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Summarized Data on Trawl Selectivity for the Redfish Fishery  
in the North Atlantic Areas

by

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Redfish ranks among the most important fishes taken with bottom trawls in the North Atlantic.

The redfish become often enmeshed in the trawls. Up to now there was no a common opinion of possibility of redfish fishery regulation by means of variations in the mesh size, although the special investigations had been carried out. The scientific investigations were undertaken by the research institutes of our country as well as by the international organizations regulated the fisheries in the North Atlantic, simultaneously.

First systematized experimental data on selectivity of trawls for the redfish fishery were submitted to the 1957 ICNAF/ICES/FAO Symposium in Lisbon by Templeman, McCracken, J. Clark and Saetersdal.

All authors conducted their experiments with the codends of double manila and mainly used the covering method. The conclusions in those papers chiefly resolve themselves into the following:

a) the selectivity coefficient is higher, when the mesh size is increased; however, the data obtained are insufficient to use the adjusted numerical values of this coefficient with confidence;

b) in general outline the selectivity coefficient is de-

pendent upon the catch volume.

In 1960 the results of investigations on the selectivity of redfish with trawl, conducted by A.Brandt in FRG, were published (Brandt, 1960). The investigations were carried out by the research vessel "Anton Dohrn" in the West Greenland area. The selectivity of trawls made of double manila, perlon and trevira was studied by the method of covering the codend.

The selectivity coefficient in relation to the catch volume varied as follows:

for the codend of double manila with the 129 mm mesh size it varied from 2.8 (the catch - 400 specimens) to 2.4 (the catch - 2 300 specimens);

for the codend of perlon with approximately the same mesh size it was equal to 3.3 at the catch of 200 specimens and to 2.7 at the catch of 900 specimens. Greater variations of selectivity coefficient were registered for the codend of trevira: 3.1 at the catch of 200 specimens and 2.2 at the catch of 2 500 specimens.

These data are only referred to *S.m.marinus* (L) species of redfish ("golden redfish") from the northwestern areas of the Atlantic Ocean.

Thus, the data collected earlier were insufficient to solve the problem of possibilities and measures of the redfish fishery regulation. In addition to that, on account of fishery intensity increase the necessity of developing the measures for rational exploitation of their stocks considerably raised.

In 1960, according to recommendations of the international organizations, A.I.Treschev developed the program of studying the trawl selectivity for the redfish fishery (Treschev, 1966). To determine the number and composition of the fishes lost an extra codend made of kapron net with a 80 mm internal mesh size was used. The lower part of the main codends investigated was covered inside with the kapron net of a 40 mm mesh size.

In April 1961 the refrigerating trawler "Sulin" sailed into the Kopytov Bank. The investigations on selectivity of double manila codends with the nominal mesh size of 110, 120 and 130 mm for beaked redfish (Shestov, 1962). The real mean mesh sizes of codends were equal to 116, 120 and 130 mm. The results of experiments are summarized in Table 1. The losses of redfish in the catch (in %) in relation to the total catch in the codend and covering are represented in Table 2.

In July-August 1962 the trawler "Goncharov" was directed into the area off Iceland aimed at condition of experimental investigations (Tršchev, 1966). The aims of researches were to specify the selectivity coefficients and to study the peculiarities of the meshing of redfish in trawls. Two codends were made: of double kapron (3mm x 2), B = 120 (117.8) mm and of double manila (4mm x 2), B = 110 mm (standard). The summarized results of experiments are given in Table 3.

Simultaneously with the Soviet trawler "Goncharov" operated in the investigations on the trawl selectivity, the research vessels "Maria Julia" (Iceland), "Ernst Holt" (UK), "A.T.Cameron" (Canada) and "Anton Dohrn" (FRG) participated. Besides, in other terms the Scotch vessel "Explorer" and Norwegian vessel "Johan Hjort" took part in the experimental works.

The main task of these experiments was to determine the selectivity coefficient of trawl codends made of different materials in relation to the main commercial objects, including the redfish.

Fishing gears aboard all the vessels were made of the netting with the 35-40 mm mesh size. The materials used were polyethylene, hemp or polyamide. In all cases, excluding the nylon codends used aboard the F.R.V. "Explorer" and R.V. "Johan Hjort" the lower side of codend was covered inside with the small-meshed netting. The main results of the experiments are given in Table 4.

In February-March 1963 the scientific group on board BMRT-409 "Cometa" carried out the experimental works on studying the selectivity of kapron trawl codends. The investigations were carried out in the areas off Labrador and Flemish Cap Bank. The generalised results of the experiments, conducted in these areas are shown in Table 5.

The use of semi-codend was not practically reflected on the selectivity coefficient value. However, the range of codend selectivity approximately double decreased. If it is considered that under the equal other conditions the number of fishes lost should be in proportion to the selectivity range, then this means, that inspite of constant selectivity coefficient, the escape of fish through the codend, covered with semi-codend should be respectively decreased ( $K_s = 2.7$  and  $K_s = 2.8$ ).

The main results of experiments on trawl selectivity for redfish fishery, undertaken by VNIRO in 1961-1963 by the method of covering are represented in Table 6.

As it is above-mentioned (Table 4) some foreign countries participated in the international experiments in 1962.

The results of later foreign investigations conducted by Bohl (1963, 1964, 1966, 1968), Brandt (1963), Beverton (1963), Bucki, Strzyzewski and Zdziebkowski (1968), Dardignac, Lozano-Cabo et al. (1967), Draganik and Zukowski (1967), Hodder (1963, 1964, 1965), Nédélec (1968) and others are presented in the paper by A.I. Treschev (Treschev, 1974). The experimental data obtained by all countries in North Atlantic up to 1969 are given in Table 7.

In July-September 1969 the RV "Walther Herwig" sailed into the areas off Iceland and Grand Newfoundland Bank (Bohl, 1970) to conduct the experimental researches. The aims of the experiments were to determine the factor of selectivity and to study the relationship between the meshing of redfish and the mesh size. The main results of experiments are given in Table 8.

In the period since 1970 throughout 1977 the data on trawl selectivity for redfish are not available. Mainly, the investigations were aimed at determination of selectivity factor for cod and haddock.

In March 1978 the RV "Krenometr" in the Bear Island - Spitsbergen area carried out the investigations on selectivity of trawl codends made of kapron with the mesh sizes of 110 mm and 120 mm. The real mean mesh sizes were 114.6 and 123.5 mm. While operating with the kapron codend of the 120 mm mesh size the losses of the beaked redfish in relation to number of the fish caught amounted 29.4% and to biomass - 24.9%. The selectivity curve is greatly stretched and selectivity range is in the limits of 10-20 cm. Selectivity coefficient obtained as a result of experiment was in the limits of 1.8-2.1. While using the codend with the mesh size of 110 mm the loss of fish by abundance amounted 5.3% and by biomass - 4.5%.

The parameters of selectivity of kapron codends with the mesh size of 120 and 110 mm, obtained aboard the RV "Krenometr" were lower than those calculated earlier by A.I. Tre-shev, V.P. Shestov and others. This was explained by the fact that the experiments were carried out on the dense concentrations of ~~immature~~ beaked redfish (the average catch per hour trawling was 1.5 t., that amounted about 4 thou. of specimens) with modal size of 31-32 cm. But it is well known that the size-age composition of the fishes caught and the catch volume considerably influence upon the selectivity of fishing gears.

#### Conclusions

1. Selectivity of kapron trawls for redfish is lower than that for Gadidae. It related with the meshing of redfish, different forms of cross section of fish body in the place of greatest girth, the difference in coefficients of friction between the mesh and fish surface, the availability of

spiny rays in the redfish dorsal fin, different efforts created by fishes, when they escape through the mesh.

2. On the basis of all the data represented it may lead to the conclusion that the size of the codend mesh in the limits of 110 mm is the most favourable than that of 120 mm. However, taking into account the fact, that the investigations conducted earlier dealt with the codends made of various materials differed by construction and carried out in different areas of the North Atlantic it is impossible to compare the results of investigations and draw the final conclusions concerning the problem of reasonable mesh reduction. It is necessary to investigate in addition the loss of redfish while trawling and setting up the trawl on board, and also the survival of fishes lost.

#### References

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Table 1. Summary of data on redfish selection in manila trawls with codends of different internal mesh sizes.

Parameters	110(116.0) mm		120(119.8) mm		130(130.3) mm	
	Male	Fem.	Male	Fem.	Male	Fem.
Number of trawl hauls	8	8	6	6	6	6
Number of fish caught	9372	1801	3357	1137	5295	744
Selection range (cm)	10.0	10.3	11.1	10.8	6.7	7.8
No. of fish in selection range	2882	652	3136	905	2983	360
Mean length at 50% selection (cm)	31.2	31.1	35.2	35.9	38.0	38.3
Selectivity coefficient	2.7	2.7	2.9	3.0	2.9	2.9

Table 2. Dependence of beaked redfish loss on catch volume and codend mesh size.

Catch volume (kg)	Codend 110 (116.0) mm		Codend 120 (119.8) mm		Codend 130 (130.3) mm	
	Spec.	Wt.	Spec.	Wt.	Spec.	Wt.
100	34.1	20.7	-	-	64.4	55.7
200	23.6	21.4	33.2	23.7	-	-
300	-	-	38.6	31.7	70.7	61.4
400	12.8	9.8	37.0	29.9	-	-
500	-	-	48.7	40.6	49.2	38.6
600	23.6	16.0	-	-	-	-
700	-	-	43.0	33.3	80.7	73.1
800	-	-	-	-	44.3	34.7
1000	-	-	-	-	73.5	63.0
1100	18.5	18.3	-	-	-	-
1500	10.4	7.7	-	-	-	-
2000	10.0	8.1	-	-	-	-

Table 3. Comparison of redfish selectivity in codends made of kapron and manila.

Parameters	Kapron 120 (117.8) mm (3 mm x 2)	Manila 110 (91.7) mm (4 mm x 2)
Number of hauls	5	5
No. of fish caught	1680	3124
No. in selection range	875	778
Mean 50% selection length (cm)	37.2	23.4
Selectivity coefficient	3.2	2.5
Selection range (cm)	11.0	9.2
No. fish meshed in forward parts	217	302
% of catch	12.9	9.7
No. fish meshed in codend	165	95
% of catch	9.8	3.0

Table 4. Summary of selectivity data from the international selection experiment in 1962.

Country, vessel	No. of sets	Codend material	Mesh size (mm)	50% length (cm)	Selec- tivity factor	Sel. range (mm)	No. of fish in selection range
USSR "Goncharov"	13	kapron	118	37.2	3.2	11	940
Norway "Johan Hjort"	12	manila	108	35.0	3.2	5	40
UK "Explorer"	3	nylon	89	24.1	2.7	6	130
	6	manila	112	24.8	2.2	7	90
	8	manila	127	27.5	2.2	16	4280
	3	manila	132	36.9	2.8	15	1330
FRG "Anton Dohrn"	17	perlon	132	38.5	2.9	16	20570
	7	perlon	143	43.9	3.1	15	2960
	11	manila	139	39.6	2.9	16	6350
	10	manila	149	46.9	3.1	15	4700

Table 5. Effect of semi-codend on selectivity of redfish.

Parameters	Double kapron 110(102.8) mm (3 mm x 2 with semi-codend)	Double kapron 110(107.2) mm (3 mm x 2, no semi-codend)
Number of hauls	8	7
No. of redfish caught	10613	15752
No. of fish in selection range	1751	4547
Mean 50% selection length (cm)	27.5	28.5
Selectivity coefficient	2.7	2.8
Selectivity range (cm)	3.2	7.2

Table 6. Results of selection experiments conducted by VNIRO in 1961-1963.

Vessel	Date	Area	No. of sets	Dura- tion (min)	Mean speed (knots)	Codend material	Mesh size (mm)	Mean C/hr (kg)	Total number of fish in codend cover	50% sel. len. (cm)	Selec- tivity coeff- icient	Selec- tivity range (cm)	No. of fish in selection range	Notes	
"Sulin"	Apr 1961	Barents Sea	8	90	3.2	Double	116.0	-	7950	1422	31.2	2.7	10.0	2882	Male
			8	90	3.2	manila	116.0	-	-	-	31.1	2.7	10.3	652	Female
			6	90	3.2	"	119.8	-	-	-	35.2	2.9	11.1	3136	Male
			6	90	3.2	"	119.8	-	-	-	35.9	3.0	10.8	905	Female
			6	90	3.2	"	130.3	-	-	-	38.0	2.9	6.7	2983	Male
6	90	3.2	"	130.3	-	-	-	38.3	2.9	7.8	360	Female			
"Goncharov"	Jul-Aug 1962	Iceland, SE	5	90	3.5	D. kapron	117.8	500	641	822	37.2	3.2	11.0	1461	(1)
		Greenland	5	90	3.5	D. manila	91.7	-	-	-	23.4	2.5	9.2	1385	
"Cometa"	Mar-Apr 1973	Labrador	8	60	4.0	D. kapron	102.8	1050	8509	2104	27.5	2.7	3.2	10613	(2)
		Flemish Cap	7	70	4.0	D. kapron	107.2	1700	12771	2981	28.5	2.8	7.2	15752	(3)

- (1) Number of fish in codend together with meshed fish  
(2) With semi-codend  
(3) Without semi-codend



Table 7. Summary of redfish selectivity data from various sources for different codend materials.

Author and experiment	Number of sets	Duration of haul (min)	Number of fish in selection range	Selectivity coefficient	Deviation from mean selectivity coefficient
<u>Double manila</u>					
Templeman, 1954-56 (Marinus)	6	30	10,384	2.7	0.2
	4	30	1,205	2.7	0.2
	10	30	3,472	2.1	-0.4
	17	30	11,930	2.6	0.1
	39	30	13,627	2.5	0.0
McCracken	10	150	17,374	2.2	-0.3
	10	150	19,725	2.4	-0.1
McCracken, 1954 (Priscilla)	8	60	691	2.5	0.0
	3	60	1,036	2.4	-0.1
	4	60	187	2.3	-0.2
McCracken, 1956 (Albatross)	2	60	1,798	2.4	-0.1
	8	60	11,113	2.2	-0.3
	4	60	2,018	2.2	-0.3
	3	30	782	2.6	0.1
Brandt, (Anton Dohrn)	5	60	1,552	2.4	-0.1
Saetersdal, 1956 (G. O. Sars)	1	30	987	2.6	0.1
	1	30	163	3.1	0.6
Saetersdal, 1957 (G. O. Sars)	1	60	192	2.8	0.3
Saetersdal, 1960 (Johan Hjort)	1	90	1,608	3.0	0.5
	1	90	2,637	2.9	0.4
Brandt, 1962 (Anton Dohrn)	11	108	6,350	2.9	0.4
	10	174	4,700	3.1	0.6
Margetts, 1962 (Explorer)	6	60	90	2.2	-0.3
	8	60	4,280	2.2	-0.3
Saetersdal (Johan Hjort)	3	60	1,330	2.8	0.3
	2	78	40	3.2	0.7
Treschev, 1961 (Sulin)	8	90	1,661	2.5	0.0
	8	90	579	2.7	0.2
	6	90	2,919	2.9	0.4
	6	90	850	3.0	0.5
	6	90	2,826	2.9	0.4
Treschev, 1962 (Goncharov)	6	90	376	2.9	0.4
	5	90	1,626	2.5	0.0
<u>Double polyamide A</u>					
Margetts, 1962 (Explorer)	3	60	130	2.7	-0.1
Treschev, 1962 (Goncharov)	3	60	940	3.2	0.4
Treschev, 1963 (Cometa)	7	66	15,752	2.7	-0.1
	8	60	10,613	2.7	-0.1
Strzyzewski, 1966	5	90	9,166	2.8	0.0
	3	90	36	2.9	0.1
	1	90	372	2.3	-0.5
Zdziebkowski, 1967	3	210	1,476	3.0	0.2
<u>Double polyamide B</u>					
Brandt, 1962 (Anton Dohrn)	17	102	20,570	2.9	0.0
	7	138	2,960	3.1	0.2
Brandt, 1957 (Anton Dohrn)	12	60	189	3.5	0.6
	11	60	260	3.3	0.4
Brandt, 1960 (Anton Dohrn)	7	60	2,184	3.1	0.2

Table 7. (Cont'd)

	<u>Manila</u>	<u>Polyamide A</u>	<u>Polyamide B</u>
Range of selectivity coefficients	1.1	0.9	0.6
Weighted mean selectivity coefficient	2.5	2.8	2.9
Deviation range of selectivity coefficient (%)	44.0	32.1	20.7

Table 8. Results of selectivity experiments with polyamide codends in different fishing areas of the North Atlantic in 1969.

Parameters	NW Iceland	Southwest-Iceland		Grand Bank (Div. 3L)	
Codend - material	Polyamide	Polyamide	Polyamide	Polyamide	Polyamide
- R-tex	R18,000	R18,000	R5,000	R18,000	R6,484
- No. of meshes measured	135	180	190	225	180
- mesh size range (mm)	114-140	113-136	131-151	112-135	128-147
- average mesh size (mm)	126.6	125.0	142.1	124.1	133.8
Date	31 Jul	6 Aug	7 Aug	13-14 Aug	15-16 Aug
Number of hauls	3	4	5	5	4
Duration of trawling (min)	60	120	132	120	113
Speed of trawling (knots)	4.7	4.6	4.6	4.5	4.9
Depth of fishing (m)	220-250	250-270	260-295	300-350	290-320
Selectivity range (cm)	9.7	-	9.8	5.5	6.8
No. of fish in range - codend	262	-	214	280	1,039
cover	311	-	382	419	1,346
Total number of fish - codend	1,217	1,807	925	764	2,250
cover	800	1,999	1,867	2,564	6,620
Mean 50% selection length (mm)	360	360	449	381	387
Selectivity coefficient	2.84	2.88	3.16	3.07	2.88
Percentage of fish meshed		2.3	13.0		10.0