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Selectivity of herring in bottom trawls

by

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Mesh selection experiments with the herring bottom trawl were carried out with the research vessel "Anton Dohrn" between August 7th and 9th, 1962 in the south-western area of Shetland (59°30'-59°44'N, 00°52'-01°11'W; depth of water 100-120 m). Originally it was intended to work with three "Perlon" cod-ends of different mesh sizes, but the meshes of two of them proved to be too small for selection purposes. Therefore, all the experiments had to be done with one cod-end only ("Perlon" continuous, double-braided, tex 2500, twisted, three-ply, 48.2 mm mesh opening).

The mesh measurements were made with the ICNAF gauge exerting a pressure of 4 kg. After each haul a row of 70 meshes marked at the upper side of the rear cod-end was measured.

The covered cod-end technique has been applied. A small-meshed cover made of Nylon Td 210 x 15 (28 mm mesh opening) enveloped the whole topside of the codend. The inner underside of the cod-end was blinded with the same netting used for the cover.

Altogether 55469 herring have been caught in nine rather successful hauls. The lengths of all the herring caught were measured with small and medium catches. In case of large catches, however, the length distributions of the total catches were calculated from representative samples (hauls No. 11 and 13).- The total number of length measurements amounted to 20799. It should be mentioned that the total lengths were taken and that the unit of measurement was the centimetre below.

It was possible to calculate the selection data for each haul separately. From Table 1 it can be seen that the nine selection factors are ranging from 4.1 to 4.6, but seven of them are concentrated upon the smaller range between 4.2 and 4.4. The table also demonstrates that the small number of hauls is not sufficient to give an accurate idea of any interdependence between the selection data on the one hand

and the catch size, catch composition or the duration of tow on the other hand.

Therefore, the hauls may be summarized and treated as a whole like in Table 2 C. But in order to eliminate the sources of error possibly caused by the conversion from samples to total catches, the hauls Nos. 11 and 13 were excluded (Table 2 B) and opposed to the remaining hauls (Table 2 A). The selection factors found for these three groups of hauls are 4.24 (group A), 4.40 (group B) and 4.34 (group C). These values are identical with those found during the same trip on the occasion of midwater trawling (comp. v.BRANDT, 1962) and very similar to those found by ZIJLSTRA (1957 and 1961) for herring bottom trawls with double-braided manila cod-ends (sf 4.13-4.23). The data given by STRZYZEWSKI (1961), however, are somewhat different. The author attributes the relatively low selection factors 3.7 for a steelon cod-end and 3.9 for a cotton cod-end to extraordinarily large quantities of meshed herring.

The problem of meshed herring has also been investigated. After each haul the length distribution and accordingly the amount of meshed individuals were ascertained. Only in the case of haul No.11 this could not be done because the meshed animals were crushed by the weight of the large catch.

As to the length composition of the meshed herring, Figure 1 makes it obvious that the lengths measured tally with the length distribution of the group of small juvenile herring (year class 1960) caught in the cod-end. From the group of larger-sized herring (maximum frequency at 29.5 cm, mainly year class 1956, maturity stages IV-V) no animals were found meshed.

The mean lengths of meshed herring and their standard errors calculated for each haul are compiled in Table 3. The table shows that the range of the means is very limited (21.41-22.11 cm). Furthermore, the table gives information about the differences between the mean length of meshed fish and the 50% retention length of each haul. By means of the selection curves it becomes clear that the mean lengths of meshed herring are identical with the 45-75% retention lengths. [The corresponding redfish data given by TEMPLEMAN, 1957 (95-100% length), v.BRANDT, 1960 (75-90% length) and BOHL,1961 (70-89% length) are considerably higher owing to the opercular spines of the redfish.]

When the number of herring caught in the cod-end (meshed individuals included) is assumed to be 100, the numbers of meshed herring are ranging between 9.8 and 24.6%. A detailed tabulation of these data completed with the duration of tow is given in Table 4.- The average frequency of meshed herring calculated for the combined hauls amounts to 16.7 of the herring retained by the cod-end. The corresponding values mentioned by other authors are 21%, 22% and 16% for manila cod-ends with 53 mm, 60 mm and 68 mm mesh openings (ZIJLSTRA, 1961), 20.3% for a 57 mm cotton cod-end and 40.2% for a 61 mm steelon cod-end (STRZYZEWSKI, 1961). These values, however, cannot be compared simply with each other, because the intensity of meshing does not only depend on the mesh size, but also on the net material, the length composition of the stock, the stage of maturity and other factors.

In the given instance the duration of tow is the most interesting factor. By plotting the relative frequency of meshed herring against the duration of tow (Fig.2 and Table 4) it becomes evident that the quantity of meshed herring increases with the increasing duration of tow. A "saturation effect", as mentioned by ZIJLSTRA (1961), cannot be observed within the given range of catch sizes. Furthermore, from the material sampled it cannot be concluded that the selection is to a remarkable degree handicapped by the blocking of cod-end meshes with meshed fish.

The natural maximum girths of 216 juvenile herring have been measured. The measurements were noted separately for the individuals caught in the cod-end and for those caught in the cover. The regression lines drawn in Fig. 3 demonstrate that the herring accumulated in the cover is, on an average, thinner than the herring of the same length retained by the cod-end.

By means of the average regression line and some simply calculations it is possible to determine the theoretical maximum selection factor and the percentage of utilization of the internal mesh circumference by herring at the 50% retention length. These data found for the different groups of hauls are compiled in Table 5.

The high percentages of the internal mesh perimeter utilized by the maximum girth of herring at the 50% retention length (91-95%) justify the assumption that the shape of cod-end meshes during fishing

is very suitable for the process of herring selection.

Finally, it should be mentioned that the meshes of the cod-end used in the experiments were only 8-10 mm larger than those of normally used cod-ends. It is well-known that the mesh opening of commercial cod-end does not cause any serious meshing problems, but this advantage is combined with a lack of mesh selection. So long, however, as the survival of herring escaped from the cod-end is not ensured, the failure of selection in commercial herring trawls hardly counts at all.

References

Bohl, H.	1961	German Mesh Selection Experiments on Redfish. ICES, C.M. 1961, No. 88
v.Brandt, A.	1960	Selection of redfish. ICES,C.M.1960,No.10
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Templeman, W.	1957	Redfish Meshing. Joint Sc.Meeting, S-43, Lisbon
Zijlstra, J.J.	1957	Mesh experiments with a herring trawl. ICES, C.M. 1957, No. ...
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Table 1

Quantities caught, duration of tow and selection data for each haul separately

Haul No.	4	6	7	8	9	10	11	12	13
Herring (baskets), cod-end/cover	1.0/0.3	2.8/0.3	0.5/0.3	6.5/0.7	1.3/0.2	6.3/1.8	31.5/12.5	5.5/0.2	17.3/8.0
By-catch [1] (baskets), cod-end/cover	-/-	2.7/-	0.3/0.5	3.3/-	1.0/-	1.0/-	10.5/-	8.5/0.3	1.7/-
Duration of tow (minutes)	60	90	105	70	120	60	85	90	120
Total number of herring	892	1198	321	2414	600	5309	29939	1920	12876
Number of herring in cod-end	611	964	191	2009	500	3858	19617	1776	6816
Number of herring in cover	281	234	130	405	100	1451	10322	144	6060
Number of herring in selection range	553	482	225	818	223	3304	23094	324	6583
50% retention length (cm)	20.5	20.7	21.3	20.8	20.2	20.4	20.5	20.6	22.1
Average mesh opening (mm)	48.2	48.3	48.6	48.3	48.9	48.2	47.8	47.7	47.6
Selection factor	4.25	4.29	4.38	4.31	4.13	4.23	4.29	4.32	4.64

[1]) The by-catches mainly consisted of small haddock, mackerel, whiting and spiny dogfish.

Table 2

Measuring rows and selection data for summarized hauls

Length cm	A. Haul No.4,6,7,8,9,10 and 12				B. Haul No. 11 and 13				C. All hauls			
	No. of herring in		Retained in cod-end		No. of herring in		Retained in cod-end		No. of herring in		Retained in cod-end	
	cod-end	cover	%	% smoothed	cod-end	cover	%	% smoothed	cod-end	cover	%	% smoothed
18.5	2	3				29	0.0	-	2	32	5.9	-
19.5	56	112	33.3	-	213	484	30.6	24.3	269	596	31.1	26.8
20.5	876	923	48.7	49.5	4228	5766	42.3	42.7	5104	6689	43.3	43.9
21.5	2676	1343	66.6	66.0	9843	7958	55.3	57.5	12519	9301	57.4	59.1
22.5	1658	348	82.7	81.7	5912	1971	75.0	72.3	7570	2319	76.5	74.2
23.5	351	15	95.9	92.9	1107	171	86.6	87.2	1458	186	88.7	88.4
24.5	71	-	100.0	98.6	273	-	100.0	95.5	344	-	100.0	96.2
25.5	55	-		100.0	135	-		100.0	190	-		100.0
26.5	61	-			241	-			302	-		
27.5	142	-			200	-			342	-		
28.5	973	-			1171	3			2144	3		
29.5	1833	1			2065				3898	1		
30.5	905				835				1740			
31.5	218				182				400			
32.5	31				28				59			
33.5	1								1			
Total	9909	2745			26433	16382			36342	19127		

	A. Haul No.4,6,7,8,9,10 and 12	B. Haul No. 11 and 13	C. All hauls
No. of herring in selection range	6026	33152	39077
Selection range (cm)	?	3.5	3.1
50% ret. length (cm)	20.5	21.0	20.9
Mesh opening (mm)	48.3	47.7	48.2
Selection factor	4.24	4.40	4.34

Table 3

Mean lengths of meshed herring and corresponding % retention points

Haul No.	No. of meshed herring	Mean length of meshed herring ± standard errors	Difference mean length of meshed fish minus 50% retention length[1] (cm)	Corresponding % point of the selection curve
4	67	21.41 ± 0.09	+ 0.91	70
6	96	21.49 ± 0.10	+ 0.79	65
7	44	21.07 ± 0.13	- 0.23	45
8	197	21.74 ± 0.05	+ 0.94	67
9	111	21.56 ± 0.07	+ 1.36	75
10	549	21.95 ± 0.10	+ 1.55	74
12	58	21.90 ± 0.10	+ 1.30	71
13	1676	22.11 ± 0.02	+ 0.01	50

[1]) Compare Table 1.

Table 4

Relative frequencies of meshed herring and duration of tow

Haul No.[1])	No. of herring caught in the cod-end (incl. No. of meshed herring)	Relative frequency of meshed herring %	Duration of tow (minutes)
4	611	11.0	60
6	868	10.0	90
7	147	23.0	105
8	1812	9.8	70
9	389	22.2	120
10	3309	14.2	60
13	5140	24.6	120

[1]) The data of haul No. 12 (3.3% meshed fish within 90 minutes) were excluded, since in this case the process of meshing is supposed to be hindered by heavy damages in the trawl.

Table 5

Relation between natural girth and mesh selection of herring

Summarized hauls No.	4,6,7,8,9, 10 and 12	11 and 13	All hauls
Average mesh opening (mm)	48.3	47.7	48.2
Internal mesh perimeter (mm)[1])	102.6	101.4	102.4
50% retention length (cm)	20.5	21.0	20.9
Girth of fish at 50% ret.length (mm)	93.8	96.0	95.5
Percentage of internal mesh perimeter utilized by fish at 50% ret.length	91.4	94.7	93.3
Theoretical maximum selection factor[2])	4.68	4.64	4.68

[1]) The internal mesh perimeter (circumference) corresponds to twice the mesh opening plus twice the thickness of the plate of gauge (2 mm) plus 2 mm (owing to the fact that the mesh bars do not follow exactly the form of the gauge plate).

[2]) This value would be found if the girth of fish at 50% retention length and the internal mesh perimeter would be of the same size.

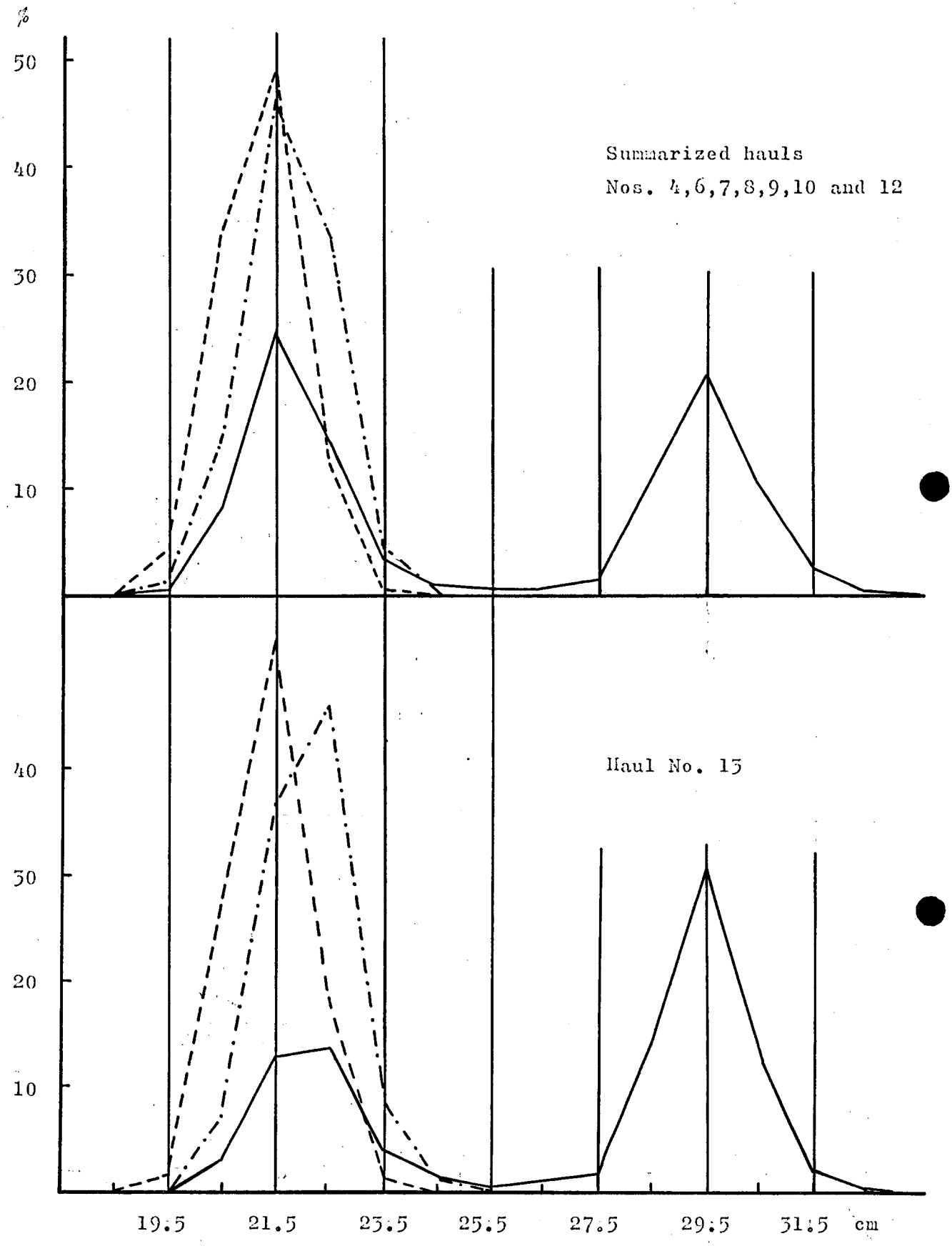

Fig.1: Length composition of herring catches in percent

——— cod-end
– – – – cover
—·—·— meshed fish

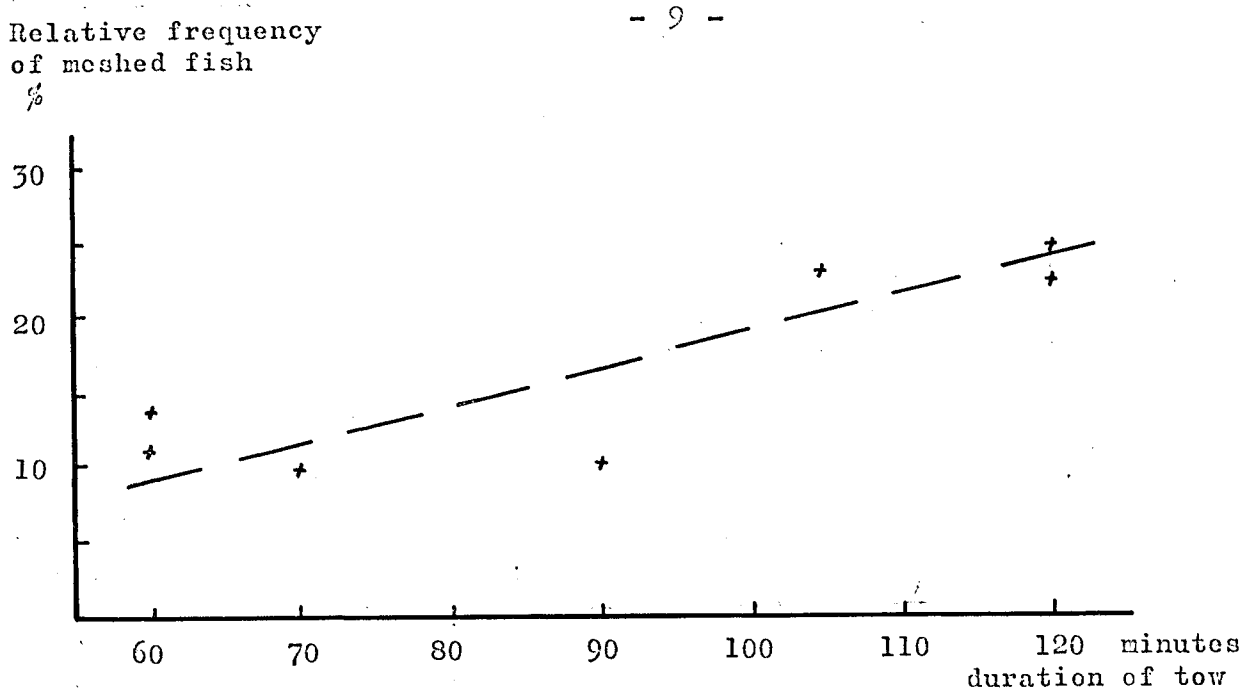

Fig.2: Relation between quantity of meshed herring and duration of tow

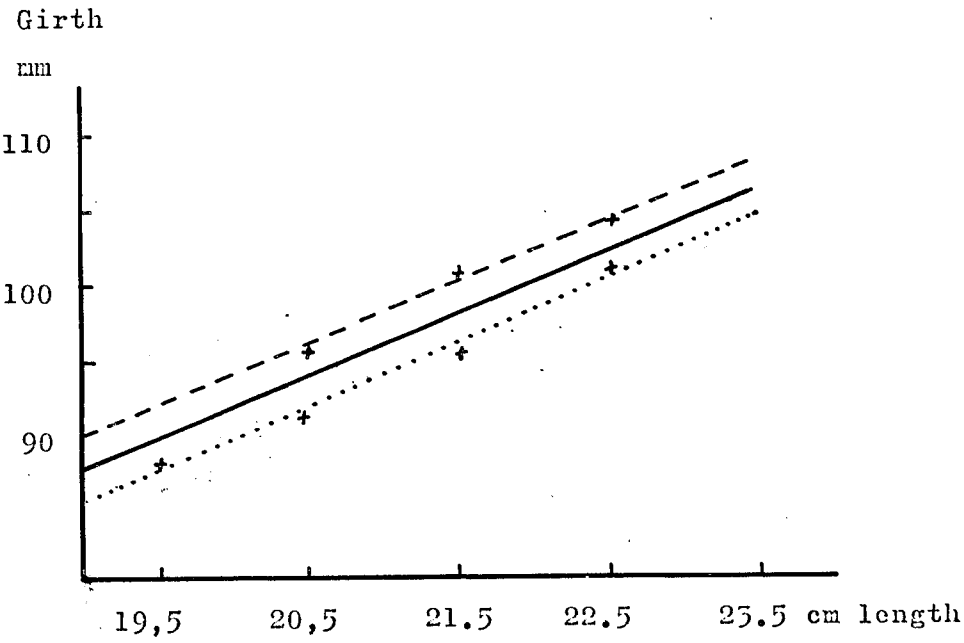

Fig.3: Relation between natural girth and total length

- - - herring caught in cod-end
..... herring caught in cover
——— average