kapron cod-ends were used by various ships during the course of the experiment.

1.3.1. 'Anton Dohrn' at Hornsund used a 102 mm covered conventionally knotted Perlon cod-end for four hauls which, combined, indicate a selection factor of 3.6, and considered separately by catch size groups give factors of 3.5 to 3.8, the highest being with the lowest catch (Tables 25 and 12). Also some hauls were made with knotless Perlon netting; two of these with hexagonal mesh and big catches gave a selection factor of 3.5, and six with diamond-shaped meshes when combined gave a factor of 3.3, but when separated according to catch size, gave factors ranging from 3.5 for light catches down to 3.2 for 1,700 kg per hour (Tables 25 and 12). These figures for knotless Perlon netting are primarily interesting in relation to the conventionally knotted Perlon, and it would be misleading to group them with knotted Perlon in any comparison with conventional natural fibres. They are included here particularly to illustrate the apparent effect on selectivity of catch size.

1.3.2. 'Tunets' used a covered 108 mm Kapron cod-end at Bear Island, making ten hauls which in light fishing lumped together gave a selection factor of 4.2 (Table 26, Fig. 8).

1.3.3. 'Ernest Holt' at Foreland Bank used a covered 122 mm double-braided nylon cod-end, making four effective hauls of not very widely different catch size, about 500 kg per hour, which together have a selection factor of 4.4 (Table 27, Fig. 7).

2. HADDOCK

In the 1959 experiment the species primarily sought after was cod, but a few haddock were caught incidentally at West Spitsbergen. There were just enough of these to give a rough measure of selectivity by the 'Ernest Holt' 120 mm and 137 mm covered manila cod-ends when hauls from three different grounds at Spitsbergen were combined (Table 28). Six hauls with the 137 mm cod-end gave a selection factor of approximately 3.3 and four hauls with the 120 mm cod-end gave a factor of approximately 3.0.

LENGTH/GIRTH RELATIONSHIP OF COD

During the course of the experiment, aboard 'Johan Hjort', 'Tunets' and 'Ernest Holt', the girths, as well as the lengths, of cod were measured. On 'Johan Hjort' the head girth at its maximum (which is over the posterior part of the operculum) and also the maximum body girth were measured; on 'Tunets' the head girth was measured just behind the operculum and the maximum body girth was also measured; on 'Ernest Holt' measurement was made of head girth at its maximum, the body girth at its maximum, and the body girth so constricted that the fish could gently be pulled through the constricting loop of the tape measure.

From the girth measurements (Table 29, Fig. 9) there appear to be no substantial fish shape differences between fishing grounds, which might have affected selection. With the variable but on the whole rather light feeding conditions prevailing, the constricted body girth was rather similar to, or slightly less than, the maximum head girth which is thus a useful dimension for selection purposes. The difference between positions at which head girth was measured probably accounts for the Russian length: head girth ratio being different from that obtained on 'Johan Hjort' and 'Ernest Holt'.

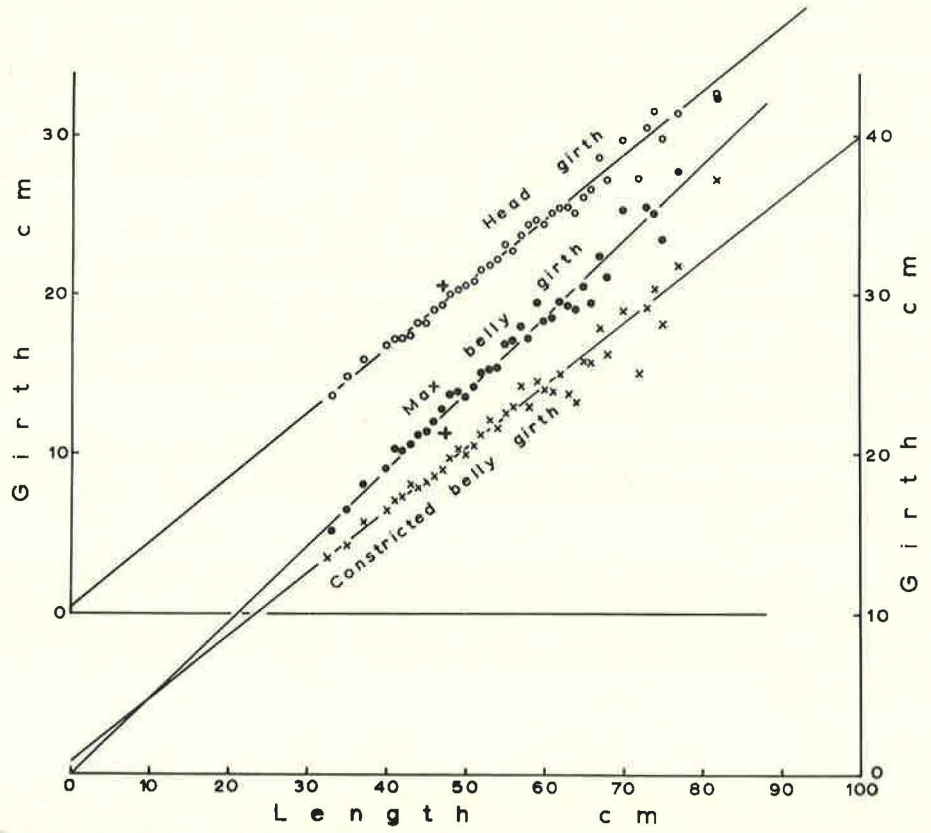

Figure 9 Cod girth/length relationship at Prince Charles Foreland Bank. 'Ernest Holt' measurements, with single crosses indicating 'Johan Hjort' mean values.

MESH SIZES

Mesh measurement on every ship was by means of a spring-loaded mesh gauge of Scottish design set to read at 4 - 5 kg stretching force on the mesh. The meshes measured were in a single longitudinal row up the full length of the top side of the cod-end, and the mean size of these, which usually numbered about 40 - 60, was calculated. Meshes were measured after each haul.

By regular measurement of the meshes it was possible to follow changes not only in the mean mesh size with usage but also in the mesh size in different parts of the cod-end. The usual stretching of meshes by big catches was observed. This is illustrated in Table 30 which contains data relating to only 'Ernest Holt' cod-ends, having been selected as typical of all participating ships' cod-ends. It shows, haul by haul, the mean mesh size in the forward part of the cod-end and that in the after part of the cod-end, the difference between them, and the weight of catch in the cod-end. A splitting strap was fitted about half-way along the cod-end. It is to be noted that after use the mesh size in the after part of the cod-end was always greater than that in the forward part, in some cases by as much as nearly a centimetre, and that a big catch usually caused a sharp increase in mesh size of the after part of the cod-end. It is known that most fish escaping from the trawl cod-end do so through the after meshes, so there would seem to be little doubt that in measuring true selectivity it is the meshes in only the after part of the cod-end that should be considered; the table here shows that there are differences between cod-ends, but that the mean mesh size throughout a cod-end will usually be between 2 and 5 mm smaller than the mean size of the after operative meshes. However, in this 1959 international experiment and for purposes of comparison

SUMMARY OF 1959 INTERNATIONAL EXPERIMENT RESULTS

In the 1959 international experiment alone the cod selection factors for double-braided manila cod-ends, as measured by covered haul technique, ranged from 2.7 to 3.9. Some of these factors are from variously grouped hauls, others from single hauls, and some with few fish, others with plenty, so that they are not all equally reliable. The great majority of the obtained factors are within $\pm$0.2 of 3.5, with the notable exceptions of the low factors from 'Anton Dohrn' and 'Johan Hjort' when catches were heavy at Hornsund.

The spread of the selection factors is not accounted for by between-ship differences, since such a spread is found within the results of single ships.

At first reading, there appear to be differences associated with different fishing grounds. However, girth measurements taken throughout the experiment did not show any significant differences between the fish on the different fishing grounds, so that selection differences could not be attributed to differences in body shape which might be expected to be a major factor in between-ground differences. The quantities of catches did vary between fishing grounds; while large catches were very infrequent and sporadic elsewhere, at Hornsund the fishing was in general good.

At Hornsund, for both of the two ships fishing there, there was a fairly conspicuous association between catch size and selection factor, most of the lower values for selection factor being obtained in hauls with high catches. Covered hauls made by 'Johan Hjort' on other grounds fitted into this pattern, but the few 'Ernest Holt' results did not show such a relationship. One interpretation is that with smaller catches (i.e. below about 500 kg per hour) there is no apparent trend in the distribution of the points, but when catches are bigger there is a tendency for escapes to decline with increase in catch; this effect eliminates the apparent between-ground differences and can account for much of the scatter of the selection factors within the range quoted above.

Another feature which might conceivably have contributed to the observed variation in selection was that at Hornsund, where selection factors were generally found to be low, cod were often in dense mid-water shoals and some may have been caught while the trawl was being hauled and so have had but little chance to escape. An effect of duration of tow would be expected to counteract to some extent the effect of size of catch.

The results from the alternate haul technique were extremely sketchy. It will be noticed that the number of hauls made was generally few for this mesh-selection technique and that consequently in analysing the data it was necessary to adjust the numbers of fish by a raising factor, sometimes as big as 4.0, equalising the numbers above the selection range. In view of the apparent effect of catch size shown in the covered hauls, the uncovered hauls, few as they were, were divided where possible into catch size groups. The selection factors measured ranged from 3.4 to 4.2, but most of them were within $\pm$0.25 of 3.95; there was no apparent relationship to size of catch (Table 31).

The few results with covered polyamide fibre cod-ends showed higher selection factors, ranging from 3.4 to 4.4, than for manila; the pattern of variation of selection factor with catch size was broadly similar to that for manila, in so far as the lower selection factors were associated with the bigger catches.

OTHER CONTEMPORARY ARCTIC TRAWL MESH EXPERIMENTS

Since the 1959 experiment other trawl mesh experiments, notably by Russia and Norway, have been carried out in the same general sea area, many of them using the same trawl as in the 1959 experiment.

Table 32 summarises Russian results with manila cod-ends for cod. Table 33 summarises Russian results with Kapron cod-ends for cod, and Table 34 gives the summed length distributions also for Kapron cod-ends and cod. Results varied between experiments but not noticeably between ships or grounds. The calculated selection factors for Kapron mesh sizes 90 - 110 mm ranged between 3.8 and 4.4 with the mean at 4.2. Considering individual hauls in three of these experiments ('Treska' 7/60, 'Melitopol' 7/60 and 'Lot' 4/59), of the 20 hauls which gave effective results, there was a slightly tendency for the hauls catching more fish to give lower selection factors than those with small catches; when the catch per hour numbered less than 1,000 fish the mean factor was 4.26, when above it was 4.02.

'Johan Hjort' continued using the Hamburg trawl in an Arctic mesh experiment in the eastern Barents Sea in 1960. This was reported by Saetersdal in a paper to ICES, C.M.1960, Comparative Fishing Committee No. 89, but for convenience of comparison, relevant parts of the results of that experiment are included here in Table 35. Interesting features of these results are the apparent contribution to a "cover effect" of the attachment of a splitting strap to the cod-end (all trawls in the 1959 experiment had splitting straps), the lack of any apparent regression of selectivity with catch size when fishing was light, and the absence of any effect on selectivity of the flip type top-side cod-end chafers. Results were obtained for cod and haddock and for manila and Terylene (a polyester fibre).

REVIEW OF ARCTIC TRAWL MESH SELECTION DATA AND CONCLUSIONS

COD

Table 36 summarises the results from the 1959 international experiment, together with others between 1956 and 1960 inclusive. In calculating mean selection factors, the factor from any one experiment or part thereof has been weighted by the number of hauls contributing to that factor, although numbers of fish in the selection ranges varied greatly between hauls. There is fairly good agreement between the means of covered manila results from the 1959 international experiment and other experiments. The overall mean selection factor for cod in double manila covered cod-ends is 3.55.

Clearly the alternate haul experiments, few as they have been, have given higher selection factor values than the covered cod-end experiments. The average selection factor from alternate haul results at 3.88 (here number of hauls is not taken into account is about 10% higher than for covered cod-ends. This difference between results obtained by the two methods is in keeping with experience in other areas; it lends itself to at least partial explanation, and should be taken into account in determining true selectivity.

Assuming that the apparent effect of the size of catch on the measured selection factor is a real one, then in determining the selection factor applicable to commercial fisheries allowance must also be made for the fact that the average commercial catch will lie within the range of catch size which does affect selection and above the range of catch size in which many of the experimental observations have been made. Thus, as so many of the observations contributing to the covered manila factor of 3.55 are from hauls with small catches, that figure is likely to be somewhat above the commercially operative one; a covered manila selection factor of about 3.4 is considered to be more appropriate. Then,

allowing 10% for the difference between results from covered and alternate haul techniques, the indicated true Arctic cod selection factor of double manila trawl cod-ends is 3.7. When comparing Arctic and North Sea cod-selection results it may be noted that the ratio length/girth of North Sea cod is about 9% less than that of Arctic cod.

The evidence does not appear to indicate any changing of selectivity with mesh size in the range 100 - 140 mm.

Experiments in which both manila and synthetic twines were used at about the same time and on the same ground have been entered in page 102 of Table 36, and on pp. 103-5 are the experiments in which just one or other of the twines was used. In page 102 of Table 36 the polyamide used by 'Anton Dohrn' was Perlon, by 'Ernest Holt' nylon, and in the Russian experiments Kapron; in the rest of the table the polyamides were Kapron in the Russian experiments and nylon in the others. Both the range 3.5 to 4.4 and mean 4.12 of selection factors from covered cod-ends of polyamide fibre were substantially above those for covered manila (Tables 36 and 37). The factors for Perlon were rather lower than those for Kapron and nylon, but all the Perlon results were from the one ship, 'Anton Dohrn', whose mean factor for manila was rather low, partly because of some very low factors from hauls with big catches. The overall mean for polyamide was 16% above that for manila.

HADDOCK

The 1959 international experiment provided few further data on the selection of Arctic haddock. The two selection factors of 3.0 and 3.3 obtained by 'Ernest Holt' fit in with other recorded covered cod-end experiment results, which have ranged from 3.0 to 3.4. In all experiments so far haddock was not the species primarily sought after, the data for haddock being collected incidentally. Numbers of haddock have generally been small, although sometimes being taken with big catches of cod. The mean covered cod-end haddock selection factor of 3.25 should probably be adjusted by 10% to allow for the apparent difference in escapes from uncovered cod-ends; the only two alternate haul observations support this. Thus a practical, if tentative, selection factor of 3.6 for Arctic haddock is indicated.

Table 10. 1959 international Arctic mesh experiment. Disposition of ships

Participants	Ships	Scientist in charge	DATES OF WORK ON FISHING GROUNDS, AUGUST 1959					
			Hornsund (deep)	Hornsund (deep)	Størfjord	Bear Island	Isfjord/ Bellsund	Prince Charles Foreland
NORWAY	'Johan Hjort'	G. Saetersdal	11 - 12	10 and 13 - 18	20 - 21	22 - 23 and 3 Sept	24 - 27	28 - 29
GERMANY	'Anton Dohrn'	A. von Brandt	11	10 and 12 - 18	19 - 21			
ENGLAND	'Ernest Holt'	A. R. Margetts			19 - 21	22 - 23	24 - 27	25 and 28 - 29
U. S. S. R.	'Tunets'	A. I. Treschev			20 - 21	22 - 29		
SCOTLAND	'Explorer'	B. B. Parrish				18 - 24		

Table 11. Description of the net twines used in the 1959 international Arctic trawl mesh experiments

Material	Natural fibre		Synthetic fibres			
			Polyamide			Polyester
Fibre	Manila	Hemp	Perlon	Kapron	Nylon	Trevira
No.	Nt 4/500	Nm 0.5/3	-	-	-	Nt 3/600
Construction	twisted	twisted	plaited	twisted	plaited	twisted
Preparation	unp.	unp.	unp.	unp.	unp.	unp.
Runnage (m/kg)	125	144	210	153	191	205
Breaking strength (kg)						
dry	223	85	144	190	241	166
wet	215	116	109	162	182	157
Overhand knot						
dry	89	59	93	111	139	76
wet	123	89	79	100	108	78
Diameter (mm)						
dry	3.9	3.1	-	3.7	2.7	2.4
wet	5.0	3.5	3.1	3.7	2.9	2.4
Flexibility						
wet	ca. 900	260	21	120	230	80
Country	E G N U	G	G N	U	E	G N

E = England
G = Germany
N = Norway
U = USSR

Table 12. 1959 international Arctic mesh experiment.
ANTON DOHRN. Hornsund. Cod. Manila and Perlon.
Covered hauls. Summary of results by single hauls

Cod-end	Mesh size (mm)	Haul duration (hr)	Catch/hr		50% Length (cm)	Selection factor
			No.	Weight (kg)		
Manila	124	1	147	250	47	3.7
"	123	1	289	250	45	3.7
"	122	1	226	300	48	3.9
"	123	1	483	400	44	3.6
"	127	1	717	800	41	3.3
"	123	1	1123	850	36	2.9
"	123	1	880	900	42	3.4
"	123	1	1360	900	35	2.7
"	121	0.5	1342	950	42	3.5
"	126	0.5	6012	3600	35	2.7
Manila, 10 hauls continued	123		1258	920	39	3.2
Knotted Perlon	103	1	580	1500	39	3.8
" "	102	0.7	1749	950	35.5	3.5
" "	102	1	2487	1550	37	3.6
Knotless Perlon	117	1	151	150	41	3.5
" "	116	1	341	350	41	3.5
" "	117	1	809	700	39	3.3
" "	117	1	1235	750	37	3.2
" "	117	0.75	2170	1350	39	3.3
" "	117	0.5	5884	3400	38	3.2

Table 13. 1959 international Arctic mesh experiment
ANTON DOHRN. Hornsund. Cod. Manila. Covered hauls.
123 mm mesh. Numbers of fish in cm groups. Ten hauls
grouped by weight of cod-end catch per hour in 500 kg intervals

Weight group	0-500 kg			501-1000 kg			1501-2000 kg			Total		
No. of hauls	5			4			1			10		
Mean weight	340			860			1800			700		
Length (cm)	Cod-end	Cov.	% Ret. in cod-end	Cod-end	Cov.	% Ret, in cod-end	Cod-end	Cov.	% Ret. in cod-end	Cod-end	Cov.	% Ret. in cod-end
25		1	0		4	0					5	0
26		2	0		2	0		1	0		5	0
27		22	0	1	11	7.7		4	0	1	37	2.6
28		45	0	6	20	23.1	2	13	13.3	8	78	9.3
29	5	102	4.7	7	44	13.7	5	18	21.7	17	164	9.4
30	9	111	7.5	13	54	19.4	6	23	20.7	28	188	13.0
31	8	125	6.0	20	61	24.7	12	35	5.4	40	221	15.3
32	13	135	8.8	34	69	33.0	29	37	43.9	76	241	24.0
33	11	177	5.9	46	105	30.5	40	71	36.0	97	353	21.6
34	35	213	14.1	71	120	35.3	79	84	48.5	185	417	30.7
35	40	352	10.2	120	166	42.0	110	110	50.0	270	628	30.1
36	69	369	15.8	154	197	43.9	170	152	52.8	393	718	35.4
37	98	425	18.7	225	228	49.7	224	152	59.6	547	805	40.5
38	125	367	25.4	240	221	52.1	244	166	59.5	609	754	44.7
39	128	330	27.9	249	185	57.4	240	106	69.4	617	621	49.8
40	137	303	31.1	283	175	61.8	230	100	69.7	650	578	52.9
41	116	216	34.9	225	146	60.6	245	81	75.2	586	443	56.9
42	112	185	37.7	228	110	67.5	198	62	76.2	538	357	60.1
43	102	122	45.5	200	106	65.4	174	41	80.9	476	269	63.9
44	91	99	47.9	164	82	66.7	137	34	80.1	392	215	64.6
45	80	93	46.4	169	80	67.9	127	23	79.4	376	196	65.7
46	67	52	61.5	134	57	70.2	111	21	84.1	312	130	70.6
47	72	57	55.8	161	51	75.9	105	8	92.9	348	116	75.0
48	64	44	59.3	145	38	79.2	83	13	86.5	292	95	75.5
49	69	27	71.9	135	31	81.3	79	6	92.9	273	64	81.0
50	62	25	71.3	124	28	81.6	68	3	95.8	254	56	81.9
51	42	23	64.6	117	21	84.8	57	3	95.0	216	47	82.1
52	33	13	71.7	88	16	84.6	51	-	100.0	172	29	85.6
53	41	13	75.9	105	23	82.0	31	-	100.0	177	36	83.1
54	32	10	76.2	84	8	91.3	33	1	97.1	149	19	88.7

Table 13. (cont)

Weight group	0-500 kg			501-1000 kg			1501-2000 kg			Total		
No. of hauls	5			4			1			10		
Mean weight	340			860			1800			700		
Length (cm)	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.
55	34	6	85.0	84	13	86.6	17	1	94.1	135	20	87.1
56	24	2	92.3	73	5	93.6	13	-	100.0	110	7	94.0
57	13	2	86.7	75	6	92.6	18	-	-	106	8	93.0
58	12	1	92.3	53	2	96.4	9	-	-	74	3	96.1
59	10	1	90.9	52	1	98.1	17	-	-	79	2	97.5
60	13	1	92.9	58	1	98.3	11	-	-	82	2	97.6
61	11		100.0	31	3	90.6	7	1	-	49	4	92.5
62	6		-	27	-	100.0	7		-	40		100
63	3			17	1	94.4	5			25	1	96.2
64	5			17		100.0	4			26		100
65+	13			49			8			70		
Total	1805	4071		4084	2491		3006	1370		8895	7932	
50% point (cm)	44.9			37.1			35.0			39.0		
25 - 75% range (cm)	12			16			14			14		
Selection factor	3.5			3.0			2.8			3.2		

Table 14. 1959 international Arctic mesh experiment
ANTON DOHRN. Hornsund. Cod. Manila. Alternate hauls

	116 mm uncovered (12 hauls)	123 mm covered (10 hauls)	123 mm raised by 1.7	% retained 116 mm
Length (cm)				
25	2	5	9	22
26	7	5	9	78
27	9	38	65	14
28	16	86	147	11
29	39	181	310	13
30	63	216	369	17
31	67	261	446	15
32	91	317	542	17
33	154	450	770	20
34	258	602	1029	25
35	396	898	1536	26
36	599	1111	1900	32
37	859	1352	2312	37
38	1049	1363	2331	45
39	1039	1238	2117	49
40	1155	1228	2100	55
41	1087	1029	1760	62
42	1046	895	1530	68
43	857	745	1274	67
44	858	607	1038	83
45	805	572	978	82
46	769	442	756	102
47	742	464	793	94
48	683	387	662	103
49	600	337	576	104
50	575	310	530	108
51	482	263	450	107
52	403	201	344	117
53	339	213	364	93
54	255	168	287	89
55	277	155	265	105
56	221	117	200	110

Table 14. (cont)

	116 mm uncovered (12 hauls)	123 mm covered (10 hauls)	123 mm raised by 1.7	% retained 116 mm
Length (cm)				
57	160	114	195	82
58	142	77	132	108
59	116	81	139	83
60	106	84	144	74
61	85	53	91	93
62	67	40	68	99
63	43	26	44	98
64	34	26	44	77
65	25	22	38	66
66	14	11	19	74
67	16	13	22	73
68	16	8	14	114
69	6	7	12	50
70	4	4	7	57
71	9	1	2	450
72	2			-
73	1	1	2	50
74				
75+	6	2	3	200
Total	16654	16826	28775	
50% point (cm)				39.0
25 - 75% range (cm)				9
Selection factor				3.4

Table 15. 1959 international Arctic mesh experiment
JOHAN HJORT. Cod. Manila. Covered hauls

Ground	Hornsund Deep			Hornsund Deep			Hornsund Shallow			Hornsund Shallow		
No. of hauls	1			1			3			2		
Duration of hauls (hr)	1.5			1			1			1		
Catch/hr (kg)	550			1500			70			910		
Mesh (mm)	131			131			128			128		
Length (cm)	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.
< 25		2			8							
25					3						1	
26					4						9	
27		2			5			6		2	17	11
28		1			4			10		5	42	11
29		1			2			21		6	88	6
30		1			8		1	37	3	31	115	21
31		2			7	0	1	43	2	27	141	16
32				1	8	11	1	55	2	22	147	13
33		2		2	7	22		73		25	189	12
34		1		1	3	25	2	100	2	50	231	18
35		2	0	5	6	45	3	119	2	71	308	19
36	2	8	20	4	15	21	8	127	6	104	303	26
37	1	2	33	10	15	40	10	136	7	152	291	34
38		4	0	10	25	29	10	140	7	172	244	41
39	4	5	44	29	18	62	13	112	10	179	221	45
40	1	17	6	26	26	50	20	84	19	188	180	51
41	3	17	15	26	44	37	21	49	30	172	135	56
42	7	7	50	43	30	59	20	50	29	162	88	65
43	6	14	30	32	26	55	21	32	40	146	42	78
44	11	7	61	45	26	63	19	15	56	107	45	70
45	19	9	68	58	22	65	12	15	44	23	29	81
46	19	19	50	68	22	76	8	14	36	91	32	74
47	36	10	78	76	14	84	10	14	42	88	20	81
48	36	10	78	64	20	76	10	3	77	70	12	85
49	40	3	93	77	8	90	9	5	64	63	3	95
50	37	5	88	69	4	95	5	5	50	60	10	86

Table 15. (cont)

Ground	Hornsund Deep			Hornsund Deep			Hornsund Shallow			Hornsund Shallow		
No. of hauls	1			1			3			2		
Duration of hauls (hr)	1.5			1			1			1		
Catch/hr (kg)	550			1500			70			910		
Mesh (mm)	131			131			128			128		
Length (cm)	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.
51	41	7	85	62	6	91	5		100	32	4	89
52	42	1	98	51	4	93	3	2	60	38	4	90
53	40	2	95	52	1	98	7		100	26	3	90
54	40	3	93	46	6	89	1	2	33	15		100
55	34		100	44	2	95	2		100	17	1	94
56	23		100	29	1	97	2		100	15		100
57	29	1	96	29	1	97	2		100	10	0	100
58	29	1	96	24	1	96	1		100	12		100
59	19		100	19		100	2		100	8		100
60	20		100	15						5		100
61	8	1	89	9						6		100
62	15		100	7						4		100
63	11			6						1		100
64	5			1						1		100
65+	15			8			1		100	8		500
Total	593	167		1048	402		230	1269		2314	2955	
50% point (cm)	44.0			41.0			45.0			39.8		
25-75% range (cm)	8?			12?			9			8		
Selection factor	3.35			3.1			3.5			3.1		

Table 15. (cont)

Ground	Stø rfjord			Bear Island			Bear Island			Isfjord-Bellsund		
No. of hauls	3			3			1			3		
Duration of hauls (hr)	1.3			1.2			1.5			1		
Catch/hr (kg)	250			270			1190			160		
Mesh (mm)	126			129						129		
Length (cm)	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.
<25		3						1				
25		6		1		10					3	
26		7			2			1		2	9	18
27		2			2			1		1	14	7
28		4	0		5			2		1	15	6
29	1	6	14	1	9	10		4			18	
30		5	0		10			1		2	19	10
31		3			16			2	0	1	23	4
32		5		1	8	11	1	6	14	1	27	4
33		3	0	1	13	7		2	0	2	17	11
34	1	6	14	1	21	5	2	4	33	2	19	10
35		2	0		16			9	0	1	29	3
36		7		2	12	14		11	0	2	40	5
37		9	0	2	18	10	3	11	21	6	58	9
38	1	7	12	1	24	4	1	15	6	1	81	1
39	2	3	40	3	33	8	1	7	12	4	67	6
40		9	0	5	19	21	5	9	36	6	74	8
41	1	10	9	4	29	12	3	7	30	11	59	16
42	4	4	50	11	23	32	1	4	20	11	39	22
43	2	7	22	10	15	40	4	4	50	12	42	22
44	4	1	80	7	30	19	2	5	29	20	25	44
45	3	7	30	8	21	28	7	6	54	17	21	45
46	2	5	29	15	10	60	7	4	64	21	21	50
47	7	2	78	12	18	40	4	5	44	26	15	63
48	3	7	30	11	13	46	5	4	55	34	13	72
49	5	3	63	19	20	49	11	6	65	19	12	61
50	7	4	64	32	10	76	6	8	43	36	6	86

Table 15. (cont)

Ground	Størfjord			Bear Island			Bear Island			Isfjord-Bellsund		
No. of hauls	3			3			1			3		
Duration of hauls (hr)	1.3			1.2			1.5			1		
Catch/hr(kg)	250			270			1190			160		
Mesh (mm)	126			129						129		
Length (cm)	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.
51	7	3	70	23	15	61	15	8	65	20	3	87
52	9	4	69	16	19	46	12	6	67	18	2	90
53	6	2	75	24	5	83	14	9	61	12	2	86
54	15	3	83	17	4	81	21	7	75	5	2	71
55	13	4	76	19	4	83	36	3	92	9		100
56	19	4	83	29	6	83	21	2	91	6		100
57	11	1	92	16	4	80	24	4	86	3		100
58	13	1	93	13	2	87	20	2	91	5		100
59	12	1	92	18	1	95	21	1	95	6		100
60	18		100	22	2	92	19	1	95	1		100
61	18			11		100	19		100	4		100
62	19		100	6			21			3		100
63	16	2	89	5			11			5		100
64	9		100	6			16			2		100
65+	76			53			202			6		400
Total	304	162		425	472		535	182		345	784	
50% point (cm)	48.0			47.7			47.0			45.5		
25-75% range (cm)	8?			9			14?			7		
Selection factor	3.8			3.7			3.6			3.5		

Table 15. (cont)

Ground	Isfjord/Bellsund			Foreland Bank			Hornsund Shallow			Hornsund Shallow		
No. of hauls	3			3			2			2		
Duration of hauls (hr)	1.3			1			1			1		
Catch/hr (kg)	750			310			200			500		
Mesh (mm)	129			130			103			103		
Length (cm)	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.
<25		5			13			2			1	
25		3		1	15		3	3	50		1	
26		6			22		4	4	50		3	
27		7		1	58		3	7	30	1	6	14
28		16			63	0	3	12	20	1	8	11
29		23		1	58	2	7	11	39	1	11	8
30	3	31	9	2	72	3	3	8	27	5	23	18
31	3	48	6	1	75	1	6	8	43	10	26	28
32	3	30	9	4	89	4	7	16	30	12	32	27
33	7	41	15	8	128	6	3	15	17	21	27	44
34	12	56	18	7	173	4	12	18	40	36	44	45
35	20	107	16	7	156	4	12	28	30	54	54	50
36	26	138	16	10	158	6	26	30	46	74	51	59
37	38	170	18	12	144	8	16	22	42	104	51	67
38	49	188	21	15	90	14	30	18	62	112	45	71
39	56	242	19	10	82	11	24	18	57	106	25	81
40	79	238	25	7	56	11	37	4	90	112	19	85
41	89	191	32	11	43	20	31	6	84	93	14	87
42	77	192	29	12	35	26	14	4	78	79	6	93
43	85	171	33	10	35	22	24	2	92	66	2	97
44	91	155	37	5	37	12	14	1	93	73	2	97
45	120	120	50	10	29	26	14	1	93	61	3	95
46	86	104	45	19	29	40	9	2	82	50		100
47	123	93	57	14	22	39	10		100	50		100
48	130	88	60	15	21	42	9	1	90	37	1	97
49	146	62	70	27	14	66	5		100	41		100
50	139	50	74	36	13	73	9		100	24		100

Table 15. (cont)

Ground	Isfjord/Bellsund			Foreland Bank			Hornsund Shallow			Hornsund Shallow		
No. of hauls	3			3			2			2		
Duration of hauls (hr)	1.3			1			1			1		
Catch/hr(kg)	750			310			200			500		
Mesh (mm)	129			130			103			103		
Length (cm)	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.
51	119	27	82	11	8	58	8		100	18		100
52	84	20	81	15	9	63	7		100	22		100
53	97	13	88	18	3	86	6		100	12		100
54	73	11	87	22	3	88	3		100	18		100
55	55	5	92	18	2	90	7		100	11		100
56	43	1	98	17	2	89	3		100	10		100
57	38	1	97	14	1	93	1		100	3		100
58	30	2	94	18	1	95	4		100	6		100
59	26	2	93	21	1	95	1		100	2		100
60	33	2	94	23		100	1		100	1		100
61	26		100	12			1		100	1		100
62	16		100	18			1		100	1		100
63	12		100	13			3		100			
64	11		100	10			1		100			
65+	26		1,100	50			1		100	2		200
Total	2,071	2662		525	1759		385	241		1330	455	
50% point (cm)	45.7			48.0			37.0			34.7		
25-75% range (cm)	10			9			10?			8		
Selection factor	3.5			3.7			3.6			3.4		

Table 16. 1959 international Arctic mesh experiment
JOHAN HJORT. Cod. Manila. Covered hauls

	Hornsund Deep	Hornsund Deep	Hornsund Shallow	Hornsund Shallow	Størfjord	Bear Island	Bear Island	Isfjord/ Bellsund	Isfjord/ Bellsund	Foreland Bank	Hornsund Shallow	Hornsund Shallow
No. of hauls	1	1	3	2	3	3	1	3	3	3	2	2
Duration of haul (hr)	1.5	1	1	1	1.3	1.2	1.5	1	1.3	1	1	1
Catch/hr (kg)	550	1500	70	910	250	270	1190	160	750	310	200	500
Mesh (mm)	131	131	128	128	126	129	130	129	129	130	103	103
Selection factor	3.35	3.1	3.5	3.1	3.8	3.7	3.6	3.5	3.5	3.7	3.6?	3.4

Table 17. 1959 international Arctic mesh experiment
JOHAN HJORT. Cod. Manila. Alternate hauls

Ground	Hornsund					Hornsund			Hornsund	
No. of hauls	2	5		6		5			1	
Duration of hauls (hr)	1.2					1.1			0.5	
Catch/hr (kg)	825					170			6020	
Mesh (mm)	A 127 Uncov.	B 128 Cov.	$\frac{A}{B \times 4.3}$	C 110 Uncov.	A/C	D 127 Uncov.	$\frac{D}{B \times 1.6}$	$\frac{D \times 2.5}{C}$	E 110 Uncov.	$\frac{E}{B \times 3.2}$
Length (cm)										
25		1								
26		9								
27		25								
28		57								
29		115		2						
30		184		8		1		31	6	1
31	2	212		12	16	1		21	10	1
32	1	225		33	3	2	1	15	24	3
33	7	287	1	47	15	3	1	16	34	4
34	10	383	1	82	12	5	1	15	60	5
35	16	501	1	129	12	5	1	10	86	5
36	31	542	1	200	16	11	1	14	139	8
37	45	589	2	288	16	18	2	16	173	9
38	73	566	3	358	20	28	3	20	212	12
39	79	525	3	454	17	26	3	14	290	17
40	78	472	4	455	17	52	7	29	271	18
41	103	377	6	402	26	47	8	29	253	21
42	116	320	8	437	27	53	10	30	270	26
43	118	241	11	438	27	51	13	29	279	36
44	131	186	16	417	31	48	16	29	287	48
45	130	179	17	403	32	71	25	44	271	47
46	139	145	22	355	39	80	34	56	258	56
47	157	132	28	399	39	81	38	51	280	66
48	150	95	37	316	47	90	59	71	222	73
49	141	80	41	284	50	75	59	66	203	79
50	129	80	38	256	50	65	51	63	165	64
51	149	41	85	225	66	57	87	63	171	130

Table 17. (cont)

Ground	Hornsund					Hornsund			Hornsund	
No. of hauls	2	5		6		5			1	
Duration of hauls (hr)	1.2					1.1			0.5	
Catch/hr (kg)	825					170			6020	
Mesh (mm)	A 127 Uncov.	B 128 Cov.	A / B x 4.3	C 110 Uncov.	A/C	D 127 Uncov.	D / B x 1.6	D x 2.5 / C	E 110 Uncov.	E / B x 3.2
Length (cm)										
52	123	47	61	185	66	54	72	73	141	94
53	121	36	78	158	77	29	50	46	123	107
54	101	18	130	112	90	33	115	74	74	128
55	85	20	99	72	118	33	103	115	57	89
56	73	17	100	76	96	30	110	99	48	88
57	62	12	120	60	103	27	141	112	44	115
58	57	13	102	51	112	20	96	98	37	89
59	44	10	102	43	102	14	88	81	36	112
60	44	5	205	43	102	12	150	115	29	181
61	27	6	105	26	104	10	104	109	19	99
62	23	4	134	23	100	3	47	47	12	94
63	11	1	256	16	69	10	625	192	10	313
64	8	1	186	13	62	3	188	125	9	281
65+	22	9	57	28	79	9	62	80	23	80
Total	2606	6768		6906		1157			4626	
50% point (cm)			50.3		49.0		48.4	46.7		45.5
25-75% range (cm)			6		10		6	10		7
Selection factor			4.0		3.85		3.8	3.7		4.1

Table 17. (cont)

Ground	Hornsund		Hornsund		Isfjord/Bellsund			Isfjord/ Bellsund		Isfjord/ Bellsund	
No. of hauls	3		2		2	6		4		3	
Duration of hauls (hr)	1.1		1.1		1.5			1.6		1.4	
Catch/hr (kg)	220		360		470			140		850	
Mesh (mm)	F 110	F x 1.54 / B	G 110	G x 1.43 / B	H 129	J 129 cov.	H x 2.64 / J	K 129	K x 2.09 / J	L 110	L x 1.19 / J
Length (cm)						16					
25						6					
26						17					
27						22				3	16
28						32					
29	2	3				41				2	6
30	1	1	1	1		55				6	13
31	1	1	1	1	2	71	7			10	17
32	1	1	8	5	1	59	4			8	16
33	4	2	9	4	1	67	4			8	14
34	9	4	13	5	3	89	9	1	2	23	31
35	19	6	24	7	4	157	7	1	1	30	23
36	29	8	32	8	5	206	6	1	1	56	32
37	50	13	65	16	9	272	9	5	4	64	28
38	65	18	81	20	13	319	11	10	7	62	23
39	75	22	89	24	24	369	17	8	5	97	31
40	76	25	108	33	37	397	25	14	7	121	36
41	67	27	82	31	31	350	23	15	9	130	44
42	65	31	102	46	21	319	17	18	12	154	57
43	67	43	92	55	32	310	27	14	9	175	67
44	60	50	70	54	45	291	41	18	13	162	66
45	72	62	60	48	48	278	46	33	25	190	81
46	47	50	50	49	52	232	59	35	32	196	101
47	62	72	57	62	57	257	59	38	31	220	102
48	46	75	48	72	68	265	68	32	25	226	101
49	32	62	49	88	70	239	77	37	32	228	114
50	36	69	55	98	55	231	63	40	36	160	82
51	28	105	26	91	46	169	72	40	49	146	103

Table 17. (cont)

Ground	Hornsund		Hornsund		Isfjord/Bellsund			Isfjord/ Bellsund		Isfjord/ Bellsund	
No. of hauls	3		2		2	6		4		3	
Duration of hauls (hr)	1.1		1.1		1.5			1.6		1.4	
Catch/hr (kg)	220		360		470			140		850	
Mesh (mm)	F 110	F x 1.54 / B	G 110	G x 1.43 / B	H 129	J 129 cov.	H x 2.64 / J	K 129	K x 2.09 / J	L 110	L x 1.19 / J
Length (cm)											
52	23	75	21	64	48	124	102	23	39	118	113
53	15	64	20	79	34	124	72	33	56	91	87
54	19	163	19	151	31	91	90	22	51	73	95
55	8	62	7	50	21	69	80	23	70	60	103
56	9	82	19	60	19	50	100	24	100	56	133
57	10	128	6	72	22	42	138	16	80	51	144
58	7	83	7	77	20	37	143	17	96	33	106
59	5	77	2	29	22	34	171	21	129	19	66
60	9	277	5	143	14	36	103	16	93	17	56
61	6	154	1	24	11	30	97	15	104	19	75
62	4	154	7	250	5	19	69	10	110	16	100
63	5	770	1	143	3	17	47	7	86	10	70
64	2	308	2	286		13		3	48	4	37
65+	1	17	4	64	15	32	124	11	72	19	71
Total	1037		1243		889	5854		601		3063	
50% point (cm)		46.1		44.3			45.8		52.8		41.7
25-75% range (cm)		9		9			7		9		6
Selection factor		4.2		4.0			3.55		4.1		3.8

Table 17. (cont)

Ground	Isfjord/Bellsund	
No. of hauls	3	
Duration of hauls (hr)	1.8	
Catch/hr (kg)	190	
Mesh (mm)	M 110	M x 4 J
Length (cm)		
25		
26		
27	1	18
28		
29		
30	5	36
31		
32	1	7
33	3	18
34	3	13
35	5	13
36	10	19
37	14	21
38	10	13
39	28	30
40	39	39
41	50	37
42	57	71
43	56	72
44	64	88
45	53	76
46	55	95
47	59	92
48	67	101
49	56	94
50	44	76
51	37	88
52	41	132

Ground	Isfjord/Bellsund	
No. of hauls	3	
Duration of hauls (hr)	1.8	
Catch/hr (kg)	190	
Mesh (mm)	M 110	M x 4 J
Length (cm)		
53	23	74
54	22	97
55	24	139
56	15	120
57	11	105
58	10	108
59	11	129
60	7	78
61	5	67
62	4	84
63	6	141
64		
65+	6	75
Total	902	
50% point (cm)		40.7
25-75% range (cm)		5
Selection factor		3.7

Table 18. 1959 international Arctic mesh experiment
ERNEST HOLT. Cod. Manila. Covered hauls.

Mesh (mm)	120			120			137			137			137		
Ground	Bear Island			Isfjord/Bellsund			Isfjord/Bellsund			Foreland Bank			Foreland Bank		
No. of hauls	1			4			4			1			3		
Duration of hauls (hr)	1			1			1			1			1		
Mean cod-end catch (kg/hr)	480			130			190			1800			710		
Length (cm)	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.
20				1		100		5	0						
21								2	0						
22								2	0						
23					1	0	1	2	33						
24		1	0	5	1	83		8	0						
25		2	0	2	4	33		9	0		3	0			
26		4	0	1	6	14	1	11	8		3	0		2	0
27		5	0	5	7	42	4	14	22					2	0
28	3	6	33	3	15	17	2	15	12					2	0
29		7	0	2	26	71	4	14	22					3	0
30	1	17	6	2	16	11	2	21	9				2	4	33

Table 18. (cont)

Mesh (mm)	120			120			137			137			137		
Ground	Bear Island			Isfjord/Bellsund			Isfjord/Bellsund			Foreland Bank			Foreland Bank		
No. of hauls	1			4			4			1			3		
Duration of hauls (hr)	1			1			1			1			1		
Mean cod-end catch(kg/hr)	480			130			190			1800			710		
Length (cm)	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.
31	2	17	11	1	11	8	1	14	7					5	0
32	4	15	21	3	16	16	6	30	17					6	0
33	2	18	10	5	12	29	7	15	32		15	0		16	0
34	2	15	12	2	2	50	3	26	10		30	0	2	28	7
35	6	11	35	2	13	13	7	36	16		48	0		37	0
36	6	14	30	1	4	20	8	28	22	6	84	7		43	0
37	4	10	29	11	15	42	13	23	36	21	90	19	5	49	9
38	6	9	40	8	23	26	15	40	27	18	129	12	6	74	7
39	9	8	53	10	19	34	8	46	15	12	174	6	4	65	6
40	5	9	36	16	25	39	19	33	37	18	117	13	8	42	16
41	4	4	50	17	11	61	15	49	23	33	117	22	9	59	13
42	4	3	57	28	16	64	15	39	28	33	135	20	14	62	18

Table 18. (cont)

Mesh (mm)	120			120			137			137			137		
Ground	Bear Island			Isfjord/Bellsund			Isfjord/Bellsund			Foreland Bank			Foreland Bank		
No. of hauls	1			4			4			1			3		
Duration of hauls (hr)	1			1			1			1			1		
Mean cod-end catch(kg/hr)	480			130			190			1800			710		
Length (cm)	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.
43	4	2	67	13	14	48	26	29	47	9	162	5	20	84	31
44	3	1	75	17	7	71	19	24	44	3	96	3	28	84	33
45	4	2	67	14	6	70	29	38	43	18	150	11	29	89	33
46	8	0	100	19	8	70	31	31	50	27	111	20	32	68	32
47	7	3	70	24	2	92	31	22	58	21	96	28	44	66	40
48	6		100	24	6	80	27	15	64	33	75	31	38	78	32
49	5		100	24	1	96	25	15	62	30	42	42	41	63	39
50	3		100	27	3	90	32	8	80	39	54	42	42	48	47
51	5	2	71	17	2	90	17	10	63	39	36	52	48	41	54
52	4		100	14		100	27	6	82	36	48	43	60	44	58
53	8		100	21	1	96	17	6	74	33	18	65	50	32	61

Table 18. (cont)

Mesh (mm)	120			120			137			137			137		
Ground	Bear Island			Isfjord/Bellsund			Isfjord/Bellsund			Foreland Bank			Foreland Bank		
No. of hauls	1			4			4			1			3		
Duration of hauls (hr)	1			1			1			1			1		
Mean cod-end catch(kg/hr)	480			130			190			1800			710		
Length (cm)	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.
54	7	1	88	15		100	15	2	88	51	27	65	66	16	80
55	10		100	20			15	2	88	42	15	74	49	18	73
56	12			15			17	3	85	57	15	79	42	26	62
57	7			9			14	2	88	63	12	84	63	6	91
58	7			10			14	2	88	57	9	85	58	5	92
59	12			19			11		100	60	6	91	71	10	88
60	8			8			12		100	45	3	94	55	7	89
61	8			7			5	1	83	42	12	78	79	8	91
62	6			9			4		100	60	6	91	83	6	93
63	6			3			7			36	9	80	53	3	95
64	9			2			6			48	3	94	41	4	91

Table 18. (cont)

Mesh (mm)	120			120			137			137			137		
Ground	Bear Island			Isfjord/Bellsund			Isfjord/Bellsund			Foreland Bank			Foreland Bank		
No. of hauls	1			4			4			1			3		
Duration of hauls(hr)	1			1			1			1			1		
Mean cod-end catch(kg/hr)	480			130			190			1800			710		
Length (cm)	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.
65	5			3			2			36	3	92	32	2	94
66	1			3			3			36	3	92	32	1	97
67	3			3			2			21		100	15	1	94
68+	50			4			9			21			44	0	100
Total	271	186		469	293		548	698		1098	1956		1271	1309	
50% point (cm)	40.6			41.0			45.4			51.2			50.6		
25-75% range (cm)	10			10			12			7			12		
Selection factor	3.4			3.4			3.3			3.7			3.7		

Table 19. 1959 international Arctic mesh experiment
ERNEST HOLT. Cod. Manila. Covered hauls

Ground	Mesh (mm)	No. of hauls	Haul duration (hr)	Cod-end catch (kg/hr)	50% length (cm)	Selection factor
Bear Island	120	1	1	480	40.6	3.4
Isfjord/Bellsund	120	4	1	130	41.0	3.4
" "	137	4	1	190	45.4	3.3
Foreland Bank	137	1	1	1800	51.2	3.7
" "	137	3	1	710	50.6	3.7

Table 20. 1959 international Arctic mesh experiment
ERNEST HOLT. Cod. Manila. Alternate hauls

Ground	W. Spitsbergen			Isfjord/Bellsund			Bellsund/Foreland Bank			
No. of hauls	5	6		3	10		5	10		
Duration of hauls (hr)	1			1			1			
Catch/hr(kg)	660			170			260			
Mesh (mm)	A 101	B 120 cov.	A / B x 2.19	C 119	D 120+137 cov.	C x 2.39 / D	E 137	E x 1.22 / A	F 137 cov.	E x 2.73 / F
Length (cm)										
<25	1	10			28				22	
25	1	8	6		15				13	
26	1	17	3		17				24	
27	3	24	6		44				33	
28	3	43	3		57				38	
29	1	59	1		74				41	
30	2	69	1	1	78	3			45	
31	5	58	4		61				41	
32	11	116	4		91				58	
33	16	146	5	1	57	4			60	
34	54	178	14		77				101	
35	66	240	13	3	105	7	2	3	143	3
36	127	232	25	1	115	2			199	
37	181	224	37	2	146	3	1	1	233	1
38	221	213	47	5	186	6			315	
39	267	192	64	7	194	9	1	0	341	1
40	240	171	64	7	186	9	3	2	261	3
41	264	159	76	13	204	15	6	3	304	5
42	234	146	73	20	196	24	3	2	323	2
43	209	100	95	6	154	9	1	0	353	1
44	199	100	91	25	138	43	7	5	269	7
45	180	84	98	20	140	34	6	4	364	4
46	150	72	95	19	130	35	9	7	312	8
47	150	78	88	22	126	42	9	7	288	9
48	149	80	85	29	120	58	9	7	276	9
49	118	69	78	25	108	56	19	19	223	23

Table 20. (cont)

Ground	W. Spitsbergen			Isfjord/Bellsund			Bellsund/Foreland Bank			
No. of hauls	5	6		3	10		5		10	
Duration of hauls (hr)	1			1			1			
Catch/hr(kg)	660			170			260			
Mesh (mm)	A 101	B 120 cov.	A / (B x 2.19)	C 119	D 120+137 cov.	(C x 2.39) / D	E 137	(E x 1.22) / A	F 137 cov.	(E x 2.73) / F
Length (cm)										
50	80	70	52	34	107	76	11	16	229	13
51	94	50	85	21	74	68	13	17	199	18
52	90	36	114	26	82	76	17	23	228	20
53	60	36	76	25	58	103	16	33	159	28
54	48	28	79	17	47	87	23	58	186	34
55	56	36	71	15	49	73	24	52	144	46
56	49	21	107	16	42	90	23	57	166	38
57	56	20	127	16	32	119	38	82	165	63
58	43	12	165	14	30	110	26	74	149	48
59	44	29	69	10	39	62	29	80	169	47
60	44	17	119	15	29	124	40	111	134	81
61	58	14	187	13	17	182	40	84	154	71
62	41	11	171	8	14	158	38	112	158	66
63	47	8	261	8	12	183	46	119	118	107
64	43	7	287	9	12	100	30	86	107	77
65	23	6	177	3	7	167	32	170	87	100
66	36	3	514	4	6	167	26	89	79	90
67	38	4	422	4	6	100	18	58	42	117
68+	73	17	202	7	19	88	61	69	94	177
Total	3877	3313		471	3530		627		7437	
50% point (cm)			38.4			47.6?		54.8		57.0
25-75% range (cm)			5			10?		6		9
Selection factor			3.8			4.0?		4.0		4.2

Table 21. 1959 international Arctic mesh experiment.
TUNETS. Stø rfjord. Cod. Manila. Covered hauls

Mesh (mm)	105			128		
No. of hauls	10			10		
Duration of haul (hr)	1.5			1.5		
Catch/hr (kg)	431			460		
Length (cm)	Cod-end	Cover	% Ret.	Cod-end	Cover	% Ret.
<25	12	72		8	208	
25	6	43	12	5	70	7
26	4	48	8	8	99	7
27	14	69	17	7	122	5
28	14	79	15	13	89	13
29	9	52	15	11	90	11
30	23	78	23	17	150	10
31	18	56	24	6	104	6
32	23	84	22	20	124	14
33	34	77	31	18	133	12
34	48	63	43	22	97	18
35	74	72	51	42	130	24
36	53	44	55	18	80	18
37	73	52	58	27	84	24
38	88	39	69	37	86	30
39	59	21	74	23	52	31
40	109	22	83	35	79	31
41	95	10	90	27	53	34
42	101	11	90	51	83	38
43	121	6	95	60	49	55
44	111	6	95	53	44	55
45	71	1	99	64	47	58
46	113	2	98	45	39	54
47	127	2	99	56	39	59
48	103	1	99	78	19	80
49	116	4	97	83	15	85
50	157	1	99	109	38	74
51	96	2	98	91	16	85

Table 21. (cont)

Mesh (mm)	105			128		
No.of hauls	10			10		
Duration of haul (hr)	1.5			1.5		
Catch/hr (kg)	431			460		
Length (cm)	Cod-end	Cover	% Ret.	Cod-end	Cover	% Ret.
52	135		100	102	11	90
53	109			110	5	96
54	144			92	5	95
55	146			148	8	95
56	148			119	2	98
57	148			110	5	96
58	113			98	2	98
59	110			97	1	99
60	215			162	9	95
61	106			101	-	100
62	122			107		
63	105			98		
64	115			75		
65+	545			608		
Total	4133	1017		3061	2278	
50% point (cm)	35.3			43.7		
25-75% range (cm)	8			11		
Selection factor	3.4			3.4		

Table 22. 1959 international Arctic mesh experiment
EXPLORER. Bear Island. Cod. Manila. Covered hauls.

Mesh (mm)	109		
No. of hauls	4		
Mean duration of hauls (hr)	1.2		
	Cod-end	Cover	% Ret.
Length (cm)			
20			
21			
22			
23			
24		2	0
25		3	0
26	2	15	12
27	7	12	37
28	3	50	6
29	11	98	10
30	12	104	10
31	23	131	15
32	33	181	15
33	52	177	23
34	69	225	23
35	74	209	26
36	100	178	36
37	120	133	47
38	154	165	48
39	121	93	57
40	119	54	69
41	119	67	64
42	116	32	79
43	120	14	90
44	112	14	89
45	118	9	93
46	89	3	97
47	82	1	99
48	93	3	97

Table 22. (cont)

Mesh (mm)	109	
No. of hauls	4	
Mean duration of hauls (hr)	1.2	
	Cod-end	Cover	% Ret.
Length (cm)			
49	70	1	99
50	72		100
51	59	1	98
52	74		100
53	67		
54	65		
55	47		
56	37		
57	39		
58	32		
59	39		
60+	252		
Total	2602	1935	
50% point (cm)	38.0		
25-75% range (cm)	7		
Selection factor	3.5		

Table 23. 1959 international Arctic mesh experiment
ANTON DOHRN. Storfjord. Cod. Hemp. Covered hauls

No. of hauls	10		
Mesh (mm)	136		
	Cod-end	Cover	% Ret.
Length (cm)			
25	3	36	
26	1	43	2
27		38	0
28	1	18	5
29	5	21	19
30		31	0
31	3	20	13
32	1	21	5
33	3	17	15
34	1	16	6
35	4	19	17
36	3	34	8
37	6	44	12
38	19	58	25
39	14	87	14
40	24	83	22
41	21	91	19
42	30	69	30
43	33	63	34
44	36	72	33
45	39	63	38
46	40	71	36
47	53	79	40
48	69	52	57
49	63	35	64
50	68	49	58
51	73	51	59
52	79	40	66
53	96	30	76
54	92	26	78

Table 23. (cont)

No. of hauls	10		
Mesh (mm)	136		
	Cod-end	Cover	% Ret.
Length (cm)			
55	90	10	90
56	101	14	88
57	105	10	91
58	98	13	88
59	96	6	94
60	115	13	90
61	82	4	95
62	82	6	93
63	75	3	96
64	68	3	96
65	53	2	96
66	46		100
67	27	3	90
68+	223		100
Total	2139	1464	
50% point (cm)	48.0		
25-75% range (cm)	11		
Selection factor	3.5		

Table 24. 1959 international Arctic mesh experiment
TUNETS. Bear Island. Cod. Hemp. Covered hauls

No. of hauls	10		
Mesh (mm)	109		
	Cod-end	Cover	% Ret.
Length (cm)			
< 25	1	9	
25		12	0
26		11	0
27	1	10	9
28	1	9	10
29	6	11	35
30	6	10	38
31	9	4	69
32	2	15	12
33	6	12	33
34	8	9	47
35	5	12	29
36	8	12	40
37	11	11	50
38	20	12	62
39	6	9	40
40	30	16	65
41	9	4	69
42	9	8	53
43	5	7	36
44	11	3	78
45	21	9	70
46	23	3	88
47	19	3	86
48	17	2	81
49	23	3	88
50	46	1	98
51	44		100
52	51	1	98

Table 24. (cont)

No. of hauls	10		
Mesh (mm)	109		
	Cod-end	Cover	% Ret.
Length (cm)			
53	38	1	97
54	41		100
55	56		
56	48		
57	39		
58	45		
59	29		
60	66		
61	29		
62	39		
63	34		
64	37		
65+	618		
Total	1516	229	
50% point (cm)	39?		
25-75% range (cm)	13?		
Selection factor	3.4		

Table 25. 1959 international Arctic mesh experiment
ANTON DOHRN. Hornsund. Cod. Perlon. Covered hauls

Mesh				102 mm Knotted						117 mm Knotless		
No. of hauls	2			1			1			6		
Duration of hauls (hr)	1			0.6			1			0.88		
Mean catch/ hr (kg)	500			1560			950			1100		
	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.
Length (cm)												
25		5	0		1		1	1	50	1	3	25
26	1	9	10		5	0	1	6	14	3	16	16
27	3	8	27	2	7	22	3	20	13	10	49	17
28	1	20	5	3	33	8	2	38	5	14	108	11
29	2	19	10	10	19	34	10	64	14	38	185	17
30	2	13	13	20	38	35	16	80	17	44	254	15
31	2	23	8	26	37	41	23	93	20	68	300	18
32	1	24	4	18	37	33	31	94	25	72	340	17
33	2	36	5	34	41	45	37	119	24	118	368	24
34	10	42	19	42	63	40	67	128	34	189	516	27
35	13	53	20	53	69	43	81	175	32	308	619	33
36	19	56	25	88	79	53	126	140	47	390	660	37
37	21	57	27	109	82	57	127	132	49	515	648	44
38	32	44	42	112	75	60	136	117	54	532	611	46
39	42	33	56	121	50	71	141	76	65	558	478	54
40	55	22	71	115	56	67	154	69	69	614	404	60
41	48	30	62	127	34	79	136	35	80	489	319	61
42	65	11	85	124	23	84	93	32	74	467	190	71
43	51	9	83	102	15	87	85	18	82	379	156	71
44	51	8	86	61	11	85	77	12	86	293	103	74
45	48	4	92	57	8	88	67	9	88	336	93	78
46	53	6	90	71	10	88		5	92	232	67	78
47	56	3	95	57	2	96	47	5	90	234	39	86
48	70	2	97	43	1	98	43	1	88	138	33	81
49	56		100	52		100	26	3	90	179	9	95

Table 25 (cont)

Mesh				102 mm Knotted					117 mm Knotless		
No. of hauls	2			1			1		6		
Duration of hauls (hr)	1			0.6			1		0.88		
Mean catch/ hr (kg)	500			1560			950		1100		
	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.
Length (cm)												
50	52		100	33	3	92	34		100	132	15	90
51	39		100	41	1	98	22			124	8	94
52	60	1	98	21		100	22			117	5	96
53	37		100	20			25			95	5	95
54	41			21			14			69	1	99
55	39			14			9			62		100
56	41			20			6			49		
57	25			13			6			42		
58	32			10			4			22		
59	28			8			4			22		
60	22			2			2			21		
61	13			2			5			18		
62	14			2						10		
63	6						1			7		
64	6									6		
65+	12			5			4			11		
Total	1171	538		1659	800		1749	1472		7105	6645	
50% point (cm)	39.0			35.5			37.0			38.4		
25-75% range (cm)	5			13?			9			11		
Selection factor	3.8			3.5			3.6			3.3		

Table 26. 1959 international Arctic mesh experiment
TUNETS. Bear Island. Cod. Kapron. Covered hauls

No. of hauls	10		
Duration of hauls (hr)	1.5		
Mesh (mm)	108		
	Cod-end	Cover	% Ret.
Length (cm)			
<25	6	238	
25	2	20	9
26	3	14	18
27	4	28	12
28	6	12	33
29	2	20	9
30	7	24	23
31	5	32	14
32	9	38	19
33	6	30	17
34	11	27	29
35	24	56	30
36	13	44	23
37	17	49	30
38	11	49	18
39	11	37	23
40	21	61	26
41	13	40	24
42	20	39	34
43	29	26	53
44	17	25	40
45	25	32	44
46	15	34	31
47	45	33	58
48	57	17	77
49	52	22	70
50	57	34	80
51	50	23	68
52	90	20	82

Table 26. (cont)

No. of hauls	10		
Duration of hauls (hr)	1.5		
Mesh (mm)	108		
	Cod-end	Cover	% Ret.
Length (cm)			
53	109	18	86
54	89	12	88
55	133	21	86
56	101	4	96
57	116	12	91
58	165	16	91
59	115	5	96
60	170	15	92
61	103)		
62	122)		
63	120)	49	92
64	97)		
65	108)		
66+	1212		100
Total	3355	1276	
50% point (cm)	46.0		
25-75% range (cm)	10		
Selection factor	4.2		

Table 27. 1959 international Arctic mesh experiment
ERNEST HOLT. Foreland Bank. Cod. Nylon. Covered hauls

No. of hauls	4		
Mesh (mm)	122		
	Cod-end	Cover	% Ret.
Length (cm)			
< 25			
25			
26			
27			
28		1	0
29			
30	1	8	11
31		3	0
32	3	9	25
33	1	18	5
34	4	19	17
35	2	27	7
36	4	60	6
37	7	66	10
38	6	75	7
39	8	63	11
40	8	91	8
41	9	82	10
42	10	101	9
43	7	111	6
44	14	93	13
45	11	85	11
46	11	81	12
47	18	111	14
48	15	104	13
49	17	91	16
50	29	63	32
51	25	70	26
52	27	47	36
53	28	49	36

Table 27. (cont)

No. of hauls	4		
Mesh (mm)	122		
	Cod-end	Cover	% Ret.
Length (cm)			
54	32	26	55
55	44	30	59
56	46	17	73
57	49	7	88
58	45	21	68
59	45	19	70
60	65	13	83
61	62	1	98
62	65	5	93
63	54	4	93
64	47		100
65	37	2	95
66	28		100
67	27	2	93
68+	51		100
Total	962	1675	
50% point (cm)	53.9		
25-75% range (cm)	7		
Selection factor	4.4		

Table 28. 1959 international Arctic mesh experiment
ERNEST HOLT. West Spitsbergen. Haddock. Manila.
Covered hauls.

Mesh (mm)	120			137		
No. of hauls	4			6		
	Cod-end	Cover	% Ret.	Cod-end	Cover	% Ret.
Length (cm)						
20					1	0
21	1		100			
22	1	5	17		3	0
23		2	0			
24		2	0		5	0
25	1	4	20		2	0
26		11	0		7	0
27	1	10	9		15	0
28	4	23	15	1	20	5
29	4	30	12	2	20	9
30	3	22	12	1	24	4
31	1	13	7	1	17	6
32	5	8	38		23	0
33	1	9	10	3	10	23
34	4	3	57		11	0
35	3	4	43	4	19	17
36	4	6	40	4	26	13
37	9	2	82	5	17	23
38	8	6	57	5	31	14
39	14	3	82	7	23	23
40	17	3	85	7	31	18
41	9	2	82	6	12	33
42	9	2	82	5	6	45
43	7	1	88	4	5	44
44	10		100	3	7	30
45	5			2	2	50
46	4			2	2	50
47	2			7	1	87
48	2			2	6	25
49	3			5	2	71

Table 28. (cont)

Mesh (mm)	120			137		
No. of hauls	4			6		
	Cod-end	Cover	% Ret.	Cod-end	Cover	% Ret.
Length (cm)						
50	2			3	1	75
51	3			2		100
52	4			3		100
53	3			4		100
54	1			1	2	33
55	3	1		8		100
56	2			7		
57				8		
58	3			9		
59	3			8		
60	2			6		
61	3			6		
62	5			2		
63	3			4		
64	2			1		
65+	13			66		
Total	184	172		214	351	
50% point (cm)	35.6			44.7		
25-75% range (cm)	5			8		
Selection factor	3.0			3.3		

Table 29. 1959 international Arctic mesh experiment. Cod. Length/girth relationships

Area	No. measured		Length range (cm)			Length/head girth			Length/max.body girth			Length/ constricted body girth
	'Johan Hjort'	'Ernest Holt'	'Johan Hjort'	'Ernest Holt'	'Tunets'	'Johan Hjort'	'Ernest Holt'	'Tunets'	'Johan Hjort'	'Ernest Holt'	'Tunets'	'Ernest Holt'
Hornsund Deep	168	-	28-67			2.30	-		2.27	-		
Hornsund Shallow	429	-	32-66			2.25	-		2.13	-		
Storfjord	124	127	33-84	26-112	) 26-72	2.29	2.27	) 2.16	2.20	1.98	) 2.00	2.19
Bear Island	187	37	30-64	37-105	)	2.33	2.36	)	2.28	2.22	)	2.50
Isfjord-Bellsund	322	59	33-63	32- 71		2.26	2.37		2.17	2.09		2.49
Foreland	176	216	30-63	33- 82		2.30	2.43		2.22	2.10		2.44

Table 30. 1959 international Arctic mesh experiment. Mesh sizes within ERNEST HOLT cod-ends after each haul

Cod-end material and length	Cod-end catch (kg)	Mesh size (mm)		
		Forward half	After half	Difference
Manila 36 meshes	280	133.1	132.8	-0.3
	160	134.8	133.7	-1.1
	280	135.6	134.6	-1.0
	80	133.5	134.2	0.7
	1,800	134.8	140.2	5.4
	720	135.3	139.7	4.4
	750	134.4	139.5	5.1
	880	134.2	138.7	4.5
Manila 46 meshes	400	117.8	122.7	4.9
	400	117.8	122.7	4.9
	560	116.4	123.4	7.0
	620	117.1	126.4	9.3
	340	117.2	125.3	8.1
	480	115.8	125.0	9.2
	200	115.0	124.8	9.8
	120	115.2	124.5	9.3
	100	116.2	124.6	8.3
	340	117.3	125.4	8.1
	40	115.3	124.7	9.4
	640	116.2	123.7	7.5
Manila 46 meshes	480	115.3	116.7	1.4
	640	116.7	118.7	2.0
	1,760	116.1	122.6	6.5
	80	116.9	120.5	3.6
	200	118.3	121.6	3.3

Table 30. (cont)

Cod-end material and length	Cod-end catch (kg)	Mesh size (mm)		
		Forward half	After half	Difference
Manila 47 meshes	440	136.4	139.2	2.8
	1,200	136.4	141.2	4.8
	600	137.8	142.7	4.9
	200	135.1	140.3	5.2
	160	135.5	140.0	4.5
	40	135.0	140.1	5.1
	360	135.2	139.6	4.4
	600	133.5	139.6	6.1
	560	134.0	140.3	6.3
Manila 60 meshes	400	93.9	95.9	2.0
	400	89.2	92.8	3.6
Manila 60 meshes	500	98.8	99.3	0.5
	340	98.9	101.9	3.0
	680	98.8	102.1	3.3
	920	99.7	102.0	2.3
	400	100.3	102.8	2.5
	80	100.2	102.9	2.7
	2,280	99.3	104.5	5.2
	440	99.6	103.8	4.2
	280	98.7	103.0	4.3
Nylon 46 meshes	120	123.4	123.3	-0.1
	440	123.2	123.0	-0.2
	660	122.7	122.8	0.1
	520	121.9	122.3	0.4

Table 31. 1959 international Arctic mesh experiment. Summary of results by covered cod-end and alternate haul techniques, for different materials

Material	Method	Ship	Ground	No. of hauls	Mesh (mm)	Selection factor
Manila	Covered	'Anton Dohrn'	Hornsund	1	124	3.7
"	"	" "	"	1	123	3.7
"	"	" "	"	1	122	3.9
"	"	" "	"	1	123	3.6
"	"	" "	"	1	127	3.3
"	"	" "	"	1	123	2.9
"	"	" "	"	1	123	3.4
"	"	" "	"	1	123	2.7
"	"	" "	"	1	121	3.5
"	"	" "	"	1	126	2.7
"	"	'Ernest Holt'	Bear Island	1	120	3.4
"	"	" "	Isfjord/Bellsund	4	120	3.4
"	"	" "	" "	4	137	3.3
"	"	" "	Foreland Bank	1	137	3.7
"	"	" "	" "	3	137	3.7
"	"	'Tunets'	Størfjord	10	105	3.4
"	"	"	"	10	128	3.4
"	"	'Explorer'	Bear Island	4	109	3.5
"	"	'Johan Hjort'	Hornsund Deep	1	131	3.35
"	"	" "	" "	1	131	3.1
"	"	" "	" Shallow	3	128	3.5
"	"	" "	" "	2	128	3.1
"	"	" "	" "	2	103	3.6?
"	"	" "	" "	2	103	3.4
"	"	" "	Størfjord	3	126	3.8
"	"	" "	Bear Island	3	129	3.7
"	"	" "	" "	1	130	3.6
"	"	" "	Isfjord/Bellsund	3	129	3.5
"	"	" "	" "	3	129	3.5
"	"	" "	" "	3	130	3.7

Table 31. (cont)

Material	Method	Ship	Ground	No. of hauls	Mesh (mm)	Selector factor
Manila	Alternate haul	'Anton Dohrn'	Hornsund	12	116	3.4
"	"	'Ernest Holt'	W. Spitzbergen	5	101	3.8
"	"	" "	"	3	119	4.0?
"	"	" "	"	5	137	4.0 or 4.2
"	"	'Johan Hjort'	Hornsund Shallow	2	127	4.0 or 3.85
"	"	" "	" "	5	127	3.7 or 3.8
"	"	" "	" "	1	110	4.1
"	"	" "	" "	3	110	4.2
"	"	" "	" "	2	110	4.0?
"	"	" "	Isfjord/Bellsund	2	129	3.55
"	"	" "	" "	4	129	4.1?
"	"	" "	" "	3	110	3.8
"	"	" "	" "	3	110	3.7
Hemp	Covered	'Anton Dohrn'	Storfjord	10	136	3.5
"	"	'Tunets'	Bear Island	10	109	3.4
Polyamide-Perlon	Covered	'Anton Dohrn'	Hornsund	2	102	3.8
" "	"	" "	"	1	102	3.5
" "	"	" "	"	1	102	3.6
" -Kapron	"	'Tunets'	Bear Island	10	108	4.2
" -Nylon	"	'Ernest Holt'	Foreland Bank	4	122	4.4

Table 32. 1960 Russian Arctic mesh experiments
Murman Bank. Cod. Manila. Covered hauls

Ship	'Melitopol'			'Treska'		
Date	4/60			6/60		
Mesh (mm)	106			125		
No. of hauls	10			10		
Duration of hauls (hr)	1.5			1.5		
Mean catch/hr(kg)	680			540		
	Cod-end	Cover	% Ret.	Cod-end	Cover	% Ret
Length (cm)						
<31	24	364	6	120	2465	5
31	8	115	6	16	379	4
32	12	165	7	32	436	7
33	10	88	10	20	303	6
34	10	75	12	25	345	7
35	32	89	27	28	352	7
36	29	57	34	37	365	9
37	38	70	35	35	361	9
38	65	60	52	18	219	8
39	57	18	76	27	242	10
40	43	13	77	46	281	14
41	47	16	75	40	283	12
42	115	12	91	65	280	19
43	51	2	96	80	279	22
44	30	2	94	85	184	32
45	59	1	98	145	265	35
46	41		100	140	239	37
47	46			176	166	52
48	72			126	108	54
49	20			147	108	58
50	28			167	83	67
51	19			146	41	78
52	52			155	30	84
53	25			113	21	84
54	12			110	11	91

Table 32. (cont)

Ship	'Melitopol'			'Treska'		
Date	4/60			6/60		
Mesh (mm)	106			125		
No. of hauls	10			10		
Duration of hauls (hr)	1.5			1.5		
Mean catch/hr(kg)	680			540		
	Cod-end	Cover	% Ret.	Cod-end	Cover	% Ret.
Length (cm)						
55	36			141	19	88
56	23			112	7	94
57	14			91	6	94
58	24			44	8	85
59	4			61	2	97
60	21			79	3	96
61	9			45	4	92
62	18			40		100
63+	137			339		
Total	1231	1147		3031	7895	
50% point (cm)	37.8			47.5		
25-75% range (cm)	5			8		
Selection factor	3.7			3.8		

Table 33. Summary of results of Russian covered Kapron trawl selection experiments, other than 1959 international experiment,

Ship	Area	Date	No. of hauls	Mesh (mm)	50% Point (cm)	Selection factor
'Treska'	Barents Sea	June 1959	10	98	43.5	4.4
'Lot'	" "	April 1959	10	109	45.4	4.2
'Treska'	" "	1959	10	110	48.8	4.4
'Treska'	" "	1959	20	90	39.0	4.3
'Treska'	" "	1959	10	90	37.0	4.1
'Lot'	" "	April 1959	10	108	46.0	4.3
'Lot'	" "	April 1959	10	108	40.6	3.8
'Treska'	Murman Bank	July 1960	10	103	43.0	4.2
'Melitopol'	" "	July 1960	10	93	36.8	4.0
'Lot'	Barents Sea	April 1959	10	106	46.8	4.4
'Treska'	" "	June 1959	10	104	42.0	4.0

Table 34. 1959 and 1960 Russian Arctic mesh experiments
Cod. Kapron. Covered hauls

Ship	'Treska'			'Lot'			'Treska'			'Treska'		
Area	Barents Sea			Barents Sea			Barents Sea			Barents Sea		
Date	June 1959			April 1959			1959			1959		
Mesh (mm)	98			109			110			90		
No.of hauls	10			10			10			20		
Duration of hauls (hr)	2			1.5			2			2		
Mean catch/ hr (kg)	800			300			1000			815		
	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.
Length (cm)												
<31	1	271		9	680	1	5	402	1	37	2159	2
31	2	49	4	1	130	1	2	67	3	15	217	6
32	3	33	8	3	117	2	6	97	6	18	232	3
33	2	80	2	1	139	1	4	78	5	15	228	6
34	3	50	6	1	137	1	2	103	2	25	182	12
35	4	68	6	6	217	3	6	131	4	54	294	16
36	6	53	10	9	186	5	6	123	5	51	139	27
37	7	63	10	3	155	2	4	157	2	44	118	27
38	13	58	18	13	161	7	4	95	4	67	86	50
39	4	40	9	9	140	6	7	139	5	74	58	56
40	20	60	25	53	364	13	16	198	7	193	189	51
41	13	41	24	94	232	29	17	139	11	101	47	68
42	47	70	40	65	171	28	15	139	10	141	70	67
43	63	75	46	36	133	21	17	168	9	150	41	79
44	62	56	58	125	172	42	27	133	17	215	26	89
45	111	72	61	117	214	35	69	229	23	396	80	83
46	110	65	63	155	87	64	66	126	34	281	40	88
47	140	51	73	138	38	78	62	146	30	290	22	93
48	185	44	81	131	42	76	80	98	45	280	12	96
49	132	16	89	99	17	85	129	128	50	211	8	96
50	134	33	80	296	30	91	214	117	65	462	19	88

Table 34 (cont)

Ship	'Treska'			'Lot'			'Treska'			'Treska'		
Area	Barents Sea			Barents Sea			Barents Sea			Barents Sea		
Date	June 1959			April 1959			1959			1959		
Mesh (mm)	98			109			110			90		
No.of hauls	10			10			10			20		
Duration of hauls (hr)	2			1.5			2			2		
Mean catch/ hr (kg)	800			300			1000			815		
	Cod-end	Cov.	%Ret.	Cod-end	Cov.	%Ret.	Cod-end	Cov.	%Ret.	Cod-end	Cov.	% Ret.
Length (cm)												
51	172	16	91	131	9	94	128	69	65	157	3	98
52	308	13	96	71	3	96	129	59	69	285	7	98
53	287	10	97	61	7	90	139	33	81	213	2	99
54	227	3	99	79	7	92	145	33	81	169	2	99
55	264	1	100	78	5	94	229	30	88	347	1	100
56	234		100	53		100	128	9	93	235		100
57	218	2	99	27	1	96	140	4	97	164	1	99
58	218	1	100	35	4	90	115	4	97	201		100
59	143	1	99	18	2	90	123	3	98	133		
60	325		100	58		100	155	2	99	365		
61+	1916			143			578	3	100	218		
Total	5374	1395		2118	3600		2767	3262		5607	4283	
50% point (cm)	43.5			45.4			48.8			39.0		
25-75% range (cm)	7			6			8			7		
Selection factor	4.4			4.2			4.4			4.3		

Table 34 (cont)

Ship	'Treska'			'Lot'			'Lot'			'Treska'		
Area	Barents Sea			Barents Sea			Barents Sea			Murman Bank		
Date	1959			April 1959			April 1959			July 1960		
Mesh (mm)	90			108			108			103		
No. of hauls	20			10			10			10		
Duration of hauls(hr)	2			1.5			1.5			2		
Mean catch/ hr (kg)	800			400			1000			500		
	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.
Length (cm)												
< 31	259	5120	5		127	0	109	6204	2	125	3153	4
31	45	406	10	1	22	4	18	1107	2	24	686	3
32	125	382	25		36	0	18	742	1	70	920	8
33	64	297	18		45	0	15	662	2	53	655	8
34	63	317	17	1	25	4	18	426	4	98	704	12
35	148	455	25	8	62	11	55	702	7	99	752	12
36	164	167	50	3	47	6	48	270	15	98	688	14
37	93	112	45	2	53	4	43	170	20	130	721	18
38	110	61	64	5	39	11	60	111	35	144	316	46
39	101	26	80	8	30	21	19	78	19	156	461	34
40	174	45	79	20	101	17	138	163	46	252	418	38
41	75	16	82	14	85	14	80	34	70	182	309	37
42	150	13	92	32	82	27	80	28	74	297	379	44
43	129	8	94	25	75	25	30	23	57	157	321	33
44	130	8	94	40	67	37	72	20	78	215	212	50
45	320	15	96	78	90	46	183	31	86	380	187	67
46	189	5	97	62	66	48	85	4	96	212	95	69
47	214	12	95	83	69	55	79	4	95	261	95	73
48	176	5	97	104	51	67	82	5	94	182	26	88
49	133	4	97	70	19	79	34	5	87	172	31	85
50	320	8	98	152	66	70	203	12	94	267	48	85
51	123		100	119	28	81	75	2	96	187	8	96

Table 34 (cont)

Ship	'Treska'			'Lot'			'Lot'			'Treska'		
Area	Barents Sea			Barents Sea			Barents Sea			Murman Bank		
Date	1959			April 1959			April 1959			July 1960		
Mesh (mm)	90			108			108			103		
No. of hauls	20			10			10			10		
Duration of hauls (hr)	2			1.5			1.5			2		
Mean catch/ hr(kg)	800			400			1000			500		
	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.
Length (cm)												
52	175	3	98	134	32	81	22	1	96	172	13	93
53	99		100	104	18	85	19	1	95	116	13	90
54	67			105	10	91	21		100	179	8	96
55	110			138	14	91	18	1	95	160	8	95
56	59			99	7	93	7		100	151	14	92
57	35			107	6	95	4			99	2	98
58	31			77	8	91	6			72	2	97
59	23			42	1	98	6			80	5	94
60	71			152	4	97	12			123	4	97
61+	140			870		100	10			768		100
Total	4115	7485		2655	1385		1669	10806		5681	11254	
50% point (cm)	37.0			46.0			40.6			43.0		
25-75% range (cm)	5			8			5			8		
Selection factor	4.1			4.3			3.8			4.2		

Table 34 (cont)

Ship	'Melitopol'			'Lot'			'Treska'		
Area	Murman Bank			Barents Sea			Barents Sea		
Date	July 1960			April 1959			June 1959		
Mesh (mm)	93			106			104		
No. of hauls	10			10			10		
Duration of hauls (hr)	2			1.5			2		
Mean catch/ hr(kg)	1000			810			600		
	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.
Length (cm)									
<31	185	1154	14	40	785	5	152	3560	4
31	90	485	16	10	178	5	23	673	3
32	254	788	24	6	160	4	42	506	8
33	137	722	14	5	198	2	17	430	4
34	230	533	30	8	186	4	14	240	6
35	303	546	36	12	173	6	28	302	8
36	232	370	38	9	145	6	31	110	22
37	468	364	56	9	120	7	41	103	28
38	467	252	65	15	171	8	15	67	18
39	239	78	75	7	112	6	9	37	20
40	411	99	81	28	194	13	17	40	30
41	291	50	85	31	121	20	22	31	42
42	478	48	91	37	116	24	26	1	96
43	246	20	92	41	129	24	12	9	57
44	164		100	54	161	25	10	4	72
45	211	4	98	104	160	39	22	6	79
46	92	2	98	66	94	41	6	1	86
47	143	1	99	88	54	62	18	4	82
48	163	1	99	92	56	62	36		100
49	50	1	98	44	43	52	16	1	94
50	62	1	98	176	54	76	30	1	97
51	58		100	70	7	90	12		100

Table 34 (cont)

Ship	'Melitopol'			'Lot'			'Treska'		
Area	Murman Bank			Barents Sea			Barents Sea		
Date	July 1960			April 1959			June 1959		
Mesh (mm)	93			106			104		
No. of hauls	10			10			10		
Duration of hauls (hr)	2			1.5			2		
Mean catch/ hr (kg)	1000			810			600		
	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.	Cod-end	Cov.	% Ret.
Length (cm)									
52	116			82	16	84	7	1	88
53	60			102	7	94	16		100
54	37			48	5	91	8		
55	45			78	10	89	2		
56	16			60	4	94			
57	40			37	2	95	6		
58	16			37	4	90	5		
59	5			16	2	90	2		
60	22			31	2	94			
61	107			85		100			
Total	5426	5519		1491	3013		645	6127	
50% point (cm)	36.8			46.8			41.6		
25-75% range (cm)	6						8		
Selection factor	4.0			4.4			4.0		

Table 35. Summary of results of Norwegian ('Johan Hjort') trawl selection experiments, 1960, in Barents Sea. Covered cod-end results except where indicated.

Cod-end		Species	Ground	Mesh (mm)	Hauls	Selection factor	25-75% Range (cm)	No. of fish in Selection range		Mean wt (kg) of catch/haul		Haul Dur - ation (hr)	Towing Speed (knots)
Material	Rigging							Cod-end	Cover	Cod-end	Cover		
Manila	With splitting strap	Cod	A	132	2	3.4	9.0	799	983	840	460	1.5	3.40
"	without splitting strap	"	A	132	2	3.7	8.5	238	399	520	400	1.5	2.90
"	" " "	"	A	132	4	3.5	7.0	162	210	270	100	1.5	3.03
"	" " "	"	C	132	4	3.75		165	34	590	250	1.5	2.80
"	With flap chafers	"	A	130	11	3.7		676		415		1.5	2.91*
"	" " "	"	C	130	6	3.75	7.0	440	470	410	200	1.5	2.51
"	" " "	"	D	130	5	4.05	11.0	303	224	688	112	1.5	2.30
Terylene	With splitting strap	"	A	108	4	3.85	5.5	663	745	530	180	1.5	3.20
"	Without splitting strap	"	A	106	4	4.0	6.0	741	811	570	200	1.5	3.50
Manila	With " "	Haddock	A	132	2	3.0	8.0	274	191	840	460	1.5	3.40
"	Without " "	"	A	132	2	3.3	7.5	336	374	520	400	1.5	2.90
"	" " "	"	C	132	5	3.35	9.0	971	778	460	220	1.5	2.76
"	With chafers	"	C	130	10	3.25	8.0	1047	763	340	160	1.5	2.51
"	" "	"	D	130	5	3.3	8.0	467	234	688	112	1.5	2.30
Terylene	With splitting strap	"	A	108	4	3.25	4.0	127	115	530	180	1.5	3.20
"	Without " "	"	A	106	4	3.5	4.0	187	123	570	200	1.5	3.50

* Alternate hauls

Table 36. Summary of results of Arctic trawl mesh selection experiments, for cod by covered cod-end technique. Comparison of manila and synthetic fibres.

Experiment	Manila				Polyamide				Polyester				Synthetic S.F. % above Manila
	No. of hauls	Mesh (mm)	S.F.	Mean S.F.	No. of hauls	Mesh (mm)	S.F.	Mean S.F.	No. of hauls	Mesh (mm)	S.F.	Mesh S.F.	
'Anton Dohrn' 1959	10	123	3.2		2	102	3.8						
					1	102	3.5	3.7					15
					1	102	3.6						
'Tunets' 1959	10	105	3.4	3.4	10	108	4.2						23
	10	128	3.4										
'Ernest Holt' 1959	4	120	3.4		4	122	4.4						
	4	137	3.3	3.46									26
	1	137	3.7										
	3	137	3.7										
'Treska' 1960	10	125	3.8		10	103	4.2						10
'Melitopol' 1960	10	106	3.7		10	93	4.0						8
'Anton Dohrn' 1956	17	113	3.4	3.43	12	113	3.6	3.6					6
	6	133	3.5		5	107	3.6						
					6	134	3.7						
'Johan Hjort' 1960	4	132	3.5	3.6					4	108	3.85	3.92	9
	4	132	3.75						4	108	4.0		

Table 36. (cont)

Experiment	Manila				Polyamide				Polyester				Synthetic S.F. % above Manila
	No. of hauls	Mesh (mm)	S.F.	Mean S.F.	No. of hauls	Mesh (mm)	S.F.	Mean S.F.	No. of hauls	Mesh (mm)	S.F.	Mesh S.F.	
'Ernest Holt' 1959	1	120	3.4										
'Explorer' 1959	4	109	3.5										
'Johan Hjort' 1959	1	131	3.35										
	1	131	3.1										
	3	131	3.5										
	2	131	3.1										
	3	131	3.8	3.56									
	3	131	3.7										
	1	131	3.6										
	3	131	3.5										
	3	131	3.5										
	3	131	3.7										
	2	103	3.6										
	2	103	3.4										
'Ernest Holt' 1956	1	109	3.6										
	6	109	3.8										

Table 36. (cont).

Experiment	Manila				Polyamide				Polyester				Synthetic S.F. % above Manila
	No. of hauls	Mesh (mm)	S.F.	Mean S.F.	No. of hauls	Mesh (mm)	S.F.	Mean S.F.	No. of hauls	Mesh (mm)	S.F.	Mesh S.F.	
'Ernest Holt' 1959	4	118	3.7										
	8	118	3.4										
	7	118	3.2										
'Johan Hjort' 1958	14	111	3.8	3.56									
'G.O. Sars' 1956	6	144	3.6										
	1	144	3.4										
	1	144	3.8										
	5	144	3.4										18
'Treska' 1959					10	98	4.4						
'Lot' 1959					10	109	4.2						
'Treska' 1959					10	110	4.4						
					20	90	4.3						
					10	90	4.1	4.2					
'Lot' 1959					10	108	4.3						
					10	108	3.8						
'Lot' 1960					10	106	4.4						
'Treska' 1960					10	104	4.0						
'G.O. Sars' 1958					11	140	4.2						

Table 36. (cont)

Experiment	Manila				Polyamide				Polyester				Synthetic S.F. % above Manila
	No. of hauls	Mesh (mm)	S.F.	Mean S.F.	No. of hauls	Mesh (mm)	S.F.	Mean S.F.	No. of hauls	Mesh (mm)	S.F.	Mesh S.F.	
'Anton Dohrn' 1956					13	104	4.1	4.2.					
All experiments				3.55				4.12					16

Table 37. Number of experiments, as tabulated in Table 36, yielding particular selection factors.

Selection factor	Number of results	
	Manila	Polyamide
4.5		
4		4
3		2
2		4
1	1	1
4.0		2
3.9	1	
8	5	2
7	11	1
6	5	3
5	7	1
4	11	
3	4	
2	1	
1	2	
3.0		
2.9	1	
8		
7	3	
6		
2.5		

PART III. SUMMARY RESULTS OF ICES AREA TRAWL AND SEINE MESH SELECTION EXPERIMENTS

The following tables are a comprehensive summary of trawl and seine mesh selection results obtained in the ICES area up to 1960. Most of the entries were collected together by Mr. E. Akyus at the Working Group meetings, but time there did not allow all of the very extensive data to be covered, and so the tables have been completed and checked by Mr. Pope and others subsequent to the second Group meeting.

Much of the information required could not be taken directly from the publications because it was not given explicitly by the authors: where sufficient information was available to allow the estimation of the required items this was done.

In the majority of cases the entries have been checked by the relevant authors.

Bracketed entries refer to items of low accuracy and should be treated with caution.

HADDOCK: NORTH SEA (Region IV)

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Gear: Otter Trawl Material: Natural Fibres (Manila and Sisal)															
Beverton and Holt	Fish. Invest. 19,1957	1933	'G. R. Purdy'	Double Manila (tarred)		Parallel hauls	70.5	23.4	3.3		400	110 925			
"	"	"	'C. T. Purdy'	"		"	83.0	27.7	3.3			96 313			
Bowman	Unpublished	1929	'Explorer'	Double Manila (tarred)		Covers	57.2	17.5	3.1	1.5	11	(11 000)			
"	"	"	"			"	67.0	20.5	3.1	3.2	59	(30 000)			
"	"	"	"	"		"	88.0	23.8	2.7	6.5	15	(11 000)			
von Brandt	C.M. 1956, No. 71	June 1956	'Anton Dohrn'	Double Manila	160 m/kg	Covers	74	19	2.6	4.0	7	1 827	3 633	1 094	2 045
"	"	"	"	"	160 m/kg	"	108	32	3.0	5.5	3	1 587	3 111	528	445
Davis	Fish. Invest., 14 (1)	1934	'George Bligh'	Double Manila (white)	202 m/kg	Covers	(80)	23.7	3.0	4.6	25	15 506	14 989	6 920	6 538
Margetts	C.M. 1955, No. 43	Aug. 1955	'Platessa'	Double Sisal	302 m/kg	Covers	69.0	23.5	3.4	2.7	5	1 633	472	463	349
"	"	Nov. 1954	'Sir Lancelot'	"	252 m/kg	"	72.1	(23)	(3.2)	-	4	1 154	13	-	-
"	C.M. 1956, No. 73	Sept. 1956	"	"	302 m/kg	"	72.6	25.6	3.5	-	7	1 798	1 941	-	-
"	"	"	"	"	302 m/kg	"	63.1	(19.5)	(3.1)	-	2	1 042	23	-	-
Marine Laboratory Aberdeen	Unpublished	July 1957	'Scotia'	Double Manila	-	Long cotton cover	76.8	23.0	3.0	4.3	13	5 713	963	1 431	609
"	"	"	"	"	-	Short cotton cover	76.8	21.0	2.7	4.9	7	2 082	233	101	41
"	"	April 1959	'Explorer'	"	-	Top Courlene cover	94.3	30.5	3.2	6.8	5	1 870	5 191	371	305
"	"	"	"	"	-	Whole Courlene cover	94.3	30.3	3.2	5.3	9	1 616	5 646	317	312
"	"	Sept. 1960	"	"	226 m/kg	"	77.6	28.5	3.7	9.2	7	1 024	804	754	618
Parrish and Pope	C.M. 1951	-	'Explorer'	Double Manila (tarred)		Covers	98.5	25.2	2.6	4.3	18	2 488	4 131	577	575
Pope et al.	This Report	June 1957	'Anton Dohrn'	Double Manila	262 m/kg	Covers	65.5	21.0	3.2	3.4	8	3 820	1 739	1 660	1 601
"	"	"	'Explorer'	"	156 m/kg	"	64.6	20.4	3.2	2.8	4	1 465	314	342	270
Pope and Hall	C.M. 1960, No. 183	June 1960	'Explorer'	Double Manila	226 m/kg	Whole Courlene	70.2	26.0	3.7	6.7	9	1 677	820	940	693

HADDOCK: NORTH SEA (Region IV) continued

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Gear: Otter Trawl Material: Natural Fibres (Cotton and Hemp)															
Margetts	C.M. 1955, No. 43	Nov. 1954	'Sir Lancelot'	Single Cotton	363 m/kg	Covers	72.3	(24.8)	(3.4)	(5)	8	1 412	127	123	56
"	"	Aug. 1955	'Platessa'	"	363 m/kg	"	68	23.8	3.5	4.9	5	780	297	361	255
"	"	"	"	Double Cotton	452 m/kg	"	69	(21.5)	(3.1)	-	12	1 573	135	-	-
"	C.M. 1956, No. 73	Sept. 1956	"	Single Cotton		"	70.0	25.3	3.6	-	4	804	737	-	-
Gear: Seine Net Material: Natural Fibres (Cotton and Hemp)															
Lucas et al.	J. du Cons., 20(1) 1954	8 Sept. 1953	'Helen Herd')	Cotton		Covers	59	20.9	3.5		7	2 087	276	384	181
"	"	"	'Margaret Herd')	"		"	71	27.3	3.8	4.8	37	4 930	5 621	1 810	3 113
"	"	"	"	"		"	80	32.6	4.1	8.0	27	1 621	5 694	1 146	1 608
Marine Laboratory Aberdeen	Unpublished	Sept. 1953	'Helen Herd')	Cotton		Covers	71	27.0	3.8	6.2	8	1 092	1 848	670	873
"	"	"	'Margaret Herd')	"		"	80	35.4	4.4	9.0	8	1 118	9 507	534	1 218
Gear: Otter Trawl Material: Synthetic Fibres (Polyesters and Polyamides)															
von Brandt	C.M. 1956, No. 71	June 1956	'Anton Dohrn'	Double Perlon	210 m/kg	Covers	73	22	3.0	4.5	2	1 707	8 727	191	357
"	"	"	"	"	210 m/kg	"	107	35	3.3	13.5	14	2 061	12 977	1 400	1 276
"	ICNAF Spec. Publ. 5	"	"	"	280 m/kg	"	83	32	3.9	6.0	2	4 448	3 380	784	646
Margetts	C.M. 1956, No. 73	Sept. 1956	'Platessa'	Single nylon	302 m/kg	Cover	64.4	25.3	3.9	-	4	1 048	602		
Marine Laboratory Aberdeen	Unpublished	June 1959	'Scotia'	Single nylon		Cover	69.2	23.7	3.4	6.1	6	570	634	435	529
"	"	"	"	"		"	69.2	23.2	3.4	5.7	8	915	1 132	813	1 034
"	"	Sept. 1959	"	"		Top Courlene cover	65.7	25.9	3.9	8.0	8	1 033	1 352	895	1 329
"	"	"	"	"		Whole Courlene cover	65.7	29.0	4.4	-	10	842	2 780	-	-
"	"	"	"	"		Alternate hauls	65.7	28.6	4.4	4.5	4	528		85	-
"	"	Sept. 1960	'Explorer'	Single Terylene		Whole Courlene cover	70.3	23.4	3.3	6.8	6	1 053	364	195	112
"	"	"	"	Double Terylene		"	73.3	24.9	3.4	4.5	8	1 475	718	341	309

HADDOCK: NORTH SEA (Region IV) continued

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Pope et al.	This Report	June 1958	'Anton Dohrn'	Double Perlon	210 m/kg	Covers	63.7	22.1	3.5	4.2	8	2 544	1 946	1 131	1 562
"	"	"	"	Double Trevira	385 m/kg	"	78.0	29.1	3.7	7.2	5	969	1 915	357	478
"	"	"	'Explorer'	Single nylon	136 m/kg	"	68.0	20.4	3.0	3.6	5	1 667	565	566	495
"	"	"	"	Single Terylene	127 m/kg	"	82.5	23.4	2.8	6.9	6	1 335	1 115	570	974
Gear: Otter Trawl Material: Synthetic Fibres (Polyethylenes)															
Marine Laboratory Aberdeen	Unpublished	Sept. 1960	'Explorer'	Single Courlene		Whole Courlene cover	84.1	27.7	3.3	5.9	7	1 648	908	619	433
Pope et al.	This Report	June 1958	'Willem Beukelsz'	Double Nymplex	933 m/kg	Covers	79.6	23.1	2.9	5.2	2	218	102	51	76
"	"	"	'Anton Dohrn'	Double Courlene	200 m/kg	"	71.4	23.4	3.3	4.5	8	2 604	2 923	957	1 683
Pope and Hall	C.M. 1960, No. 183	June 1960	'Scotia'	Single Courlene		Whole Courlene cover	87.2	27.0	3.1	9.4	12	1 676	1 260	1 277	1 072

HADDOCK: ARCTIC (Regions I and II)

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Gear: Otter Trawl Material: Natural Fibres (Manila and Sisal)															
Beverton	C.M. 1956, No. 74	July - Aug. 1956	'Ernest Holt'	Double Manila (white)	121 m/kg	Covers	109	36.5	3.4	8	1	(1022)		284	275
"	"	"	"	"	121 m/kg	"	109	35.5	3.3	(8)	1	(213)		72	80
"	"	"	"	"	121 m/kg	"	109	35.5	3.3	(8)	1	(175)		52	44
* "	C.M. 1959, No. 117	1959	"	"	101 m/kg	"	119	39	3.3	7	5	102	43	26	32
+ "	"	"	"	"	101 m/kg	"	118	40	3.4	7	9	434	465	57	90
≠ "	"	"	"	"	101 m/kg	"	119	39	3.3	7	3	101	31	17	17
von Brandt	ICNAF Spec. Publ. 5	July - Aug. 1956	'Anton Dohrn'	Double Manila	160 m/kg	Covers	113	34	3.0	6.0	22	3 610	727	571	297
Margetts et al.	This Report	Aug. 1959	'Ernest Holt'	Double Manila	125 m/kg	Nymplex cover 70 mm	120	35.6	3.0	5	4	184	172	34	38
"	"	"	"	"	125 m/kg	"	137	44.7	3.3	8	6	214	351	39	44
Saetersdal	C.M. 1958, No. 72	July 1958	'Johan Hjort'	Double Manila		Cover	111	35.0	3.2	6	5	(350)	(147)	90	73
"	ICNAF Spec. Publ. 5	April 1957	'Thor Iversen'	Double Manila		Parallel hauls	152	57.5	3.8	9	1	(120)			
"	"	"	'Peder Rønnestad'	"		"	100				1	(434)			
"	"	"	'Thor Iversen'	"		"	100				1	(118)			
"	"	"	'Peder Rønnestad'	"		"	133	(48)	(3.6)		1	(166)			
"	"	"	'G.O. Sars'	"		Covers	144	49	3.4	11	4	(591)	(720)		
"	C.M. 1960, No. 89	Aug. 1960	'Johan Hjort'	Double Manila	125 m/kg	Nymplex covers	131.5	39.4	3.0	8.0	2			(274)	(191)
"	"	"	"	"	125 m/kg	"	131.6	44.1	3.4	9.0	5			(971)	(778)
"	"	"	"	"	125 m/kg	"	131.6	43.4	3.3	7.5	2			(336)	(374)
"	"	"	"	"	125 m/kg	Double cod-end with shrimp-net cover	104.0	23.9	2.3	4.0	6			(67)	(57)
"	"	"	"	"	125 m/kg	Chafers and cover	130.3	42.3	3.2	8.0	10			(1047)	(763)
"	"	"	"	"	125 m/kg	"	130.3	43.0	3.3	8.0	5			(467)	(234)

* No chafer

\+ Large mesh chafer

≠ Small " "

HADDOCK: ARCTIC (Regions I and II) continued

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Gear: Otter Trawl Material: Synthetics (Polyesters and Polyamides)															
von Brandt	ICNAF Spec. Publ. 5	July - Aug. 1956	'Anton Dohrn'	Double Perlon	210 m/kg	Covers	107	33	3.1	9.0	5	359	175	211	127
"	"	"	"	"	280 m/kg	"	113	34	3.0	5.5	7	2645	1185	917	632
"	"	"	"	Double nylon	380 m/kg	"	104	35	3.4	7.0	11	710	1445	211	242
Saetersdal	C.M. 1958, No. 71	Oct. 1957	'G.O. Sars'	Double nylon (tarred)	260 m/kg	Nylon cover	140	53.5	3.8	7.5	11			358	427
"	C.M. 1960, No. 89	Aug. 1960	'Johan Hjort'	Double Terylene	136 m/kg	Nymplex cover	107.7	35.0	3.2	4.0	4			(127)	(115)
"	"	"	"	"	136 m/kg	"	106.4	37.2	3.5	4.0	4			(187)	(123)

HADDOCK: FAROES (Region VB)

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Gear: Otter Trawl Material: Natural and Synthetic Fibres															
Marine Laboratory Aberdeen	Unpublished	Dec. 1957	'Explorer'	Double Manila	302 m/kg	Covers	104.8	31.6	3.0	6.2	6	2 388	1 175	149	242
"	"	"	"	Single nylon		"	106.0	35.0	3.3	5.0	7	1 501	1 287	192	187
"	"	"	"	Double Manila	151 m/kg	"	93.5	23.3	2.5	4.5	9	3 854	856	644	297
"	"	Dec. 1958	"	"	151 m/kg	"	82.0	23.7	2.9	4.7	2	755	711	215	179
"	"	"	"	"	151 m/kg	"	99.3	25.7	2.6	4.7	6	5 628	3 575	1 354	1 135
"	"	"	"	"	151 m/kg	"	82.0	24.5	3.0	5.2	2	767	864	247	253
"	"	"	"	"	151 m/kg	"	99.3	28.3	2.8	5.7	6	2 387	5 157	683	1 038
"	"	"	"	"	151 m/kg	"	82.0	24.6	3.0	4.4	4	2 858	2 757	876	872
"	"	"	"	"	151 m/kg	"	82.0	25.3	3.1	4.0	4	1 402	3 127	803	1 033

HADDOCK: ICELAND (Region VA)

Gear: Otter Trawl Material: Natural Fibres															
Jones	C.M. 1958, No. 82	June 1958	'Explorer'	Double Manila		Covers	97.4	28.0	2.9	6.5	6			1 487	956
"	"	"	"	"		"	97.4	26.4	2.7	5.0	6			598	308
"	"	"	"	"		"	97.4	30.6	3.1	6.3	8			1 560	1 159
Jónsson	C.M. 1960, No. 134	July 1960	'Maria Julia'	Double Manila		Covers	67	25.9	3.8	-	3	563	173		
"	"	"	"	"		"	104	35.9	3.5	9	3	207	794		
"	"	"	"	"		"	110	38.3	3.5	16	5	871	541		
"	"	"	"	"		"	117	38.4	3.3	13	4	232	198		
"	"	Aug. 1960	"	"		"	112	37.0	3.3	18	4	1 482	659		
"	"	"	"	"		"	178	51.6	2.9	29	4	454	789		
"	"	Aug. 1959	"	"		"	88	30.2	3.4	-	3	1 394	741		
"	"	Aug. 1958	"	"		"	90	28.6	3.2	-	3	318	175		
"	"	"	"	"		"	90	29.4	3.3	-	2	649	319		

WHITING: NORTH SEA (REGION IV)

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Gear: Otter Trawl Material: Natural Fibres (Manila and Sisal)															
Boerema	J. du Cons. 21 (2) 1956	Jan. - July 1954	'Antoni van Leewenhoek'	Double Manila	250 m/kg	Cover (cane hoops)	69	26.3	3.8	3.9	24	2 104	3 649	1 029	861
"	"	"	"	"	250 m/kg	"	80	29.1	3.6	5.2	5	461	1 572	276	433
Bowman	Unpublished	1929	'Explorer'	Double Manila		Cover	57.2	19.0	3.3	2.5	11	11 000			
"	"	"	"	"		"	67.0	24.0	3.6	3.5	59	12 000			
von Brandt	ICNAF Spec. Publ. 5	June 1956	'Anton Dohrn'	Double Manila 2000 tex. x 3	160 m/kg	Cover	74	20	2.7	4.5	7	2 889	263	248	111
"	Unpublished	June 1958	"	"	160 m/kg	"	73	25	3.4	4.0	3	1 394	6 198	332	346
Furnestin	Permanent Commission 1955		'Clemenceau'	Double Manila		Cover	73	27	3.7	-	-)	2000			
"	"		"	"		"	63	23	3.7	-	-)				
Gilis	Unpublished	May-June 1960	'Hinders'	Double Manila	350 m/kg	Courlene cover	81	28.1	3.5	9.6	14	222	552	127	182
Gulland	J. du Cons. 21 (3) 1956		'Sir Lancelot'	Double Sisal		Cover	70	27.1	3.9	4.5	13	4 000	6 600		
"	"		"	"		"	77	28.7	3.7	4.4	16	1 600	5 900		
"	"		"	"		"	74	24.2	3.3	6.9	24	2 500	3 200		
Lindquist	C. M. 1958	1958		Manila		Courlene cover	69.5	19.6	2.8		11				
"	"	"		"		Cotton cover	79.4	(26)	(3.3)		6				
"	"	"		"		Courlene cover	89.7	28.4	3.2		2				
Margetts	Unpublished	1950	'Sir Lancelot'	Double sisal		Cover	73.9	21.6	2.9	3.6	20	3 500	1 700	1 884	
"	"	1952	'Platessa'	"		"	68.7	26.0	3.8	2.4	14	1 000	1 300	154	
"	C. M. 1955, No. 43	Mar. 1954	"	"	302 m/kg	"	73.3	25.0	3.4	3.5	8	617	1 532	326	424
"	"		"	"	302 m/kg	"	70.8	26.4	3.7	2.8	7	465	1 997	199	210
"	"	Nov. 1954	'Sir Lancelot'	"	252 m/kg	"	72.1	26.7	3.7	4.2	5	370	202	154	151
"	"	Dec. 1954	"	"	252 m/kg	"	65.7	24.3	3.7	6.2	5	(1 047)	(318)	369	233
"	"	Aug. 1955	'Platessa'	"	302 m/kg	"	69.0	26.5	3.8	4.4	5	1 714	764	337	371

WHITING: NORTH SEA (REGION IV) (continued)

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Margetts	C. M. 1956, No. 73	Sept. 1956	'Platessa'	Double sisal	302 m/kg	Cover	72.6	29.3	4.0	-	3	1 175	535		
"	"	"	"	"	302 m/kg	"	63.1	23.5	3.7	-	2	246	70		
Marine Laboratory Aberdeen	Unpublished	Sept. 1958	'Scotia'	Double Manila		Covers (cotton 32/30)	63.0	26.0	4.1	3.6	4	781	324	192	185
"	"	"	"	"		Covers (cotton 12/24)	63.0	26.7	4.2	3.3	7	1 438	565	298	216
"	"	"	"	"		Courlene cover	63.0	27.5	4.4	3.2	7	1 387	696	387	340
"	"	July 1957	"	"		Cotton cover (long)	76.8	30.8	4.0	3.8	13	1 324	4 962	651	858
"	"	"	"	"		Cotton cover (short)	76.8	30.8	4.0	4.5	6	619	1 893	288	376
"	"	Apl. 1959	'Explorer'	"		Top Courlene cover	94.3	39.4	4.2	8.2	5	517	3 623	187	289
"	"	"	"	"		Whole Courlene cover	94.3	37.9	4.0	8.0	5	429	2 556	232	346
"	"	June 1959	'Scotia'	"		Cover	62.0	21.9	3.5	5.4	5	687	1 329	547	960
"	"	"	"	"		"	62.0	19.2	3.1	3.7	5	1 258	1 174	995	1 034
"	"	Sept. 1960	'Explorer'	"		Whole Courlene cover	77.6	31.9	4.1	7.0	5	2 471	5 514	1 566	2 036
Pope & Hall	C. M. 1960, No. 183	Dec. 1959	'Explorer'	Double Manila	280 m/kg	Full Courlene cover	75.9	26.2	3.5	6.8	4	291	1 247	115	117
Pope et al.	C. M. 1958, No. 88	June 1958	'Willem Beukelsz'	Double Manila	232 m/kg	Cover	66.8	22.5	3.4	4.9	3	688	560	182	162
"	"	"	"	"	232 m/kg	"	65.7	23.8	3.6	5.4	2	318	725	174	282
"	"	"	"	Single Manila	232 m/kg	"	63.2	21.5	3.4	4.7	4	747	546	197	176
"	"	"	"	"	232 m/kg	"	61.9	21.2	3.4	4.6	2	562	400	264	255
"	"	"	'Anton Dohrn'	Double Manila	262 m/kg	"	67.1	24.5	3.6	4.4	6	2 390	5 752	552	566
"	"	"	"	"	262 m/kg	"	65.5	24.4	3.7	4.1	8	2 699	6 938	1 170	1 654
"	"	"	'Explorer'	"	156 m/kg	"	68.0	21.2	3.1	4.2	4	583	475	114	107
"	"	"	"	"		"	64.6	23.7	3.7	3.8	7	3 169	3 402	1 130	1 287
"	"	"	"	Single Manila	156 m/kg	"	70.1	18.7	2.7	2.8	2	261	134	39	46
"	"	"	"	"	156 m/kg	"	65.9	20.9	3.2	3.4	4	1 102	537	311	284

WHITING: NORTH SEA (REGION IV) (continued)

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Roessingh	C. M. 1959, No. 88	Apl-June 1959	'Willem Beukelsz'	Double Manila	262 m/kg	Full cover, 30mm (cane hoops)	65.4	27.2	4.2	2.5	2	88	649	24	46
"	"	June 1959	"	"	262 m/kg	"	65.4	25.9	4.0	3.1	6	315	1 202	89	146
"	"	Apl. 1959	"	"	262 m/kg	"	65.4	26.6	4.1	4.0	3	143	809	72	112
"	"	June 1959	"	"	262 m/kg	"	65.4	25.6	3.9	5.0	6	362	1 746	169	280
"	C. M. 1960, No. 100	May 1960	"	" (Herring trawl)	400 m/kg	"	50.0	18.6	3.7	3.2	10	11 624	11 247	3 851	4 377
Zijlstra	C. M. 1957	June 1957	'Willem Beukelsz'	Double Manila	400 m/kg	Full cover, 30mm (cane hoops)	52.7	20.2	3.8	2.2	7	2 955	86	40	19
"	"	"	"	"	400 m/kg	"	60.1	23.4	3.9	3.7	7	3 468	1 228	1 228	845
"	"	"	"	"	400 m/kg	"	67.8	27.2	4.0	4.0	4	619	411	213	236
Gear: Otter Trawl Material: Natural Fibres (Cotton and Hemp)															
Boerema	J. du Cons. 21 (2) 1956	Jan.-July 1954	'Antoni van Leeuwenhoek'	Double hemp	510 m/kg	Covers (cane hoops)	67	28.5	4.3	4.6	11	320	1 167	183	242
"	"	"	"	"	510 m/kg	"	72	31.3	4.4	4.9	15	347	2 187	155	192
"	"	"	"	"	510 m/kg	"	77	32.4	4.2	4.4	7	89	1 270	32	36
"	C. M. 1958, No. 58	Sept. 1958	'Willem Beukelsz'	"	510 m/kg	Top cover	72.5	31.5	4.4	5.2	4	653	5 172	182	241
"	"	"	"	"	510 m/kg	Full cover	70.8	34.1	4.8	3.3	4	133	3 970	33	55
Margetts	C. M. 1955, No. 43	Mar. 1954	'Platessa'	Double cotton	302 m/kg	Cover	70.8	27.1	3.8	4.2	9	447	2 407	214	281
"	"	"	"	"	302 m/kg	"	70.2	29.2	4.2	5.0	8	1 346	3 182	646	908
"	"	Nov. 1954	'Sir Lancelot'	Single cotton	363 m/kg	"	72.3	30.1	4.2	5.2	8	249	193	146	141
"	"	Dec. 1954	"	"	363 m/kg	"	71.7	(26)	(3.6)	(6.0)	3	304	424	15	12
"	"	"	"	"	363 m/kg	"	64.3	24.6	3.8	4.2	10	(2 271)	(640)	733	422
"	"	"	"	Double cotton	452 m/kg	"	65.5	24.9	3.8	6.6	5	(955)	(310)	585	266
"	"	Aug. 1955	'Platessa'	Single cotton	363 m/kg	"	68.0	26.9	3.9	4.1	5	824	374	335	208
"	"	"	"	Double cotton	452 m/kg	"	69.0	(24.8)	(3.6)	(4.8)	12	1 149	297	222	229
"	C. M. 1956, No. 73	Sept. 1956	"	Single cotton		"	70.0	(28.4)	(4.1)	-	3	603	300		
"	ICNAF Spec. Publ. 5		"	Double sisal)		Alternate hauls	49)	23.1	4.6	2.0	6	945		104	
"	"		'Irenic'	Single cotton)		"	50)					722		106	

WHITING: NORTH SEA (REGION IV) (continued)

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Pope et al	This Report	June 1958	'Willem Beuklesz'	Double hemp	373 m/kg	Cover	72.2	25.7	3.6	8.4	3	675	597	345	292
"	"	"	"	"	373 m/kg	"	72.6	27.9	3.8	5.5	1	134	294	33	35
"	"	"	'Anton Dohrn'	"	174 m/kg	"	53.2	20.0	3.8	2.8	2	2 813	2 499	822	1 116
Roessingh	C. M. 1959, No. 88	Apl-June 1959	'Willem Beuklesz'	Single hemp (stiff)	372 m/kg	Full cover, 30mm (cane hoops)	67.4	28.3	4.2	3.5	3	145	3 038	34	65
"	"	"	"	Single hemp (soft)	372 m/kg	"	71.1	32.7	4.6	3.5	3	89	3 390	17	34
Gear: Otter Trawl Material: Synthetic Fibres (Polyesters and Polyamides)															
von Brandt	ICNAF Spec. Publ. 5	June 1956	'Anton Dohrn'	Double Perlon	210 m/kg	Covers	73	26	3.6	6.5	2	1 940	1 566	1 081	1 034
"	Unpublished	"	"	"	280 m/kg	"	83	40	4.8	7.0	2	583	5 413	46	63
Gilis	Unpublished	Oct. 1960	'Hinders'	Double nylon	600 m/kg	Whole Courlene cover	69	25.7	3.7	5.5	13	1 778	3 119	893	1 364
Margetts	C. M. 1956, No. 73	Sept. 1956	'Platessa'	Single nylon	302 m/kg	Cover	64.4	27.2	4.2	-	3	391	794		
Marine Laboratory Aberdeen	Unpublished	June 1959	'Scotia'	Single nylon		Covers	69.2	27.9	4.0	7.6	5	208	1 007	95	145
"	"	"	"	"		"	69.2	26.6	3.8	9.4	4	387	1 106	218	312
"	"	Sept. 1960	'Explorer'	Single Terylene		Whole Courlene cover	70.3	28.4	4.0	6.3	3	1 708	2 136	986	1 049
"	"	"	"	Double Terylene		"	73.3	33.4	4.6	6.4	5	1 722	7 015	838	1 180
Pope et al.	This Report	June 1958	'Anton Dohrn'	Double Perlon	210 m/kg	Cover	65.0	25.6	3.9	5.3	5	1 518	3 997	585	664
"	"	"	"	"	210 m/kg	"	63.7	26.8	4.2	4.1	8	2 929	11 252	1 209	1 455
"	"	"	"	Double Trevira	385 m/kg	"	80.1	32.0	4.0	6.0	2	725	3 261	328	447
"	"	"	"	"	385 m/kg	"	78.0	34.8	4.5	5.7	1	42	430	16	24
"	"	"	'Explorer'	Single nylon	136 m/kg	"	70.8	27.2	3.8	8.4	4	540	899	273	291
"	"	"	"	"	136 m/kg	"	68.0	24.6	3.6	4.3	8	3 664	6 043	1 413	1 853
"	"	"	"	Single Terylene	127 m/kg	"	86.8	33.0	3.8	11.1	3	424	1 474	266	386
"	"	"	"	"	127 m/kg	"	82.5	26.9	3.3	6.8	4	988	4 979	512	749

WHITING: NORTH SEA (REGION IV) (continued)

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Roessingh	C. M. 1960, No. 100	Apl. 1960	'Willem Beuklesz'	Double nylon	557 m/kg	Full cotton cover (cane hoops)	68.8	29.7	4.3	5.3	1	120	1 603	64	100
"	"	"	"	"	557 m/kg	"	68.8	29.7	4.3	3.6	17	612	9 472	247	521

WHITING: NORTH SEA (Region IV) and IRISH SEA (Region VIIA)

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Gear: Otter Trawl Material: Synthetic Fibres (Polyethylenes)															
Bedford & Jones	C.M. 1960, No. 58	Feb. 1960	'Platessa'	Single Courlene		Cover (nylon)	69.3	26.7	3.9	4	5	207	462	86	
"	"	"	"	"		"	69.3	25.3	3.7	3.5	9	2 245	592	651	
Boerema	C.M. 1958, No. 58	Sept. 1958	'Willem Beukelsz'	Double Nymplex	933 m/kg	Top cover, 20 mm	75.5	28.4	3.8	3.9	4	912	5 539	337	369
"	"	"	"	"	933 m/kg	Full cover, 30 mm (Cane hoops)	74.1	31.0	4.2	4.6	4	468	4 471	196	242
von Brandt	Unpublished	June 1958	'Anton Dohrn'	Double Courlene	200 m/kg	Covers	73	25	3.4	4.0	3	437	1 046	78	92
Gilis	Unpublished	8 Sept. 1960	'Hinders'	Double Courlene x 3 S.48		Full Courlene cover x 3 S30	66	23.3	3.5	7.0	7	1 202	2 671	836	1 562
Marine Laboratory Aberdeen	Unpublished	Sept. 1960	'Explorer'	Single Courlene		Whole cover, Courlene	84.1	30.7	3.7	7.7	5	2 662	5 379	1 930	2 899
Pope and Hall	C.M. 1960, No. 183	Dec. 1959	'Explorer'	Single Courlene 3 x 21		Full Courlene cover	86.1	26.6	3.1	4.3	5	734	1 450	406	464
Pop et al.	This Report	June 1958	'Willem Beukelsz'	Double Nymplex	933 m/kg	Cover	78.8	29.4	3.7	7.5	4	379	704	254	260
"	"	"	"	"	933 m/kg	"	79.6	27.7	3.5	3.8	1	78	1 198	32	31
"	"	"	'Anton Dohrn'	Double Courlene	200 m/kg	"	71.4	27.1	3.8	5.0	6	1 731	7 276	717	881

WHITING: IRISH SEA (Region VIIA)

Gear: Otter Trawl Material: Cotton

Bedford & Jones	C.M. 1960, No. 58	Feb. 1960	'Platessa'	Cotton		Cover	62.9	24.0	3.8	4.0	6	385	99	101	

WHITING: BALTIC (Region III)

Gear: Otter Trawl Material: Cotton

* Bohl	C.M. 1960, No. 162	Mar. 1960	'Hermann Wattenberg'	Cotton 20/24	720 m/kg	Cover (Top) cotton	65.0	16.2	2.5	-	6	1 470	1 250	-	-
+ "	"	"	"	"	720 m/kg	"	65.6	27.2	4.2	-	4	35	876	-	-

* Trawl without lastrich line

+ Trawl with " "

WHITING: NORTH SEA (Region IV) and IRISH SEA (Region VIIA)

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Gear: Seine Net Material: Various															
Region VIIA															
Bedford and Jones	C.M. 1960, No. 58	Dec.1959-Feb. 1960	'Margaret Rose'	Cotton		Cover (nylon shrimp netting)	67.8	26.9	4.0	6.7	3	6 616	11 653	5009	
"	"	"	"	Single Courlene		"	57.2	22.0	3.8	4.2	4	2 559	2 980	1554	
"	"	"	"	"		"	57.2	23.8	4.2	(2)	1	1 176	1 137	149	
"	"	"	"	Cotton		"	64.4	26.6	4.1	5.0	2	(533)	(711)	234	
"	"	"	'Maria McClements'	Single Courlene		"	70.5	31.4	4.5	4.1	3	(277)	(1471)	345	
Region IV															
Lucas et al.	J, du Cons., 20(1), 1954	Aug. - Sept. 1953	'Helen Herd' and 'Margaret Herd' (commercial seiners)	Cotton		Cover (sprat netting)	59.0	22.3	3.8	7.2	7	10 437	6 763	5 205	6 026
"	"	Aug. - Sept. 1953	"	"		"	71.0	29.2	4.1	8.5	37	6 859	43 289	4 747	8 184
"	"	"	"	"		"	80.0	36.2	4.5	6.4	26	1 153	11 695	115	226
REDFISH: S. W. GREENLAND (Region XV)															
Gear: Otter Trawl Material: Various															
von Brandt	C.M. 1960, No. 10	April - May 1960	'Anton Dohrn'	Manila 2000 Tex. x 3	160 m/kg	Covers	129	31	2.4	8.5	5	4 980	1 498	995	557
"	"	Aug. 1957		Double Perlon I plaited	210 m/kg	"	129	45	3.5	6.0	12	194	497	68	121
"	"	4 May 1960		"	210 m/kg	"	132	41	3.1	9.5	7	1 927	1 851	1 158	1 026
"	"	Aug. 1957		Double Perlon II plaited	280 m/kg	"	129	42	3.3	10.5	11	354	327	95	165
"	"	April - May 1960		Double Trevira 92 tex x 24	400 m/kg	"	133	37	2.8	-	5	3 910	1 035	(1085)	(717)

REDFISH: ARCTIC (Regions I and II)

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Gear: Otter Trawl Material: Various															
Saetersdal	ICNAF, Spec. Publ. 5	Sept.1956	'G. O. Sars'	Double Manila		Covers	144	37	2.6	14.5	1	727	706		
"	"	Feb. 1957	"	"		"	144	45	3.1	-	1	97	147		
"	"	April 1957	"	"		"	144	40	2.8	9	1	66	175		
"	C.M. 1960, No. 89	Aug. 1960	'Johan Hjort'	"	125 m/kg	Nymplex covers	131.6	40.1	3.0	4.0	1			(878)	(730)
"	"	"	"	"	125 m/kg	"	132.0	38.3	2.9	7.0	1			(1583)	(1054)

COD: ARCTIC (Regions I and II)

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Gear: Otter Trawl Material: Natural Fibres (Manila, Flax and Hamp, Sisal)															
Beverton	C.M. 1956, No. 74	July - Aug. 1956	'Ernest Holt'	Double Manila (white)	121 m/kg	Cover (nylon)	109	39.5	3.6	8.0	1	(525)		120	97
"	"	"	"	"	121 m/kg	"	109	41.5	3.8	7.0	6	?		124	97
"	C.M. 1959, No. 117	July 1959	"	"	101 m/kg	Cover (large mesh chafers)	118	44.0	3.7	8.5	4	491	648	253	313
"	"	"	"	"	101 m/kg	Cover (small mesh chafers)	119	38.6	3.2	8.2	5	6 268	1 095	687	495
"	"	"	"	"	101 m/kg	Cover (large mesh chafers)	119	38.5	3.2	8.0	2	5 710	1 193	1 233	772
"	"	"	"	"	101 m/kg	Cover (no chafers)	120	41.2	3.4	8.6	5	3 059	657	494	363
"	"	"	"	"	101 m/kg	"	118	39.0	3.3	11.0	3	1 206	214	183	148
von Brandt	C.M. 1956, No. 71	July - Aug. 1956	'Anton Dohrn'	Double Manila 2000 tex. x 3	160 m/kg	Cover	113	38.0	3.4	8.0	17	4 373	738	340	353
"	"	"	"	"	160 m/kg	"	133	46.0	3.5	10.5	6	5 011	1 035	746	650
Margetts et al.	This Report	Aug. 1959	'Tunets'	Double Manila	125 m/kg	"	105	35.3	3.4	8.0	10	4 133	1 017	452	452
"	"	"	"	"	125 m/kg	"	128	43.7	3.4	11.0	10	3 061	2 278	492	504
"	"	"	'Anton Dohrn'	"	125 m/kg	"	123	44.9	3.5	12.0	5	1 805	4 059	1 014	1 236
"	"	"	"	"	125 m/kg	"	123	37.1	3.0	16.0	4	4 082	2 502	2 428	2 061
"	"	"	"	"	125 m/kg	"	123	35.0	2.8	14.0	1	2 996	1 370	1 985	1 197
"	"	"	'Explorer'	"	151 m/kg	"	109	38.0	3.5	7.0	4	2 602	1 935	807	899
"	"	"	'Johan Hjort'	"	125 m/kg	"	131	44.0	3.4	(8.0)	1	593	167	137	93
"	"	"	"	"	125 m/kg	"	131	41.0	3.1	(12.0)	1	1 048	402	427	283
"	"	"	"	"	125 m/kg	"	128	45.0	3.5	9.0	3	230	1 269	130	197
"	"	"	"	"	125 m/kg	"	128	39.8	3.1	8.0	2	2 314	2 955	1 275	1 504
"	"	"	"	"	125 m/kg	"	126	48.0	3.8	(8.0)	3	304	162	43	35
"	"	"	"	"	125 m/kg	"	129	47.7	3.7	9.0	3	425	472	137	152
"	"	"	"	"	125 m/kg	"	130	47.0	3.6	(14.0)	1	535	182	112	83
"	"	"	"	"	125 m/kg	"	129	45.5	3.5	7.0	3	345	784	149	149
"	"	"	"	"	125 m/kg	"	129	45.7	3.5	10.0	3	2 071	2 662	1 086	1 226
"	"	"	"	"	125 m/kg	"	130	48.0	3.7	9.0	3	525	1 759	152	182

COD: ARCTIC (Regions I and II) continued

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Margetts et al.	This Report	Aug. 1959	'Johan Hjort'	Double Manila	125 m/kg	Cover	103	37.0	3.6	(10.0)	2	385	241	205	163
"	"	"	"	"	125 m/kg	"	103	34.7	3.4	8.0	2	1 330	455	423	330
"	"	"	'Ernest Holt'	"	125 m/kg	"	120	40.6	3.4		1				
"	"	"	"	"	125 m/kg	"	120	41.0	3.4		4				
"	"	"	"	"	125 m/kg	"	137	45.4	3.3		4				
"	"	"	"	"	125 m/kg	"	137	51.2	3.7		1				
"	"	"	"	"	125 m/kg	"	137	50.6	3.7		3				
"	"	"	"	"	125 m/kg	Alternate hauls	101	38.4	3.8	5.0	5	3 877	-	1 300	-
"	"	"	"	"	125 m/kg	"	119	(47.6)	(4.0)	(10.0)	3	471	-	227	-
"	"	"	"	"	125 m/kg	"	137	54.8/ 57.0 *	4.0/ 4.2	6.0/ 9.0	5	627	-	141 219	-
"	"	"	'Anton Dohrn'	"	125 m/kg	"	116	39.0	3.4	9.0	12	16 654	-	8 087	-
Saetersdal	ICNAF Spec. Publ. 5	May 1954	'Thor Iversen'	"		Parallel hauls	100				12	(5 485)			
"	"	"	'Peder Rønnestad'	"		"	130	53.5	4.1	10	12	(2 111)			
"	"	"	'Thor Iversen'	"		"	130	57.5	4.4	10	12	(856)			
"	"	"	'Peder Rønnestad'	"		"	100				12	(6 065)			
"	"	"	'Thor Iversen'	"		"	100				10	(1 932)			
"	"	"	'Peder Rønnestad'	"		"	130	50.0	4.3	10	10	(416)			
"	"	Nov. 1956	'G.O. Sars'	"		Covers	144	51.5	3.6	9	6	(562)	(176)		
"	"	"	"	"		"	144	(49)	(3.4)	-	1	(248)	(70)		
"	"	Mar. 1957	"	"		"	144	55.5	3.8	8	1	(74)	(65)		
"	"	April 1957	"	"		"	144	49.5	3.4	15	5	(490)	(525)		
"	C.M. 1958, No. 72	July 1958	'Johan Hjort'	Double Manila (chafer)		Cover	108	39.5	3.7	11	3	(877)	(449)	320	341
"	"	"	"	"		"	109	40.5	3.7	11	2	(1 262)	(542)	476	386
"	"	"	"	Double Manila (no chafer)		"	110	44.5	4.0	9	1	(402)	(353)	163	180
"	"	"	"	"		"	111	40.5	3.6	11.5	5	(406)	(349)	202	234
"	"	"	"	"		"	112	39.0	3.5	14	2	(1 319)	(523)	553	433
"	"	"	"	Double Manila (chafer)		"	113	44.5	3.9	9.5	1	(486)	(352)	197	210
"	C.M. 1960, No. 89	Aug. 1960	"	Double Manila	125 m/kg	Nymplex covers	131.5	45	3.4	9.0	2			(799)	(983)
"	"	"	"	"	125 m/kg	"	131.6	49	3.7	8.5	2			(238)	(399)

*Calculated with 2 different samples of population present

COD: ARCTIC (Regions I and II) continued

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Saetersdal	C.M. 1960, No. 89	Aug. 1960	'Johan Hjort'	Double Manila Double cod-end	125 m/kg	Shrimp net covers	104.0	25	2.4	6.0	7			(301)	(149)
"	"	"	"	"	125 m/kg	"	104.0	30	2.8	8.0	4			(1 500)	(570)
"	"	"	"	Double Manila	125 m/kg	Nymplex covers	131.6	46	3.5	7.0	4			(162)	(210)
"	"	"	"	Double Manila (chafers)	125 m/kg	Alternate hauls	130.0	48	3.7	7.0	11/10			(676) (1 736)	
"	"	"	"	"	125 m/kg	Nymplex covers	130.3	49	3.8	7.0	6			(440)	(470)
"	"	"	"	Double Manila	125 m/kg	"	131.6	49	3.8	-	4			(165)	(34)
"	"	"	"	Double Manila (chafers)	125 m/kg	"	130.3	53	4.0	11.0	5			(303)	(224)
Treschev	Unpublished	April 1960	'Melitopol'	Manila		Covers	106	37.8	3.6	5	10	1 231	1 147	264	307
"	"	June 1960	'Treska'	"		"	125	47.5	3.8	8	10	3 031	7 895	986	1 153
Margetts et al.	This Report	Aug. 1959	'Tunets'	Hemp		Nymplex cover 70 mm	109	(39)	(3.4)	(13)	10	1 516	229	(143)	(112)
"	"	"	'Anton Dohrn'	"		"	136	48.0	3.5	11.0	10	2 139	1 464	649	605

Gear: Otter Trawl Material: Synthetic Fibres (Polyesters and Polyamides)

von Brandt	C.M. 1956, No. 71	July - Aug. 1956	'Anton Dohrn'	Double Perlon I plaited	210 m/kg	Covers	107	40	3.7	8.0	5	2 208	1 274	719	841
"	"	"	"	"	210 m/kg	"	134	49	3.7	11.5	6	5 577	872	703	514
"	ICNAF Spec. Publ. 5	"	"	Double Perlon II plaited	280 m/kg	"	113	41	3.6	8.5	12	4 749	2 453	1 100	1 016
"	"	"	"	Double nylon	380 m/kg	"	104	42	4.0	8.0	13	734	2 031	168	172
Margetts et al.	This Report	Aug. 1959	'Ernest Holt'	Double nylon	191 m/kg	Nymplex covers	122	53.9	4.4	7	4	962	1 675	251	246
"	"	"	'Anton Dohrn'	Double Perlon	210 m/kg	"	102	39.0	3.8	5	2	1 171	538	198	186
"	"	"	"	"	210 m/kg	"	102	35.5	3.5	(13)	1	1 659	800	(748)	(646)
"	"	"	"	"	210 m/kg	"	102	37.0	3.6	9	1	1 749	1 472	1 005	991
"	"	"	'Tunets'	Double Kapron	153 m/kg	"	108	46.0	4.2	10	10	3 355	1 276	367	285
Saetersdal	C.M. 1958, No. 71	Oct. 1957	'G.O. Sars'	Double nylon (tarred)	260 m/kg	Nylon cover	140	59	4.2	9	11	(941)	(1 110)		
"	C.M. 1960, No. 89	Aug. 1960	'Johan Hjort'	Double Terylene	136 m/kg	Nymplex covers	107.7	41	3.8	5.5	4			(663)	(745)

COD: ARCTIC (Regions I and II) continued

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Saetersdal	C.M. 1960, No. 89	Aug. 1960	'Johan Hjort'	Double Terylene	136 m/kg	Nymplex covers	106.4	43	4.0	6.0	4			(741)	(811)
Treschev	Unpublished	1959	'Treska'	Kapron		Covers	110	48.8	4.4		10				
"	"	1959	"	"		"	90	39.0	4.3		20				
"	"	1959	"	"		"	90	37.0	4.1		10				
"	"	April 1959	'Lot'	"		"	109	45.4	4.2		10				
"	"	"	"	"		"	108	46.0	4.3		10				
"	"	"	"	"		"	108	40.6	3.8		10				
"	"	"	"	"		"	106	46.8	4.4		10				
"	"	June 1959	'Treska'	"		"	98	43.5	4.4		10				
"	"	"	"	"		"	104	42.0	4.0		10				
"	"	July 1960	"	"		"	103	43.0	4.2		10				
"	"	"	'Melitopol'	"		"	93	36.8	4.0		10				

COD: ICELAND (Region VA)

Gear: Otter Trawl Material: Natural Fibres (Manila)

Jónsson	C.M. 1960, No. 134	July 1958	'Maria Julia'	Double Manila		Covers	90	33.0	3.7		5	768	242		
"	"	Aug. 1958	"	"		"	88	34.8	4.0		3	674	106		
"	"	July 1960	"	"		"	111	33.3	3.0		4	1 023	119		
"	"	"	"	"		"	116	34.0	2.9		4	2 255	840		
"	"	"	"	"		"	115	36.9	3.2	16	4	1 212	358		
"	"	"	"	"		"	115	32.4	2.8	18	4	387	116		

COD: BALTIC (Region III)

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Gear: Otter Trawl Material: Natural Fibres (Manila and Sisal)															
Cieglewicz and Strzyzewski	C.M. 1957, No. 25	4 May 1957	'Michal Siedlecki'	Manila		Cotton cover, 40/24	72.1	24.3	3.4	4.5	4	5 465	1 589	462	449
"	"	Sept.1957 April-July 1957	"	Sisal		"	67.3	20.2	3.0	9.1	7	6 125	1 300	588	560
"	C.M. 1958, No. 111	April 1958	"	Manila		Full cotton cover, 40/21	68.9	23.6	3.4	5.5	3	2 064	120	70	74
Otterlind	C.M. 1959, No. 120	Oct. 1958	'Skagerak'	Single Manila	209 m/kg	Full Courlene cover, 3 x 16	73.6	24.0	3.3	3.5	2	482	2 256	168	194
"	"	"	"	"	209 m/kg	"	75.7	23.0	3.0	4.0	2	434	2 186	143	167
"	"	"	"	"	209 m/kg	Full cotton cover, 12/24	75.7	20.5	2.7	4.0	3	1 288	2 909	619	461
"	"	"	"	"	209 m/kg	"	75.7	(27)	(3.6)	4.0	1	110	763	25	40
"	"	Jan. - Feb. 1959	"	"	209 m/kg	Full Courlene cover, 3 x 16	73.2	26.4	3.6	4.0	4	1 826	4 331	447	490
"	"	"	"	"	209 m/kg	"	78.2	26.0	3.3	4.0	2	515	1 609	160	171
"	"	"	"	"	209 m/kg	"	79.6	26.6	3.3	4.0	6	2 209	6 345	619	610
"	"	"	"	"	209 m/kg	Full cotton cover, 12/15	76.6	26.0	3.4	3.5	1	1 866	578	151	209
Gear: Otter Trawl Material: Natural Fibres (Cotton, Hemp, and Rami)															
* Bohl	C.M. 1960, No. 162	Mar. 1960	'Hermann Wattenberg'	Cotton 20/24	720 m/kg	Top cotton cover	65.0	13.8	2.1	7.0	6	1 105	497	490	431
+ "	"	"	"	"	720 m/kg	"	65.6	20.6	3.1	3.0	4	284	418	32	83
Cieglewicz and Strzyzewski	C.M. 1957, No. 25	April-May 1956	'Michal Siedlecki'	Cotton 40/24		Full cotton	67.4	25.5	3.7	3.9	4	3 762	563	84	85
"	"	May 1956	"	"		cover, 40/24	75.4	28.2	3.7	7.0	1	1 085	265	124	85
"	"	June 1956	"	Cotton 20/54		"	73.1	22.3	3.1	5.9	5	5 546	1 574	539	471
"	"	July 1957	"	Hemp		"	74.7	27.2	3.6	3.4	3	1 166	318	141	120
"	C.M. 1958, No.111	Sept. 1958	"	Cotton		Full cotton cover, 40/21	83.4	32.0	3.8	6.0	2	519	88	28	27
"	"	April-May 1958	"	Rami		"	92.9	31.5	3.4	6.0	3	1 537	1 511	242	125
"	"	May 1958	"	"		"	77.8	30.5	3.9	3.0	3	452	972	37	19

COD: BALTIC (REGION III) (continued)

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Otterlind	C. M. 1959, No. 120	Oct. 1958	'Skagerak'	Double cotton 12/45	230 m/kg	Full cotton cover, 12/15	75.5	23.4	3.1	4.0	3	1 006	4 769	412	443
"	"	"	"	"	230 m/kg	Full Courlene Cover, 3x16	78.1	23.0	2.9	6.0	2	814	1 777	407	435
"	"	Jan-Feb. 1959	"	"	230 m/kg	"	77.8	26.1	3.4	5.5	3	1 284	5 086	490	580
"	C. M. 1960, No. 205	Mar. 1960	"	Double cotton 12/42	217 m/kg	Full Courlene cover, 3x5	80.7	25.0	3.1	10.5	4	(3 527)+	(5 338)+	2 133	2 015
"	"	Mar-Apl. 1960	"	"	217 m/kg	"	79.8	25.0	3.1	8.5	2	1 154	2 600	540	592
"	"	Apl. 1960	"	"	217 m/kg	"	80.0	25.0	3.1	8.0	2	644	2 111	188	193
"	"	Aug. 1960	"	"	217 m/kg	"	78.4	22.5	2.9	(8.5)	2	(1 023)+	(774)+	-	-
"	"	"	"	"	217 m/kg	"	74.7	22.2	3.0	4.5	1	490	1 896	119	138
Gear: Otter Trawl Material: Synthetic Fibres (Polyethylenes)															
Otterlind	C. M. 1960, No. 205	Nov. 1959	'Skagerak'	Single Courlene 3 x 20	514 m/kg	Full Courlene cover, 3x5	69.9	20.8	3.0	5.0	4	(2 820)	(3 054)	1 133	961
"	"	"	"	"	514 m/kg	"	81.4	25.0	3.1	9.5	5	(1 005)	(3 975)	-	-
"	"	"	"	"	514 m/kg	"	81.5	(25)	(3.1)	(10.5)	4	(1 012)	(3 597)	461	793
"	"	Jan. 1960	"	"	514 m/kg	"	80.9	24.8	3.1	5.0	4	2 942	1 541	477	345
"	"	Aug. 1960	"	"	514 m/kg	"	82.8	28.8	3.5	7.0	4	(2 511)	(9 233)	742	802
"	"	"	"	"	514 m/kg	"	81.7	26.0	3.2	10.0	3	(1 408)	(1 947)	731	960
"	"	Nov. 1959	"	"	514 m/kg	"	92.0	(28.4)	(3.1)	(11.5)	2	(610)	(4 020)	349	614
"	"	Jan. 1960	"	"	514 m/kg	"	90.6	26.5	2.9	8.0	1	352	530	119	125
"	"	Jan-Feb. 1960	"	"	514 m/kg	"	88.8	27.5	3.1	8.0	2	1 402	1 267	424	438
"	"	Jan. 1960	"	"	514 m/kg	"	89.3	25.6	2.9	6.0	3	1 366	1 040	395	316
"	"	Feb. 1960	"	"	514 m/kg	"	87.8	28.7	3.3	7.0	1	604	2 010	210	226
"	"	Jan. 1960	"	"	514 m/kg	"	88.1	29.5	3.3	4.5	2	874	1 037	182	188

+ Not all fish below 25% length measured

COD: BALTIC (REGION III) (continued)

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Gear: Otter Trawl Material: Synthetic Fibres (Polyvinylalcohols, Polyesters and Polyamides)															
Cieglewicz & Strzyzewski	C. M. 1959, No. 32	June 1959	'Michal Siedlecki'	Kuralon	343 m/kg	Full cotton cover, 40/21	76.3	25.9	3.4	5.2	5	1 883	1 646	509	541
"	"	July 1959	"	Steelon	394 m/kg	"	78.2	25.6	3.3	5.6	5	1 843	2 400	1 069	906
"	C. M. 1960, No. 63	Mar-Apl. 1960	"	Kuralon	343 m/kg	"	86.4	29.4	3.4	4.9	5	2 598	4 066	232	271
"	"	May 1960	"	Steelon	394 m/kg	"	82.9	28.2	3.4	4.1	3	414	1 555	30	32
Otterlind	C. M. 1960, No. 205	Aug. 1960	'Skagerak'	Single Terylene (new)	83.8 m/kg	Full Courlene cover, 3x5	71.8	19.2	2.7	5.0	3	5 144	5 688	2 920	2 579

COD: NORTH SEA (REGION IV)

Gear: Otter Trawl Material: Natural Fibres (Manila and Sisal)															
Beverton	C. M. 1956, No. 74	Apl. 1956	'Sir Lancelot'	Double white sisal	252 m/kg	Cotton cover	127	40.0	3.2	10	18			404	
"	C. M. 1958, No. 113	June 1957	"	"	252 m/kg	Nylon cover (extension bag)	126	46.4	3.5	9.0					
"	"	"	"	"	252 m/kg	Nylon cover	126	44.5	3.7	5.0					
"	"	"	"	Double white Manila	252 m/kg	Nylon cover (extension bag)	109	35.1	3.2	5.5					
"	"	"	"	"	252 m/kg	Nylon cover	109	37.1	3.4	5.0					

COD: S. W. GREENLAND (REGION XV)

Gear: Otter Trawl Material: Various															
von Brandt (Messtorff)	Unpublished	Aug. 1957	'Anton Dohrn'	Double Manila	160 m/kg	Covers	127	47	3.7	10.5	12	3 232	595	350	420
"	C. M. 1958, No. 23	"	"	Double Perlon	210 m/kg	"	129	52	4.0	15.0	14	2 672	3 794	1 005	1 968
"	"	"	"	"	280 m/kg	"	129	50	3.9	9.5	9	2 150	2 192	515	866
"	"	"	"	Double Trevira	400 m/kg	"	122	47	3.9	9.0	9	2 505	1 394	569	696

DAB: NORTH SEA (REGION IV)

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Gear: Otter Trawl Material: Manila and Sisal															
Boerema	J. du Cons. 21 (2) 1956	Jan-July 1954	'Antoni van Leeuwenhoek'	Double Manila	250 m/kg	Cover (whole and hoops)	68	16.9	2.5	1.7	22	11 180	15 973	4 457	3 941
"	"	"	"	"	250 m/kg	"	80	19.7	2.5	2.1	10	2 527	10 487	1 308	2 056
"	"	"	"	"	250 m/kg	"	83	20.8	2.5	1.5	5	565	3 644	112	186
Roessingh	C. M. 1959, No. 88	1959	'Willem Beuklesz'	Double Manila (Manila trawl)	262 m/kg	Cover	65.4	17.2	2.6	1.6	2	614	1 485	155	51
"	"	"	"	"	262 m/kg	"	65.4	16.8	2.6	1.5	3	1 343	3 821	345	651
"	"	"	"	" (Perlon trawl)	262 m/kg	"	65.4	16.5	2.5	2.0	3	1 714	3 773	536	825
"	"	"	"	"	262 m/kg	"	65.4	16.5	2.5	1.9	3	1 740	4 122	477	797
Margetts	ICNAF Spec. Publ. 5		'Sir Lancelot'	Double Sisal		Covers	74	16.3	2.2	2.3		1 909	3 658	603	838
"	"		'Platessa'	"		"	69	15.2	2.2	1.8		2 939	7 198	960	1 268
Gear: Otter Trawl Material: Cotton and Hemp															
Boerema	J. du Cons. 21 (2) 1956	Jan-July 1954	'Antoni van Leeuwenhoek'	Double Hemp	510 m/kg	Full cover, 30mm (cane hoops)	67	17.0	2.5	1.5	10	3 568	3 737	1 047	975
"	"	"	"	"	510 m/kg	"	71	18.6	2.6	1.6	29	5 823	16 881	1 485	1 643
"	"	"	"	"	510 m/kg	"	74	18.9	2.6	1.4	11	1 635	4 981	762	800
"	"	"	"	"	510 m/kg	"	77	19.1	2.5	1.6	5	1 974	6 185	923	1 217
"	"	"	"	"	510 m/kg	"	66	17.2	2.6	1.7	4	854	1 187	317	415
"	"	"	"	"	510 m/kg	"	66	17.7	2.7	1.3	5	875	1 410	185	250
"	"	"	"	"	510 m/kg	"	72	18.7	2.6	1.3	4	1 196	1 938	268	416
"	"	"	"	"	510 m/kg	"	72	18.1	2.5	1.5	3	434	529	153	197
Boerema	C. M. 1958, No. 58	June 1958	'Willem Beukelesz'	Double Hemp	510 m/kg	Full cover, 30mm (cane hoops)	70.4	18.7	2.7	1.4	4	431	1 920	112	98
"	"	July 1958	"	"	510 m/kg	"	69.4	18.6	2.7	1.2	6	1 242	10 202	278	266
"	"	Sept. 1958	"	"	510 m/kg	"	69.4	18.8	2.7	1.6	2	250	2 739	78	86
"	"	"	"	"	510 m/kg	"	70.8	18.3	2.6	1.9	4	818	2 939	334	379
"	"	"	"	"	510 m/kg	Upper side cover, 20mm	71.7	18.3	2.6	1.4	3	387	1 909	84	119
"	"	"	"	"	510 m/kg	"	72.5	18.6	2.6	2.4	4	964	3 546	430	543

DAB: NORTH SEA (REGION IV)

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Roessingh	C. M. 1959, No. 88	June 1959	'Willem Beukelsz'	Single hemp (stiff)	372 m/kg	Full cover, 30mm (cane hoops)	67.4	17.7	2.6	1.8	3	286	1 264	91	218
"	"	"	"	Single hemp (soft)	372 m/kg	"	71.1	18.5	2.6	2.7	3	247	1 261	160	216
Gear: Otter Trawl Material: Synthetic Fibres															
Boerema	C. M. 1958, No. 58	June 1958	'Willem Beukelsz'	Double Nymplex	933 m/kg	Full cover, 30mm (cane hoops)	76.3	19.3	2.5	1.4	6	1 254	8 741	391	371
"	"	July 1958	"	"	933 m/kg	"	75.3	19.3	2.6	1.3	6	1 242	12 896	316	381
"	"	Sept. 1958	"	"	933 m/kg	"	74.8	18.4	2.5	1.4	2	313	991	54	86
"	"	"	"	"	933 m/kg	"	74.1	19.0	2.6	1.7	4	758	3 818	281	326
"	"	June 1958	"	"	933 m/kg	Top cover, 20mm	78.1	18.4	2.4	1.4	6	1 262	4 070	249	265
"	"	July 1958	"	"	933 m/kg	"	76.5	18.3	2.4	1.6	6	1 113	4 448	264	248
"	"	Sept. 1958	"	"	933 m/kg	"	75.5	18.4	2.4	2.3	4	1 243	3 333	435	551
Roessingh	C. M. 1960, No. 100	Apl. 1960	'Willem Beukelsz'	Double nylon	557 m/kg	Full cotton cover (with hoops)	68.6	17.8	2.6	1.2	2	493	1 852	104	316

DAB: BALTIC (REGION III)

Gear: Otter Trawl Material: Various

Jensen	C. M. 1958, No. 130	Aug-Sept. 1958	'Jens Vaever'	Single Manila	150 m/kg	Cover	109.4	25.8	2.4		2	106	1 844		
"	"	"	"	"	150 m/kg	Comparative	(80)	21.5	(2.1)		1	809			
"	"	"	"	Double Manila	200 m/kg	Cover	86.3	20.8	2.4		1	147	2 014		
"	"	"	"	"	200 m/kg	"	86.3	23.0	2.7		2	374	4 001		
Gear: Otter Trawl Material: Cotton and Hemp															
Jensen	C. M. 1958, No. 130	Nov. 1957	'Biologen'	Single Cotton 12 x 36		Cover	81.6	16.9	2.1	2.2	5	371	471		
"	"	"	"	"		"	81.6	17.8	2.2	2.5	1	349	366		
"	"	"	"	"		Comparative	81.6	19.3	2.4	1.8	1	273	-		
"	"	"	"	"		"	81.6	19.3	2.4	1.8	1	69	-		
"	"	"	"	Double cotton 12/36		Cover	73.9	15.5	2.1	2.3	2	188	187		

DAB: BALTIC (REGION III) (continued)

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Jensen	C. M. 1958, No. 130	Nov. 1957	'Biologen'	Double cotton 12/36		Cover	73.9	16.4	2.2	2.2	1	377	685		
"	"	"	"	"		"	73.9	14.3	1.9	2.7	1	330	76		
Gear: Otter Trawl Material: Nylon															
Jensen	C. M. 1958, No. 130	Aug-Sept. 1958	'Jens Vaever'	Nylon		Cover	96.3	23.3	2.4	2.4	3	306	2 941		
Gear: Seine Net Material: Various															
Jensen	C. M. 1958, No. 130	Aug-Sept. 1958	'Jens Vaever'	Single Manila	150 m/kg	Cover	(80)	14.8	(1.8)		1	2 177	545		
"	"	"	"	Double Manila	200 m/kg	"	86.3	18.0	2.1		2	7 275	12 957		
Gear: Seine Net Material: Cotton and Hemp															
Jensen	C. M. 1958, No. 130	Aug-Sept. 1958	'Jens Vaever'	Double hemp		Cover	110.5	24.2	2.2		1	216	355		
"	"	"	"	Single cotton 12/45		"	115.5	26.2	2.3		2	108	3 101		
PLAICE: NORTH SEA (REGION IV)															
Gear: Otter Trawl Material: Manila and Sisal															
Beverton and Holt	Fish.Invest., 19, 1957		'Sir Lancelot'	Sisal double white		Parallel hauls	72.2	15.6	2.2	1.3	6	(10 500)			
"	"		"	"		"	113.0	26.0	2.3	3.4	6				
"	"		'Platessa'	"		"	111.9	25.0	2.2	2.1	6	3 900			
"	"		"	"		"	140.6	30.5	2.2	3.6	6	4 400			
Boerema	J. du Cons. 21, 1956	Jan-July 1954	'Antoni van Leeuwenhoek'	Double Manila (tanned)	250 m/kg	Full cover (cane hoops)	70.0	13.9	2.0	2.8	4	3 291	124	46	45
"	"	"	"	"	250 m/kg	"	80.0	18.6	2.3	1.3	14	2 899	1 763	433	493
"	"	"	"	"	250 m/kg	"	83.0	19.0	2.3	1.6	5	2 363	857	630	533
Buckmann	Rapp. Cons. 80, 1932			Double Manila		Alternate haul	(81.0)	(12.4)	(1.5)	3.9					
"	"			Single Manila		"	(70.0)	(16.4)	(2.3)	2.3					
"	"			"		"	(82.0)	(22.8)	(2.8)	4.5					

PLAICE: NORTH SEA (REGION (IV) (continued)

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Davis	Fish. Invest. 14, 1934		'George Bligh'	Double Manila		Cover (cane hoops)	(80.0)	16.2	2.0	2.8		25 277	10 924	1 227	1 597
Gear: Otter Trawl Material: Cotton and Hemp															
Boerema	J. du Cons. 21, 1956	Jan-July 1954	'Antoni van Leeuwenhoek'	Double hemp (tanned)	373 m/kg 510 m/kg	Full cover (cane hoops)	72.0	16.8	2.3	1.1	21	4 501	562	154	264
"	"	"	"	"	373 m/kg 510 m/kg	"	74.0	17.3	2.3	1.4	5	2 689	321	142	108
"	"	"	"	"	373 m/kg 510 m/kg	"	77.0	17.1	2.2	1.7	7	3 849	704	262	235
"	C. M. 1958, No. 58	June 1958	'Willem Beukelsz'	Double hemp	510 m/kg	"	70.4	16.8	2.4	1.0	4	665	610	64	82
"	"	July 1958	"	"	510 m/kg	"	69.4	17.0	2.4	1.0	6	2 474	1 808	252	318
Gear: Otter Trawl Material: Synthetics															
Roessingh	C. M. 1960, No. 100	July 1960	'Willem Beukelsz'	Double nylon	557 m/kg	Full cover, 30mm (cane hoops)	66.8	16.5	2.5	1.8	9	2 143	635	161	246
Gear: Otter Trawl Material: Synthetics (Polyethylenes)															
Boerema	C. M. 1958, No. 58	June 1958	'Willem Beukelsz'	Double Nymplex	933 m/kg	Cover upperside, 20 mm	78.1	16.8	2.2	1.1	6	1 138	1 451	146	213
"	"	"	"	"	933 m/kg	Full cover, 30mm (cane hoops)	76.3	17.5	2.3	1.2	6	1 210	1 786	122	139
"	"	July 1958	"	"	933 m/kg	Cover upperside 20 mm	76.5	16.8	2.2	1.2	6	1 781	465	87	88
"	"	"	"	"	933 m/kg	Full cover, 30mm (cane hoops)	75.3	17.6	2.3	1.3	6	1 449	885	143	141

PLAICE: BALTIC (REGION III)

Gear: Otter Trawl Material: Manila

Jensen	C. M. 1958, No. 130	Aug-Sept. 1958	'Jens Vaever'	Double Manila	200 m/kg	Cover	86.3	(22.0)	(2.5)		2	95	478		
"	"	"	"	Single Manila	150 m/kg	"	109.4	21.9	2.0		2	97	504		

PLAICE: BALTIC (REGION III) (continued)

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Gear: Otter Trawl Material: Synthetics?															
Jensen	C. M. 1958, No. 130	Aug-Sept. 1958	'Jens Vaever'			Cover	96.3	20.8	2.2		3	120	1 112		
Gear: Seine Net Material: Manila															
Jensen	C. M. 1958, No. 130	Aug-Sept. 1958	'Jens Vaever'	Double Manila	200 m/kg	Cover	86.3	18.0	2.1		2	4 091	2 125		
"	"	"	"	"	200 m/kg	"	86.3	19.4	2.1		1	157	227		
"	"	"	"	"	200 m/kg	"	(80)	13.9	(1.7)		1	2 359	216		
Gear: Seine Net Material: Cotton and Hemp															
Jensen	C. M. 1958, No. 130	Aug-Sept. 1958	'Jens Vaever'	Single cotton, 12/45		Alternate	110.4	22.7	2.1		2	299	-		
"	"	"	"	Double hemp		Cover	110.5	21.8	2.0		1	306	896		
"	"	"	"	"		Alternate	110.5	23.2	2.1		2	278	-		
"	"	"	"	Cotton, 12/45		Cover	115.5	24.0	2.1		2	898	4 407		
"	"	"	"	"		Alternate	115.5	26.0	2.3		2	433	-		
"	"	"	"	Double hemp		Cover	110.5	(21.0)	(1.9)		1	399	371		
SOLE: NORTH SEA (REGION IV)															
Gear: Otter Trawl Material: Natural Fibres (Manila and Sisal)															
Boerema	J. du Cons. 21(2), 1956	Jan-July 1954	'Antoni van Leeuwenhoek'	Double manila	250 m/kg	Full cover, 30mm (cane hoops)	68	22.8	3.4	2.8	19	442	133	39	27
"	"	"	"	"	250 m/kg	"	80	26.0	3.2	3.0	6	139	102	29	36
"	"	"	"	"	250 m/kg	"	83	27.1	3.3	3.1	5	281	158	59	52
Furnestin	Permanent Commission 1955	Apl-May 1955	'Clemenceau'	Double manila		Covers	73	23.8	3.3			1981			
"	"	"	"	"		"	63	22.2	3.5						
Gilis	Unpublished	Nov. 1955-Feb. 1957	'Hinders'	Double manila	300 m/kg	Top cotton covers	65	19.9	3.1	5.8	18	536	63	39	31
"	"	"	"	"	300 m/kg	"	71	21.2	3.0	4.2	19	713	200	160	96

SOLE: NORTH SEA (REGION IV) (continued)

Author	Source	Date	Vessel	Material	Runnage	Method	Mean mesh size (mm)	50% length (cm)	Selection factor	Selection range	Number of hauls	Total number of fish		Fish in Selection range	
												Cod-end	Cover	Cod-end	Cover
Gilis	Unpublished	Nov. 1955-Feb. 1957	'Hinders'	Double manila	350 m/kg	Top cotton covers	75	25.2	3.3	8.3	19	302	174	132	130
"	"	Sept. 1958	"	"	350 m/kg	"	70	23.8	3.4	7.0	4	359	157	61	125
"	"	May-June 1959	"	"	350 m/kg	Whole cover	81	30.1	3.7	6.0	12	431	980	89	107*
"	Permanent Commission 2/21 1953	-	"	"	350 m/kg	(70mm) covers	80	27.2	3.4	4.3	10	1190		218	219
Margetts	J. du Cons., 20 (3)	Nov. 1953	'Sir Lancelot'	Double Sisal	252 m/kg	Top cover	67.4	21.4	3.2	2.8	8	584	150	78	43
"	"	"	"	"	252 m/kg	"	73.7	24.2	3.3	2.8	14	1 443	1 090	136	224
"	"	"	"	"	252 m/kg	"	86.5	30.3	3.5	2.5	12	458	966	136	91
"	"	"	"	"	252 m/kg	Alternate hauls	71.7	23.3	3.2	2.0	7	107		7	
							43.0				7	152		9	

Gear: Otter Trawl Material: Natural Fibres (Hemp)

Boerema	J. du Cons., 21 (2), 1956	Jan-July 1954	'Antoni van Leeuwenhoek'	Double hemp	510 m/kg	Full cover, 30mm (cane hoops)	67	22.9	3.4	2.8	11	828	107	48	41
"	"	"	"	"	510 m/kg	"	72	24.8	3.4	2.1	21	513	165	82	64
"	"	"	"	"	510 m/kg	"	74	25.4	3.4	2.6	16	834	432	219	205
"	"	"	"	"	510 m/kg	"	77	25.2	3.3	3.1	9	303	90	66	42
Furnestin	Permanent Commission 4/49 1955	1955	'Bon Pasteur'	Double hemp		Covers	79	26.2	3.3			463			
"	"	"	"	"		"	61	22.0	3.6						

Gear: Otter Trawl Material: Synthetic Fibres (various)

Gilis	Unpublished	Aug-Sept. 1960	'Hinders'	Double Courlene		Full Courlene cover	66	21.1	3.2	6.5	11	1 212	1 123	820	1 039
"	"	Oct. 1960	"	Double Nylon	600 m/kg	"	69	22.9	3.3	6.0	13	520	415	286	279
Roessingh	C. M. 1960, No. 100	Apl. 1960	'Willem Beukelsz'	Double Nylon	557 m/kg	Full Cotton cover 30mm (cane hoops)	68.8	23.5	3.4	2.0	19	789	793	38	80
"	"	Sept. 1960	"	"	557 m/kg	"	66.8	24.0	3.6	1.9	9	68	306	13	28

* Spent soles

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PART IV. GENERAL CONSIDERATIONS ON TRAWL AND SEINE MESH SELECTION AND ITS MEASUREMENT.

1. PREAMBLE

This part of the report is especially concerned with cod-end mesh selection of trawls and seines, although selection by the gear as a whole is mentioned.

Selection of catch by trawls and seines operates at various stages in the overall fishing procedure even before mesh selection can come into operation. The availability of fish to the gear is a part of the total selection process; comparative fishing experiments have shown differential species and size selection between different trawls and between trawls and seines. The relation between the spatial distribution of fish and the water swept by the gear, i. e. features of vulnerability, availability and accessibility may give rise to selection. Within the gear, selection could occur by escapes through various parts. The relative number of escapes through various parts of trawls varies greatly according to their design and operation, and also according to differences in morphological characteristics and behaviour patterns of fish species; mesh selection involving the relationship between fish size and mesh size can operate in all parts. The cod-end mesh selection is the final selective process in the catching operation. Evidence indicates that the cod-end is the most important component of the trawl and seine where escape of fish takes place and thus where mesh selection is of greatest significance. It is accepted that it is mesh selection in the cod-end which is of the greatest importance in determining the sizes of fish in the final catch, selectivity increasing with mesh size. Within the cod-end most escapes occur through the after meshes, at any rate when catches are moderate; usually more escapes occur through the top side than underside of a bottom trawl cod-end.

A review is made of methods and techniques employed for measuring cod-end mesh selectivity, discussion of their merits and disadvantages, the adjustment of results to allow for experimental errors, recommendations as to the conduct of experiments, and a review of various factors, mostly features of the gear and fishing conditions, which affect cod-end mesh selectivity. Information has been drawn from many available sources, but especially from the contributions to, and proceedings of, the Comparative Fishing Committee of ICES, the Research and Statistics Committee of ICNAF, the 1956 Biarritz Symposium Report of ICNAF and the report of the Joint ICNAF/ICES/FAO meeting at Lisbon in 1957 (ICNAF Spec. Publ. No. 5 (1963)). Of the latter, some parts are here included as direct extracts, while others have been taken and modified in the light of further evidence.

2. DEFINITIONS

The study of fishing gear selection processes has led to the introduction and adoption of a number of terms and concepts. The following are definitions of the most important terms used in this report.

> Selection - The act of choosing, taking, distinguishing or separating a group of individuals from among the larger group, aggregation or population of which they are part, on the basis of difference in one or more recognised characteristics.

Selectivity - The intensity with which the process of selection operates; the degree to which a particular process is selective.

Length Selection Curve - The relationship between the percentage of fish retained by, or escaping from, the meshes and the length of the fish.

50% Retention Length (=50% point) - The length of fish at which, for any specified mesh size, 50% are retained and 50% escape.

25 - 75% Length Selection Range (S.R.) - The range of length of fish between the 25% and 75% retention lengths.

Selection factor (S.F.) - The ratio of the 50% retention length to the mesh size, both dimensions being in the same units.

Mesh size - The distance between the inside edges of opposite corners of a mesh when it is stretched so that its sides lie parallel to each other. (See para. 3.1.4).

3. TRAWL AND SEINE COD-END MESH SELECTION

3.1 Experimental techniques for selectivity measurement

In the course of cod-end mesh selectivity experiments conducted in different parts of the world over many years a variety of experimental techniques has been used. However, these fall into two main categories known generally as the "covered cod-end" and "alternate hauls" methods respectively. In this report, therefore, only the broad features of these two methods are considered. Only selectivity by gears towed on the bottom is dealt with in this report.

3.1.1. Covered cod-end method

A cod-end cover is an arrangement of small-meshed netting attached to the cod-end in such a way as to retain fish which have escaped through the cod-end meshes. A cover may envelop the whole cod-end or it may be attached only over the top side of the cod-end. The method measures the selection of those fish escaping from the covered part of the cod-end. It has the merits of being fairly easy and convenient to do and of being direct and capable of yielding a result from a single haul. However, it has been criticised because the cover may interfere with escape and thus give rise to biased results.

Among possible ways in which this bias could be caused the following are listed:

(a) Actual masking of mesh openings by the cover netting lying close to the cod-end. This might reduce the effective selecting area of the cod-end to a small part of it (Davis, 1934; Jones, 1958).

(b) Return of fish from the cover to the cod-end.

The frequency of this is unknown, but in some mesh experiments fish have been seen to be meshed in covered cod-end netting with their heads pointing into the cod-end.

(c) Change of flow.

The presence of the cover may change the flow of water and so affect the passage of fish through the covered part of the cod-end.

(d) Cover catch size.

The presence of fish in the cover may affect escapes from the cod-end. In this respect the ratio of cover catch size to cod-end catch size may be a more important feature than the cover catch alone.

3.1.1.1. Cover construction

Material - This should be as light and thin as possible and the use of covers made of synthetic twine belonging to such as the polyethylene group (e.g. Courlene, Nymplex) is recommended because these materials are naturally bouyant in sea water. Experimental evidence is available which indicates that higher selection is obtained with covers made of Courlene than with covers of cotton (Jones, 1958; Pope, personal communication).

Mesh size - This should be chosen as large as possible consistent with the requirement that fish of the smallest size usually retained in the cod-end cannot escape through the cover. In practice, a cover mesh size of about one-third to one-half that in the cod-end will usually be suitable.

Design - The merits of a whole cover (i.e. one which completely envelopes the cod-end) as against a top cover (i.e. one which covers only the top half of the cod-end) are illustrated by results obtained by several authors (Boerema, 1958a; Cieglewicz and Strzyzewski, 1958; Pope, unpubl. and Treschev, unpubl.). It is recommended that wherever practical a whole cover should be used.

Some escapes of fish may occur through the underside of the cod-end. Estimates of the proportion of all escapes that occur through the underside have been variable, e.g. Treschev (unpubl.) 3% for cod in Arctic trawls, Cieglewicz and Strzyzewski (1958) 17-72% for cod in Baltic trawls, Gilis (unpubl.) 33-52% for soles and 5-13% for whiting in Southern North Sea trawls. It is to be expected that this would vary between species and between trawls of different construction. When only the top side of the cod-end is covered, escapes may occur through the underside and selection will be affected by an amount which will not always be accurately known and which may not always be constant. By lining the underside of the cod-end with small-meshed netting to prevent underside escapes ('blinding'), the opportunity afforded fish to escape is limited and so the measured selectivity may be lower then with alternate hauls without underside blinders. On balance it is thought that the advantages of blinding the underside of the cod-end to ensure that the top cover takes all escaping fish will outweigh the disadvantages introduced by reducing the available escape area. It is accordingly also recommended that in covered cod-end experiments using a top cover the underside of the cod-end shall be lined with small-meshed netting. Further study of differences between whole and top covers is desired.

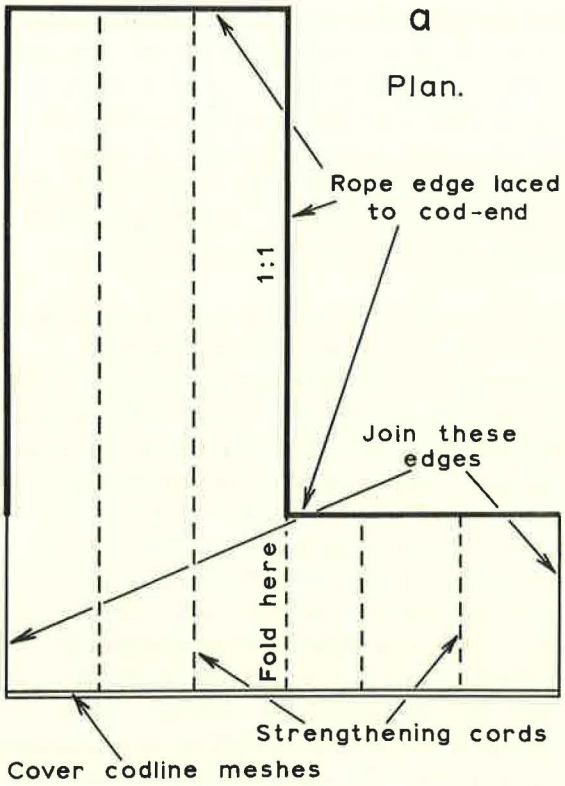

Figure 10

Construction and fixing plan for cod-end top-side cover.

(a) Small-meshed netting cut-out and construction plan. Ratios indicated are of stretched length and width, cover netting to cod-end netting.

(b) Diagram of cover ready for attachment to cod-end.

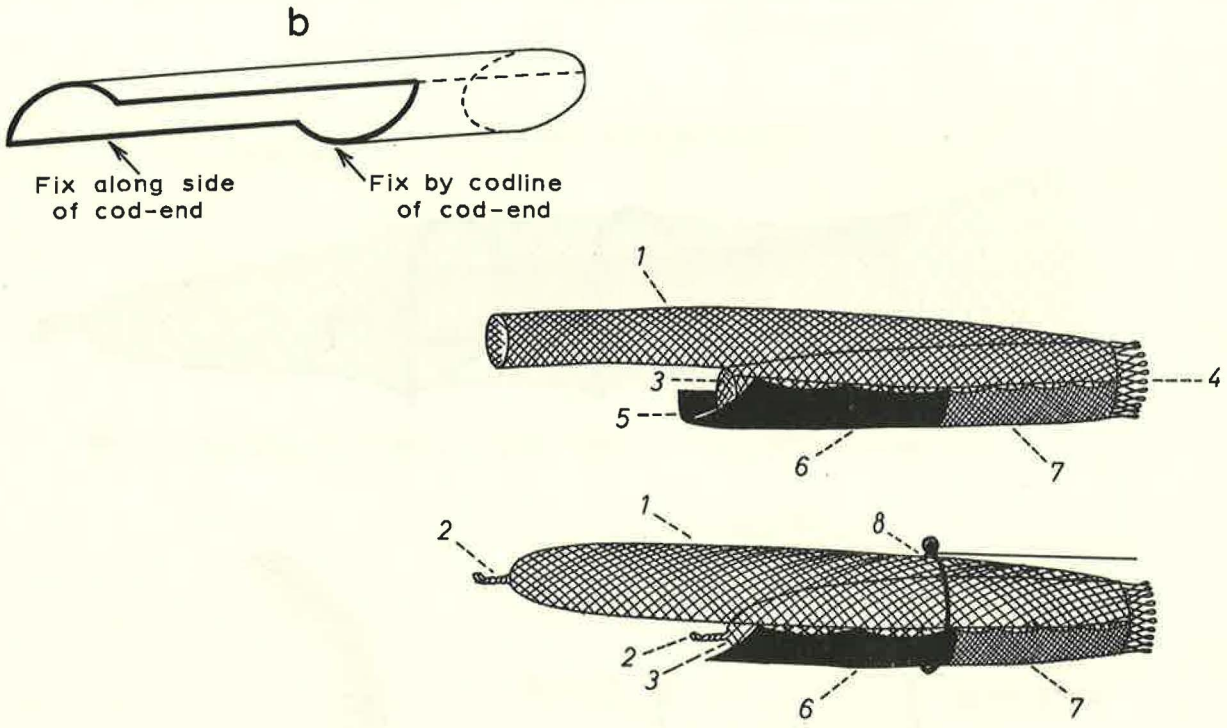

Figure 11 Diagram of attachment of cod-end top-side cover to cod-end, showing other essential ancillary rigging of cod-end. (1) Top-side cover, (2) cover and cod-end cod-lines, (3) cod-end, (4) forward edge of cod-end with rings for quick attachment to net belly, (5) small-meshed blinder of cod-line meshes and knot, (6) hide chafer beneath cod-end, (7) small-meshed blinder on inside of bottom side of cod-end, (8) splitting strap with float.

The cover should extend at least one metre and preferably two metres beyond the end of the cod-end and be about one and a half times as wide as the widest part of the cod-end when fishing. In practice the extension will be found to be limited chiefly by the ability of the ship and crew to handle it when hauling the gear in board. If large catches are expected it is advisable to strengthen the cover with ropes. A design which has proved satisfactory is shown in Figures 10 and 11.

The forward end of the cover should be attached in such a way as to allow it to float freely above the entire covered length of the cod-end (Boerema, 1958 and Cassie, 1955). The use of supporting hoops inside the cover has merits (Boerema, 1958) but requires very careful rigging when the cover is over only the top side of the cod-end, because such hoops could interfere with the normal action of the cod-end. Figure 12 illustrates a whole cover with hoops used on fine grounds by the Netherlands. When a splitting strop is attached to the cod-end it can interfere with the cover and thus with the apparent selectivity result. This has been demonstrated in the deep-water trawl fisheries where the splitting strop is heavy, made of combination wire (Saetersdal, 1960). Thus when the splitting strop cannot be dispensed with every attempt should be made to give it buoyancy. Towards this end the employment of polypropylene, polyethylene or other buoyant ropes or the attachment of effective floats or elevators will be helpful; the most effective lifting devices will probably be hydrodynamical.

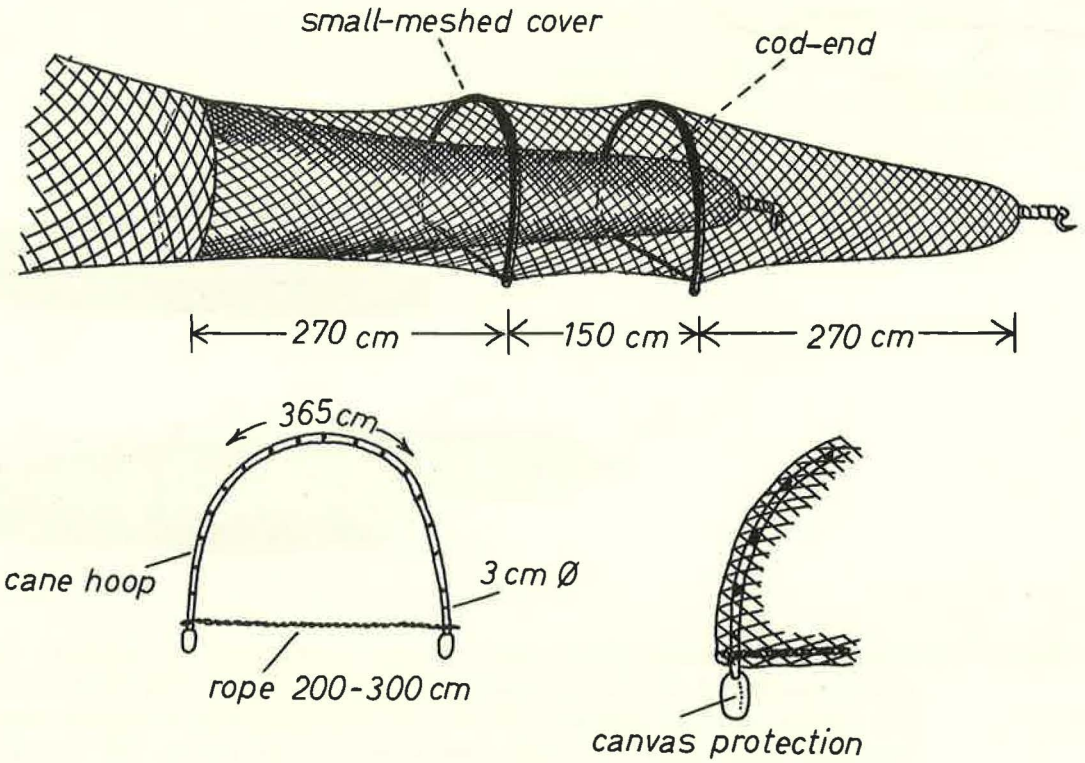

Figure 12 Diagram of rigging of whole cod-end cover with cane hoops

3.1.2. Alternate haul method

The essential feature of this method is the comparison of the length frequency distributions of the fish taken by cod-ends of different mesh size (the cod-end under investigations and another of a smaller mesh size whose selectivity is known or is mostly outside the selection range of the experimental one), either with the different nets fished side by side on two ships of comparable size and power (parallel hauls) or with the same or different nets fished from the same ship in a series of hauls. The term alternate hauls as generally used embraces series in which the cod-ends are used strictly alternately one after the other, series in which the order of use of the cod-ends is randomised, and parallel hauls. A variant of this method known as the "trouser" cod-end method involves the use on one set of gear of a special double cod-end, the two parts of which have different mesh sizes.

The special merit of the alternate haul method is that it is free from the biases caused by the use of a cover and it measures the changes in selectivity with changes in mesh that would occur in normal fishing practice. Its results will be more realistic, provided that it can be carried out sufficiently rigorously to minimise experimental errors. However, the method has a number of disadvantages which must be taken into consideration in the planning of experimental selectivity work. The following are of importance: (a) it is more costly and time-consuming than the covered cod-end method, usually requiring a very much larger series of hauls; (b) the results are not independent of the fishing power of the gear; this has proved a formidable difficulty in many instances, since increases in mesh size have been found to be associated with increases in the catch of fish above the selection range. Some methods of allowing for it have been devised but it is not clear that the correction factors are applicable over the selection range (Section 3.1.6). This disadvantage probably does not apply to the "trouser" cod-end method which, however, has other inherent deficiencies but which has not received such detailed attention as the more conventional alternate haul method.

3.1.3. Comparison of results from covered cod-end and alternate haul experiments

Because of its smaller demands on time and cost the covered cod-end method will generally prove the most convenient and economical method to use. The inaccuracies of the results from it will be governed by the magnitude of the cover biases. If these biases are large they will usually be revealed from a comparison of the cod-end catches from relatively small numbers of hauls with the cod-end covered and uncovered. It is therefore recommended that in using the covered cod-end method some of the early hauls at least should be made with the cod-end uncovered in order to gauge the order of magnitude of the covered bias.

The bias in covered cod-end experiments has usually been found to be towards lowering selectivity. Where the magnitude of the bias is constant and known a correction can be applied to the covered cod-end results.

3.1.4. Mesh measurement

The longitudinal pressure gauge with a locking device has been generally found to be the most satisfactory. Several longitudinal pressure gauges are already in existance and other gauges are being designed

which may be equally suitable for scientific work.

In view of the need for exact comparability of mesh measurements in mesh selection work it is recommended that all gauges used be calibrated against one type chosen as standard. While improved gauges are still being developed the agreed standard for the time being is the 1959 Westhoff model. (Rapp. Cons. Explor. Mer, 1959).

Attention is drawn to the fact that appropriate longitudinal pressures for particular cod-end materials have not been decided upon. For double manila, double hemp, double cotton and thick single manila, as used in trawl cod-ends, a pressure of 4 kg appears to be the most suitable for the suggested standard gauge. Less pressure will be needed for lighter, thinner twines, but more information is required about the appropriate gauge loading for them. Mesh gauge loading should be specified when presenting measurements.

It has been demonstrated that most fish escaping from the cod-end do so through the meshes in the after part of the cod-end (Beverton, 1957; von Brandt, 1960a; Clarke, 1963; Cieglewicz and Strzyzewski, 1958). Under most fishing conditions the catch occupies no more than the after half of the cod-end. After some use the meshes in the after part may be found to be bigger than those in the forward part (Margetts et al.,1964). It is recommended that the meshes to be measured should be in straight lines running fore and aft along the top side of the after half of the cod-end, not near the selvedges, starting from the third row after the cod line. Meshes adjacent to strengthening ropes, meshes with joins on the bars and meshes in repaired parts of the cod-end should not be measured. Cod-end measurements should be made immediately after every haul to enable any trend in mean size with time to be detected and measured.

The number of meshes to be measured should not be fixed arbitrarily, because the minimum number to be measured depends on the desired accuracy of the average and on the standard deviation of the mesh size, which will vary with cod-end construction and usage. It will usually be necessary that the mean mesh size be determined with an error of not more than 2%. To this end, if the observed 95% range of meshes is 20 mm and the average required to within 2 mm of the true value, measurement of about 25 meshes will usually be sufficient. If the number of meshes in one line is not sufficient a complete second line should be measured.

In quoting mesh sizes in scientific reports the number of measurements and the standard error of the mean size should be included as well as the average mesh size and range.

3.1.5. Fish measurement

The dimension which determines whether or not a fish shall escape from a cod-end is usually the maximum body girth (Margetts, 1957; Messtorff, 1958). For roundfish this will be either the head girth or the natural body girth at the time of capture, whichever is the greater. The latter should be measured as the unconstricted body girth. In some circumstances this should be measured with the air bladder punctured. For practical purposes, however, selection is always referred to the length of the fish and this should continue. In collecting selection data, sizes should be measured to the nearest cm, and the dimensions used (total length or fork length) should be stated (Pope, 1957).

Studies should be continued of girth/length relationships, with particular reference to the effect of feeding and maturity conditions and sex of the fish. These should always be reported in this connection.

3.1.6. Analysis of data

3.1.6.1. Methods of estimation

The simplest method of fitting a selection curve is by eye. Although practice brings with it a certain amount of skill in drawing selection curves by eye, no two people are likely to draw the same curve to any given set of data and this method provides no estimate of the error of fitting. Results obtained in this way cannot, therefore, be accurately compared. Numerical methods of fitting all or part of a selection curve are therefore to be preferred.

A simple numerical method of estimating the 50% point is that described by Thompson (1947). The method consists of calculating moving averages of the percentage escaping (p) and the corresponding lengths (l) and using linear interpolation in the resulting series to find the 50% length. Thus, if p_1, p_2.... are the percentages escaping at lengths l_1, l_2 .... and if 3-point moving averages are used, a series of p's and l's are calculated as follows:

$$\overline{p_2} = (p_1 + p_2 + p_3)/3 \qquad \overline{l_2} = (l_1 + l_2 + l_3)/3$$

$$\overline{p_3} = (p_2 + p_3 + p_4)/3 \qquad \overline{l_3} = (l_2 + l_3 + l_4)/3$$

The 50% point is found by linear interpolation in the series of $\overline{l}$'s. Thus if, for example, $\overline{p}_i = 65\%$, $\overline{l}_i = 25.5$ cm, and $\overline{p}_{i+1} = 43\%$, $l_{i+1} = 27.5$ cm, the 50% length is estimated as 26.9 cm. This method will be found to be generally satisfactory but it should not be used for estimating lengths other than 50% length.

The variance of this estimate of the 50% length is given approximately by

$$V(l_{50}) = f^2\left[\frac{p_{i-1}q_{i-1}}{n_{i+1}-1} + \frac{p_i q_i}{n_i - 1} + \frac{p_{i+1}q_{i+1}}{n_{i+1} - 1} + \frac{(1-f^2)}{1}\frac{p_{i+2}q_{i+2}}{n_{i+2} - 1}\right]\frac{d^2}{p_{i-1} - p_{i+2})^2}$$

$$\text{where } f = \frac{p_i + p_{i+1} + p_{i+2} - 150}{p_{i+2} - p_{i-1}}$$

If the whole curve is to be fitted mathematically it is necessary to make an assumption about its true form, such as that it is a normal frequency distribution ogive (Buchanan-Wollaston, 1927) or a logarithmic curve (Pope et al, 1964). A description of the method of fitting such curves is too long to be given here but reference may be made to, for example, Finney (1952), Berkson (1957).

No unbiased methods as simple as the moving average method have been found for estimating the 25% and 75% points, and so where fully mathematical methods are not employed reliance must at present be placed on graphical estimation. The use of special graph paper, e.g. arithmetic probability paper and logistic graph paper, in fitting selection curves by eye is recommended.

Before estimating the 50% length or fitting the selection curve to data from alternative haul experiments it may be necessary to make adjustments to allow for any observed difference in the catches of the fish above the full selection range of the cod-end with the larger mesh size. The reasons for any such difference, which is commonly observed,, are not fully understood, but often one reason will be chance variations in the catches, especially when only a few hauls are made; this can be allowed for by equalising the total numbers of fish above the selection range and adjusting the numbers within the selection range by the same ratio. Another reason, for which there is some evidence, is that change of cod-mesh size affects the fishing power of the trawl; if any change in fishing power is non-selective on size of fish then adjustment to equal numbers above the selection range will be satisfactory, but if it is selective, e.g. bigger meshes catching more of the bigger fish, then such simple adjustment is not satisfactory and the study becomes one of whole trawl selection, not just cod-end mesh selection. Adjustments to meet various situations which may arise have been devised (Beverton & Holt, 1957; Herrington, 1933) but, owing to the large sampling variation often encountered in alternate haul experiments it will often be difficult to decide which type of adjustment should be applied in any particular situation. This major drawback to the alternate haul method was appreciated by Beverton & Holt who suggested that the selection curve of a cod-end might be more precisely determined by also comparing it with a cod-end whose mesh size is only slightly (5-10 mm) smaller, giving a method of handling data so obtained. The methods of Beverton and Holt have not been sufficiently widely used up to the present and it is recommended that further studies of methods of analysis be made.

The decision as to whether or not the data from a haul in a covered cod-end experiment or from a pair of hauls in an alternate haul experiment should be used or discarded is not an easy one to make. A mathematical treatment of the problem is possible but is not likely to be practicable. Accordingly, unless it is absolutely impossible all required parameters (e.g. for the 50% length, 25-75% selection range) should be estimated and subsequently rejected only if they give extreme values. Others should not be rejected subjectively but by some recognized objective criteria (see for example Dixon, 1950).

3.1.6.2. Combination of estimates

The practice when handling observations from several hauls taken during a single experiment by a research vessel is to combine all hauls to produce a single selection curve. This curve may be regarded as a commercial average. In using such a type of curve no estimate of haul-to-haul variability is obtained and for this reason it is recommended that, whenever possible, data should be analysed by individual hauls.

If 50% points are estimated from individual hauls in any one cruise the variation between those estimates may be used to assess limits within which the 50% length for that experimental situation lies.

In arriving at a single figure for the 50% length it is desirable to attach most importance to the values that are most reliable and so some form of weighted mean is usually to be preferred. If $l_1, l_2 \ldots\ldots, l_k$ are k unbiased estimates of the 50% length with true sampling variance $v_1, v_2 \ldots\ldots, v_k$ respectively and if $w_i = 1/v_i$ then

$$\bar{l} = \Sigma\, w_i l_i / \Sigma\, w_i$$

is also unbiased and has a smaller variance than any other average of the l_i.

It is, of course, necessary to be sure that the l_i are homogeneous before combining them in this way. If there are real differences between the l_i it may be more appropriate to combine them in some other way or perhaps not even combine them at all. A test of the homogeneity of the estimates is provided by calculating the quantity

$$\chi^2_{(k-1)} = \Sigma\, w_i l_i^2 - (\Sigma\, w_i l_i)^2 / \Sigma\, w_i$$

If the estimates are homogeneous this quantity will be distributed as χ^2 for (k-1) degrees of freedom and so will exceed the tabulated 5% value of χ^2 only five times in 100 by chance. Values greater than this may be taken as indicating non-homogeneity of the estimates. When estimates of the v_i are employed this quantity will only be approximately distributed as χ^2.

Where a χ^2 test indicates non-homogeneity of the estimates in an experiment in one locality it may be possible to arrange the estimates into groups within which they are homogeneous. Weighted means within these groups may then be calculated as described. If one final overall estimate for the experiment is required it seems best, unless there is information to the contrary, to use an unweighted mean of these group means and calculate its standard error from the unweighted sum of squares.

Again, when combining estimates from several sources, unless the causes for non-homogeneity are clear and the pattern of non-homogeneity known in the commercial fishery to which the results are to be applied, an unweighted mean is the only safe estimate.

3.1.7. Miscellaneous

3.1.7.1.

A cod-end when new may give different selection from that which is produced after some use, due to changes in mesh size arising from stretching, shrinkage, knot tightening, etc. New cod-ends should, if possible, be pre-stretched and should be immersed in sea water before use so as to reduce initial mesh size changes. The age and condition of cod-ends used (e.g. number of hours of previous use) should be given in reporting results.

3.1.7.2.

The range of variation of mesh size in the experimental cod-end should, because of its effect on the selection range, be similar to that found in cod-ends used in the commercial fishery to which the results are to be applied.

3.1.7.3.

The cod-end and cover should be checked for damage after every haul.

3.1.7.4.

In experiments involving frequent changes of cod-end the use of plastic rings between trawl and cod-end is recommended in order to facilitate the changes (von Brandt, Kreuzer and Messtorff, 1958).

3.1.7.5.

Meshed fish should be treated as part of the cod-end catch for mesh selection purposes, although sometimes it may be necessary to record them separately.

3.2. Factors other than mesh size affecting cod-end selection

While the principal factor governing the sizes of fish which escape from the cod-end is the effective mesh size, experience has shown that some factors other than mesh size may also play an important part and give rise to differences in selectivity between cod-ends having the same mesh size. The identification and measurement of these factors is of importance in guiding the planning and conduct of selectivity experiments. In addition some of them are important in relation to the regulation of mesh size for fishery conservation.

3.2.1. Netting material and construction

A feature of extensive mesh selection work in the North Atlantic and other areas has been the marked selectivity differences, for some species, between cod-ends made from different materials. For example, cod-ends made from cotton, hemp and polyamide and polyester synthetic fibre twines have been found to have higher selectivities than those made from manila and sisal twines, the selectivity of polyamide cod-ends being 10-15% higher (amongst others, Graham et al., 1954; Lucas et al., 1954; von Brandt, 1956 and 1960a; Boerema, 1958; Cieglewicz and Strzyzewski, 1959; Margetts et al., 1964; Pope et al., 1964). These differences have given rise to the "Light Trawl" problem in the Permanent Commission area, which relates to the differential selectivity between nets of different twines and constructions. The measurement of the differential selectivity is of major importance for determining the appropriate mesh size to ensure the same selectivity in nets of all materials (see reports of Comparative Fishing Committee, 1955 onwards, and Reports of Liaison Committee).

While the results of experiments with many of the materials and twines in use in the North Atlantic commercial fisheries have provided some estimates of the magnitude of the differential selectivity from which this determination can be made, as yet no single property of the material or twine has been identified as the chief causative agent. It is in fact most likely that it is due to a combination of physical properties, which together affect the dynamics and performance of the cod-end during fishing, and the form and behaviour of the fish. These properties may not be determined solely by the material of the twine but also by its construction, preparation, etc. (Jensen, 1949; Roessingh, 1959; Ottèrlind, 1960).

In view of the wide and ever-growing range of materials and treated twines in use in the commercial fisheries and the need for a closer understanding of the mechanism of the selectivity differences between them, it is recommended that detailed examination and measurement should be made of the nature and physical properties of the twines and netting used in selectivity experiments. This information should be reported along with the results of the experiments. The following items are considered relevant:-

(a) Fibre: Kind of material (natural or synthetic, mono-filament, multi-filament, staple, continuous).

(b) Twine construction: Twisted or plaited (number of strands).

(c) Yarn number: Tex number.

(d) Number of ply.

(e) Lay: Number of turns per unit length.

(f) Runnage: Length of whole twine per unit weight.

(g) Diameter.

(h) Braiding: Single or double twine.

(i) Coarseness.

(j) Preparation: Treatment of basic fibre (tarring, coating, etc).

(k) Flexibility: Resistance to deformation.

(l) Extensibility: Elastic properties.

(m) Strength: Wet knotted strength.

For some of these properties (for example, coarseness, elastic properties, flexibility) no standard methods of measurement are at present available, but attention is drawn to a compilation of test methods used throughout the world (von Brandt, 1960b).*

3.2.2. Catch size

The size of the catch and the species composition in both the cod-ends and cover may play important roles in mesh selection (Beverton, 1963; Clark, 1963; McCracken, 1963 and Margetts et al., 1964). Information on the number and weight of each species of fish and the by-catch (benthos, jellyfish, etc) should, therefore, be collected and reported separately for cod-end and cover. The number of fish in the 25-75% selection range of the particular species whose selection is being studied should be reported.

Some results from covered cod-end experiments indicate that cod-end selection is reduced with large hauls (Margetts et al., 1964; von Brandt, 1960a) although others (Clark, 1963) do not show such an effect. If this is not attributable to cover effects, it could be due to a change in the cod-end mesh shape, changes in behaviour of fish with bigger catches, or blocking of meshes.

3.2.3. Fish shape

The selectivity data for different populations of a species (for example, Barents Sea and North Sea cod) can differ from one another. Local differences may also be observed. Such differences may be due to a varying girth/length relationship between areas (Section 3.1.5.).

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* Assistance in making the necessary tests has been kindly offered by the Institut für Netzforschung, Hamburg, and by the Nederlands Visserij-Proefstation, Utrecht.

3.2.4. Rigging of gear, including specially designed savings gears

To improve the selectivity of cod-ends a number of attempts have been made to arrange for the meshes to take up a shape which allows fish to escape more readily. Of the new designs tested many have proved unworkable from the practicable point of view even if resulting in improved selection (Ridderstadt, 1915; Tesch, 1930; Clark 1963; von Brandt, 1958; Treschev, 1957). A recent exception has been the rigging of the trawl with lastrich lines from the wing end to the cod-line, which Bohl (1960) has shown to be simple in use and rigging and to appreciably raise the selectivity of an ordinary cod-end, presumably by affecting mesh shape.

Attachments to the cod-end such as flappers and chafing gear (protective hides and netting) may affect selectivity, dependent upon the manner of rigging. It has been shown, however, that topside chafers consisting of netting laced tightly over the cod-end reduce selectivity but that chafers constructed according to the ICNAF specifications (Saetersdal, 1958), as well as a modified form which consists of a series of flaps or netting attached at intervals along the cod-end, have no appreciable effect on cod-end selectivity (Beverton, 1959; Saetersdal, 1960).

3.2.5. Characteristics of vessel and gear

In addition to the construction and rigging of the cod-end itself the cod-end selectivity may also be affected by the design and rigging of the gear as a whole and the size and power of the vessel as a result of either its direct influence on the operation of the cod-end (its flow, mesh shape, hydrodynamic forces) or indirectly through its effect on the size and composition of the catch, towing speed, etc. Most results so far obtained show that these factors in themselves do not have an important effect on cod-end selection (Margetts et al., 1964). However, in conducting cod-end mesh selection experiments involving different fishing units, account should be taken of the main features of the gear and the towing power of the vessel.

3.2.6. Towing speed

Present available evidence is not conclusive but there are some data that indicate an effect of towing speed on cod-end selection. Data obtained by Saetersdal (1958 and 1960) show a depression of selection factor with increasing towing speed for Arctic cod. Variation of towing speeds is chiefly of interest as an experimental variable because in many fisheries the towing speed of commercial vessels is fairly constant, although characteristic differences may occur between fleets from different countries. It is recommended that for obtaining selection data for application to fisheries management, towing speed should be as near as possible to the relevant practice. The towing speed should be recorded.

3.2.7. Duration of tow

Results from research bearing on this subject indicate that escapement increases with the duration of tow (Clark, 1963; and Beverton, 1959). This factor, however, is closely linked with the size and composition of the catch and it is to be expected that when changes in the duration of tow are accompanied by changes in the size of catch, two factors may operate together, thus masking the duration of tow effect. It is recommended that complete information on tow duration should always be included in presentation of results.

It is advisable, in mesh experiments, to use the same length of tow as is used in the relevant commercial fishery, but if a relation between selectivity and tow duration can be established then some experiments can, with advantage, be made with shorter tows.

3.2.8. Other factors

The factors enumerated above either change the hydrodynamic forces acting on the cod-end or affect the orientation and behaviour of the fish in it. Effects on one or other of these processes may also be brought about by a number of other factors, amongst which are:

(a) Depth, temperature, currents, sea swell, light intensity and weather (Margetts, 1954; Roessingh, 1960; Woodhead, 1960). These factors may have an influence on the orientation and behaviour of fish through their effects on vision or activity and on the "washing out" of the cod-end during hauling in.

(b) The presence of other species in the catch. Predatory species in the cod-end may influence the behaviour and activity of prey species (Clark, 1963).

(c) The nature of the fishing grounds. Selection on grounds where the bottom is sandy may be different from that on grounds where the bottom is muddy (Roessingh, and Gilis, pers. comm.).

At present, little is known of the magnitude of the effect of these factors, and it is recommended that further attention should be paid to them. Underwater observation techniques may prove of particular value in this work.

PRESENTATION OF DATA

In reporting the results of mesh selection experiments all information on the relevant items discussed in paras. 3.1. and 3.2. should be given. For the convenience of other workers and to permit a quick appraisal of the data it is recommended that all reports and papers should contain, in tabular form, a list comprising the following items:

Item	Units
Ship (including length and horse-power)	
Gear (design and material)	
Date	
Locality	
Cod-end material (including runnage, braiding, preparation)	
Mesh size (standardised)	Mean: to nearest mm Range: in mm s.e. of mean: to nearest 1/10 mm
Experimental method (covered cod-end, alternate hauls)	

Item	Units
Species	
50% retention length	to nearest mm
Selection factor	S. F. : 1 decimal place s. e. : 2 decimal places
25%-75% Selection range	to nearest mm
Number of fish of the species studied (cod-end, cover, S. R.)	
Average weight of all species (cod-end, cover)	kg
Number of hauls	
Average tow duration	hours and minutes
Towing speed (speed through the water)	knots.

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