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Selection of cod by polyamide trawl codends in ICNAF Division 4Vn

by H. Bohl
Institut fur Fangtechnik
Hamburg, Germany

Introduction

Recently the ICES/ICNAF Joint Working Group on Selectivity Analysis made an attempt to assess the effect of the physical properties of the netting yarns on the selectivity (ICNAF, 1970a and b). This attempt failed because until now very little data on the properties of the netting yarns used in selection experiments have been published. However, the Group thought that the elongation (extensibility) of the netting yarns is possibly one of the most important properties by which the selectivity might be influenced. Since this assumption was not yet substantiated scientifically, the Group proposed an international experiment to find out whether high elongation and high selectivity are positively correlated or not (ICNAF, 1970b, p.4). Realizing that, in general, considerable time is needed for the preparation of such an international test, the Institut fur Fangtechnik decided to start its own study of the relationship between elongation and selectivity already in the spring of 1970.

The cruise program also included the collection of selection data for a codend made of a definite polyamide netting yarn R 6,484 tex. According to a recommendation of the above-mentioned Working Group (ICNAF, 1970a, p.49), this netting yarn has been introduced to replace manila as a new standard for selectivity purposes[1]. It was suggested "that, whenever possible, research vessels should use codends made of the new standard polyamide and collect selectivity data so that a large number of selection factors covering all species, seasons, areas etc., be obtained as quickly as possible, ..." (ICNAF, 1970b, p.4).

Another important item of the cruise program was the repetition of an experiment carried out with an extra strong codend in 1969 (Bohl, 1970). This experiment had shown that there is no significant difference between the selectivities of netting yarns of normal diameter and those which are unusually thick. Therefore it was concluded that extra strong codends can be used to obviate the need for topside chafers. Since this is a matter of great consequence, it was thought advisable to confirm the result of the previous experiment by a second test.

Material and Methods

The experiments were carried out during April 1970 on the Scotian Shelf between Cape Breton and Cape Smoky in depths ranging from 105 to 180 m (ICNAF Div.4Vn). FRV Walther Herwig - a diesel-electric stern trawler of 83.23 m total length, 1,987 gross tons, capable of developing 2,000 h.p.e. at 190 rpm - used the German standard roundfish bottom trawl (140 ft groundrope).

The selectivities of four polyamide multifilament codends were studied. Two of these codends have already been mentioned above, viz. those which are made of the standard polyamide (R 6,484 tex) and the extra strong netting yarn (R 17,465 tex[2]). The remaining two codends were procured especially to evaluate the relationship between elongation and selectivity. The netting yarns of these codends are made of one and the same kind and number of single yarns (article no. N_t 3/500) and differ inasmuch as the yarn of the one codend is extremely hard

[1]This applies to ICES only (C.Res.1969/5:1, P.-v.Réun.Cons.int.Explor.mer 1969, p.120). The Standing Committee on Research and Statistics of ICNAF has not yet adopted the new standard polyamide, but it recommended that the Subcommittee on Assessments examine the requirements for further selection experiments in relation to adoption of the new standard (Rec.18, Redbook 1970, Part I, p.18).
[2]The nominal fineness is R 18,000 tex.

twisted (high twist factor) and untreated to produce a high elongation, while the yarn of the other is medium twisted (low twist factor) and thermo-fixed to produce a low elongation. In consequence of the different netting yarn construction there are also inevitable differences in some other physical properties as, e.g., fineness, diameter and flexibility.

The properties of the netting yarns and codend nettings used in the experiments were determined according to the ISO standards for testing methods. The results are given in Table 1. The relation between load and elongation, which is based on new netting yarns, is shown in Fig. 1.

During the experiments the covered codend technique was used. The topside covers used were in accordance with ICES specifications. They were made of single polyamide netting yarn (25 tex x 16 x 3, twisted), and the mesh opening was about 60 mm. The inner underside of the codends was lined with small-meshed netting similar to that of the cover.

The length composition of the catches was determined by measuring the total fish length to the centimeter below. The mesh measurements were taken immediately after each haul using an ICES gauge with an operating pressure of 4 kg.

In order to study the girth/length relationship of cod, the unconstricted maximum body girth was measured to the nearest millimeter.

Results

During the course of the experiments a total of 51 successful hauls was made. The catches, ranging from 0.6 to 6.1 metric tons, were of rather uniform composition. Cod were always predominant; they represented in 32 hauls more than 90%, in 12 hauls 80-90% and only in 7 hauls less than 80% of the catch weights. The duration of tow varied from 30 to 120 minutes, but in most cases (42 hauls) the trawl was towed for one hour.

The relative length composition of the total cod catch which consisted of 66,258 specimens caught in the codends and 31,479 specimens caught in the covers, is shown in Fig. 2. Fish of the 45.0-47.9 cm length-class were most abundant. This fact proved extremely favourable for the experiments, because the 50% retention length of the four codends used were found to be close to the modal length of the fish aggregation. Thus, unusually large numbers of specimens could be recorded within the selection ranges.

The selection data obtained from combined hauls are compiled in Table 2. The selection curves for combined hauls are shown in Fig. 3. They are based on smoothed percentages of retained fish (three-point moving averages). The curves are fitted by eye.

From Table 2 it can be seen that the extra strong codend gave a selection factor of 3.51, while the codend made of the standard polyamide yielded a factor of 3.41. Hence, the results obtained from the same codends in 1969 (Bohl, 1970) could be confirmed: There is no significant difference between the selectivity properties of extra strong and "normal" polyamide codends. This implies that the widespread use of such a robust codend as tested in the German experiments could be considered as a possible step towards the elimination of topside chafers.

As to the codends with different elongations (codend nos.56 and 57), Table 2 appears to show that a low elongation is associated with a low selection factor, and vice versa: The selection factor of the netting yarn with 21.5% elongation was 3.15 and that of the netting yarn with 38.8% elongation was 3.49. However, taking into account that the two other codends used in the experiments were also characterized by low elongations (comp. codend nos.54 and 55 in Table 1 and Fig. 1), and realizing that these codends gave selection factors of the same order of magnitude as the codend with the high elongation, it was rather doubtful whether the elongation was really the causative agent for the selectivity differences observed. Looking at all the data given in Table 2, it becomes obvious that the lowest selection factor obtained (3.15, codend no.57, "low elongation") was based on the largest catches made during the tests. This suggests that this low selection factor could probably be attributed to catch size.

To look into this matter in more detail, an analysis of single hauls had to be made. Since cod were sufficiently numerous in most of the catches, reliable selection factors could be obtained for 44 individual hauls. Only with 7 hauls was it not possible to determine the selection factors quite precisely. These factors are queried in Tables 3-6, in which all the data are presented on a haul-by-haul basis.

In the following the unweighted mean selection factors calculated from single hauls are compared with the selection factors calculated from combined hauls.

Codend no.	54	55	56	57
Selection factor based on grouped hauls	3.41	3.51	3.49	3.15
Unweighted mean selection factor ± s.e. based on single hauls	3.44 ± 0.03	3.50 ± 0.05	3.50 ± 0.05	3.16 ± 0.02
Range of selection factors	3.28-3.65	3.16-3.78	3.27-3.80	3.10-3.25
Number of hauls	18	15	12	6

For each codend separately, it can be seen that the selection factors calculated in two ways do not differ to any appreciable extent. This indicates that the selectivity was not negatively correlated with the catch size. Otherwise, provided that a sufficiently wide range of catch sizes was covered by each codend, the selection factors for grouped hauls would have been expected to be markedly lower than the unweighted mean selection factors.

The absence of a reciprocal relation between selectivity and catch size is also shown in Fig. 4, in which the selection factors derived from individual hauls have been plotted against the corresponding quantities of cod caught in the codends.

Thus it remains an open question why the selection factor for the codend No.57 was found to be significantly lower than the selection factors for the three other codends. The difference can neither be attributed to the elongation properties of the netting yarns nor to the catch sizes. Further experiments are needed to find out which property or properties of a netting yarn are of primary importance in determining its selectivity.

The result of 959 girth measurements taken during the course of the selection experiments is shown graphically in Fig. 5. The relationship between maximum body girth (G) and total length (L) is described by the regression equation $G = 0.538\ L - 3.80$ cm.

References

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Table 1: Information about codends and netting yarns used

Codend no.	54	55	56	57
Material and type of fibre	Polyamide multifilament			
Construction of netting yarn of codend	Twisted	Plaited	Twisted	Twisted
Method of manufacture of codend	Double braided Hand-made			
Treatment of netting yarn of netting	Thermo-fixed	Untreated	Untreated	Thermo-fixed
Age of codend in fishing hours	55	35	0	0
Rtex (g/1000 m)	6,484	17,465	6,588	5,655
Runnage (m/kg)	154	57	152	177
Diameter (mm)	2.9	~ 7.0	3.1	2.7
Flexibility[1]), wet (g)	48	246	375	30
Amount of twist in turns per meter (t/m)	74	-	100	62
Twist factor[2]) = αtex = t/m x $\sqrt{\text{Rtex}/1000}$	188	-	256	147
Weaver-knot breaking load, wet (kp)	299	735	257	292
Breaking load, without knot, dry (kp)	355	854	254	306
without knot, wet (kp)	315	752	194	267
Breaking length, dry (km)	54.9	48.9	38.6	54.1
wet (km)	48.6	43.1	29.4	47.2
Knot breaking length, wet, 1/2 (km)	23.1	21.0	19.5	25.8
Elongation (%) at a load				
of 5 kp	2.2	0.3	5.6	1.8
of 10 kp	4.3	1.1	9.1	3.5
of 30 kp	10.3	3.8	20.1	9.6
of 50 kp	15.9	6.2	25.7	13.1
of 1/2 weaver-knot breaking load, wet (kp)	23.8	21.0	38.8	21.5

[1]) The flexibility (resistance against deformation) has been determined by means of the "Lötzener Methode" described by v.Brandt and Carrothers (1964).

[2]) The twist factor makes it possible to compare the amount of twist of netting yarns of different fineness.

Table 2: Compilation of cod selection data for grouped hauls

Ship		FRV WALTHER HERWIG, 83.3 m length o.a., 2000 h.p.e.			
Gear		German standard roundfish bottom trawl, 140' groundrope			
Locality		ICNAF Div. 4 V n (off Cape Breton and Cape Smoky)			
Date		12 - 27 April 1970			
Experimental method		Topside cover of ICES specification			
Polyamide codend no. (comp. Table 1)		54	55	56	57
Designation		Standard	Extra strong	High elongation	Low elongation
R..tex		6,484	17,465	6,588	5,655
No. of hauls		18	15	12	6
Av. duration of haul (min)		59	58	63	70
Towing speed through water (kn)		4.7 - 5.3			
Depth range (m)		105-180	105-160	105-160	105-160
Type of mesh gauge		ICES gauge, 4 kg pressure			
Codend mesh size; mean ± s.e. (mm)		131.1±0.12	122.4±0.22	127.0±0.27	143.3±0.25
Range (mm)		121-144	109-134	112-144	132-158
No. of measurements		810	675	540	270
25-75% selection range (mm)		101	126	95	111
No. of cod in sel. range	codend	5,680	6,912	5,532	5,968
	cover	5,225	5,803	5,353	6,663
Total no. of cod	codend	18,417	20,103	15,412	12,326
	cover	7,099	7,226	7,532	9,892
Av. quantity of cod/tow	codend (baskets[1])	24 1/3	29 1/4	26 1/4	38 1/4
	cover (baskets[1])	4 2/3	5 1/4	6 1/2	16 1/4
of by-catch[2])/tow	codend (baskets)	3 1/4	4 1/2	2 1/3	3
	cover (baskets)	1/2	1/2	1/3	3/4
Range of total catch/tow	codend (baskets)	10 1/4-56 1/4	10 1/2-76	5 1/2-43 3/4	24 -59
	cover (baskets)	2 -15 3/4	2 -15 3/4	2 3/4-14 1/2	4 1/4-31 1/2
50% retention length (mm)		447	430	443	451
Selection factor		3.41	3.51	3.49	3.15

[1]) The net weight of one basket filled with cod is about 68 kg.

[2]) Mainly Hippoglossoides platessoides, skates and rays, Sebastes sp., Glyptocephalus cynoglossus; small quantities of Clupea harengus, Melanogrammus aeglefinus, Pollachius virens, Anarhichas lupus, Cyclopterus lumpus, and sporadically Urophycis sp., Cottidae, Anarhichas minor, A. denticulatus, Hippoglossus hippoglossus, Reinhardtius hippoglossoides, starfishes and sea-urchins.

Table 3: Cod selection data for individual hauls; codend no. 54

Haul No.	Date April 1970	Position	Depth (m)	Duration of haul (min)	Mesh size (mm)	50% Length (mm)	Selection Factor	Selection Range (mm)	No. of cod in Selection range		Total no. of cod caught		Quantity (baskets) of Cod		By-catch	
									Codend	Cover	Codend	Cover	Codend	Cover	Codend	Cover
18	12	46°06'N 58°47'W	170–180	60	130.8	443	3.39	79	208	165	1,064	256	22 1/4	3	1 1/2	1
19	12	46°07'N 58°49'W	155	60	131.7	446	3.39	98	699	602	1,989	782	38 3/4	9 1/2	2 1/2	+
20	13	46°07'N 58°51'W	155	60	132.2	445	3.37	113	442	427	1,087	498	22	5 1/2	2	1/4
21	13	46°09'N 58°49'W	165	60	132.1	442	3.35?	107?	326?	261?	1,495	361	31 1/4	5	2	1/2
22	13	46°08'N 58°47'W	175	60	131.3	479	3.65?	97?	77?	73?	389	111	12 3/4	2	1 1/2	1/2
23	13	46°08'N 58°49'W	155	60	131.5	443	3.37	?	?	?	1,231	286	28	3 1/2	1 1/2	1/2
24	13	46°08'N 58°49'W	155	60	131.2	441	3.36	82	116	90	1,046	161	27 1/2	2 1/2	1 1/4	1/4
68	24	46°43'N 59°40'W	140–150	60	131.3	449	3.42	?	?	?	2,579	1,262	53	15	3 1/4	3/4
69	25	46°44'N 59°43'W	120	65	131.1	456	3.48	69?	404?	396?	1,661	665	39 1/2	8	3	1/2
70	25	46°44'N 59°42'W	140	60	130.7	457	3.47?	96	225	180	1,318	278	40 3/4	3 1/4	2 1/2	1/4
72	25	46°40'N 59°37'W	120–110	60	130.5	428	3.28	136?	408?	294?	936	378	21 1/4	3 1/2	3 3/4	1/4
73	26	46°44'N 59°44'W	110	60	130.8	435	3.33	87	297	287	738	403	13 1/4	4 1/4	3 3/4	1/4
74	26	46°43'N 59°41'W	140–130	60	130.9	461	3.52	98	218	202	700	299	21	3 1/4	3 3/4	1/2
75	26	46°43'N 59°42'W	130–145	60	130.8	462	3.53?	77	163	217	553	371	13 3/4	4	3 1/2	1/4
76	26	46°43'N 59°51'W	120	60	130.8	474	3.62	67	100	110	318	311	8	3 1/2	2 1/4	1/2
78	26	46°41'N 59°39'W	110	45	130.8	449	3.43	86	130	161	404	270	20	2 3/4	3 1/4	1/4
79	27	46°16'N 59°16'W	105–115	60	130.8	434	3.31	71	110	130	569	240	14 1/4	2 3/4	11 3/4	3/4
80	27	46°14'N 59°07'W	120	60	130.7	467	3.57	85	74	81	340	167	11 1/2	1 3/4	3 1/2	1/4

Table 4: Cod selection data for individual hauls; codend no. 55

Haul No.	Date April 1970	Position	Depth (m)	Duration of haul (min)	Mesh size (mm)	50% Length (mm)	Selection Factor	Selection Range (mm)	No. of cod in Selection range		Total no. of cod caught		Quantity (baskets) of Cod		By-catch	
									Codend	Cover	Codend	Cover	Codend	Cover	Codend	Cover
43	17	46°18'N 59°23'W	120–115	60	122.7	393	3.20	99	494	382	1,222	528	19 1/4	4 1/4	5 1/4	1/2
44	17	46°17'N 59°18'W	120	60	123.4	420	3.40	99	599	581	1,214	754	19 1/4	6 1/2	6 1/2	1 1/4
45	17	46°16'N 59°04'W	150–110	60	123.0	413	3.36	88	133	105	478	158	9 1/2	1 1/2	3 3/4	1/2
46	17	46°16'N 59°13'W	120	63	122.6	424	3.46	71	198	187	733	308	13 3/4	2 3/4	7 1/2	1/2
47	17	46°15'N 59°06'W	130–122	60	122.4	387	3.16?	116	226	172	794	238	14	2	5	1
48	17	46°17'N 59°15'W	125	60	122.2	420	3.44?	82?	97?	108?	338	179	5 3/4	1 1/4	4 3/4	1
53	18	46°43'N 59°42'W	125–118	30	123.1	417	3.39	79?	150?	99?	1,104	181	21 1/2	2	2 1/2	+
59	19	46°42'N 59°38'W	140–115	60	122.7	458	3.73	85	791	852	1,973	1,152	42 1/4	13 1/2	3 1/2	1/4
60	23	46°42'N 59°39'W	110–125	60	122.7	464	3.78	96	730	686	2,302	901	60	11 1/2	5 1/2	1/4
62	23	46°44'N 59°42'W	135	60	121.5	431	3.49	94	403	261	2,958	457	73 1/4	6 1/2	2 3/4	1/2
63	23	46°45'N 59°44'W	135	60	120.6	443	3.67	86	352	303	1,187	417	25 3/4	4 1/2	4 1/4	1/4
64	24	46°44'N 59°44'W	105–120	60	122.4	448	3.66	65	204	162	926	306	21 1/2	3	3 1/2	1/4
65	24	46°42'N 59°40'W	160	60	121.4	435	3.58	?	?	?	1,663	523	39	5 3/4	3 1/2	3/4
66	24	46°42'N 59°40'W	140–130	60	123.8	450	3.63	?	?	?	2,216	816	48 1/2	10	4	1/2
67	24	46°43'N 59°40'W	140	60	120.9	434	3.59	86	262	204	995	308	23 3/4	3 1/2	5 1/4	3/4

Table 5: Cod selection data for individual hauls; codend no. 56

Haul No.	Date April 1970	Position	Depth (m)	Duration of haul (min)	Mesh size (mm)	50% Length (mm)	Selection Factor	Selection Range (mm)	No. of cod in Selection range		Total no. of cod caught		Quantity (baskets) of Cod		By-catch	
									Codend	Cover	Codend	Cover	Codend	Cover	Codend	Cover
25	13	46°08'N 58°49'W	160	60	132.0	447	3.39	84	221	186	1,293	295	31 3/4	4	1 3/4	1/2
26	14	46°08'N 58°50'W	160-140	60	128.7	444	3.45	79	312	306	1,382	470	32 1/2	5	1 1/2	1/2
27	14	46°09'N 58°5o'W	140	60	129.0	440	3.41	?	?	?	1,550	424	36 1/2	5	2 1/2	1/2
28	14	46°09'N 58°51'W	160	60	128.1	419	3.27	96	186	144	958	230	20	2 1/2	1 1/4	1/4
29	14	46°09'N 58°51'W	160	60	127.4	481?	3.78?	65?	66?	92?	211	238	4 1/2	2 1/2	1	1/2
32	14	46°07'N 58°51'W	155	90	127.0	430	3.39	?	?	?	1,819	550	40 1/2	6	3 1/4	1/2
33	14	46°13'N 59°00'W	150	60	127.1	450	3.54	97	553	500	1,558	695	31 3/4	8	3 1/4	1/4
34	15	46°13'N 59°00'W	150	60	127.5	485	3.80	106	357	547	873	765	19	8 1/2	1 1/4	1/4
55	19	46°45'N 59°46'W	110-120	60	123.4	418	3.39	68	411	388	1,248	627	19 1/2	5 1/2	2 1/2	+
56	19	46°44'N 59°43'W	115-105	60	124.2	425	3.42	84	443	432	1,042	623	18 1/2	5 1/2	3	1/2
57	19	46°42'N 59°40'W	115-110	60	124.8	439	3.52	84	871	867	1,786	1,376	31 1/4	14	4 1/4	1/2
58	19	46°42'N 59°41'W	125-110	60	125.2	450	3.59	77	790	902	1,692	1,239	29 1/4	12	3	1/2

Table 6: Cod selection data for individual hauls; codend no. 57

Haul No.	Date April 1970	Position	Depth (m)	Duration of haul (min)	Mesh size (mm)	50% Length (mm)	Selection Factor	Selection Range (mm)	No. of cod in Selection range		Total no. of cod caught		Quantity (baskets) of Cod		Quantity (baskets) of By-catch	
									Codend	Cover	Codend	Cover	Codend	Cover	Codend	Cover
37	15	46°11'N 58°57'W	150	90	144.9	471	3.25	88	198	164	780	272	22	4	2	1/4
38	15	46°11'N 58°54'W	160-150	120	144.3	453	3.14	113	540	501	1,420	701	31 1/4	9	3	1/2
39	16	46°17'N 59°17'W	105-120	60	142.8	454	3.18	120	1,730	2,102	3,290	3,173	56 3/4	29 1/4	2 1/4	1
40	16	46°17'N 59°15'W	120	45	142.7	448	3.14	107	969	1,158	1,895	1,614	32 1/4	15	3	1
41	16	46°17'N 59°19'W	120	50	142.6	451	3.16	98	1,130	1,275	2,327	1,959	42	19	3 1/4	1
42	16	46°18'N 59°22'W	120	55	142.6	442	3.10	91	1,231	1,284	2,614	2,173	44 1/2	20 3/4	4	1

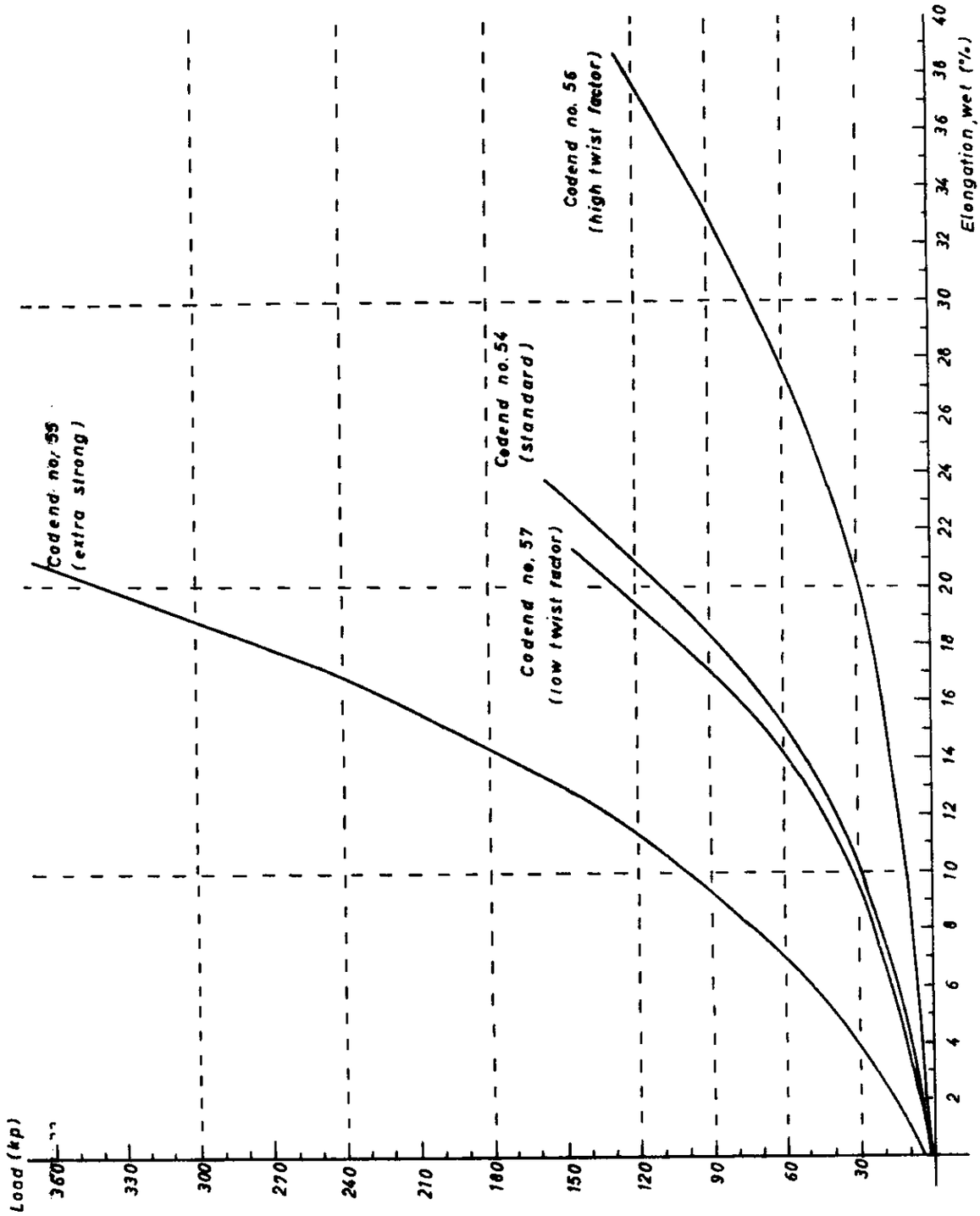

Fig. 1: Load-elongation curves for the four netting yarns used

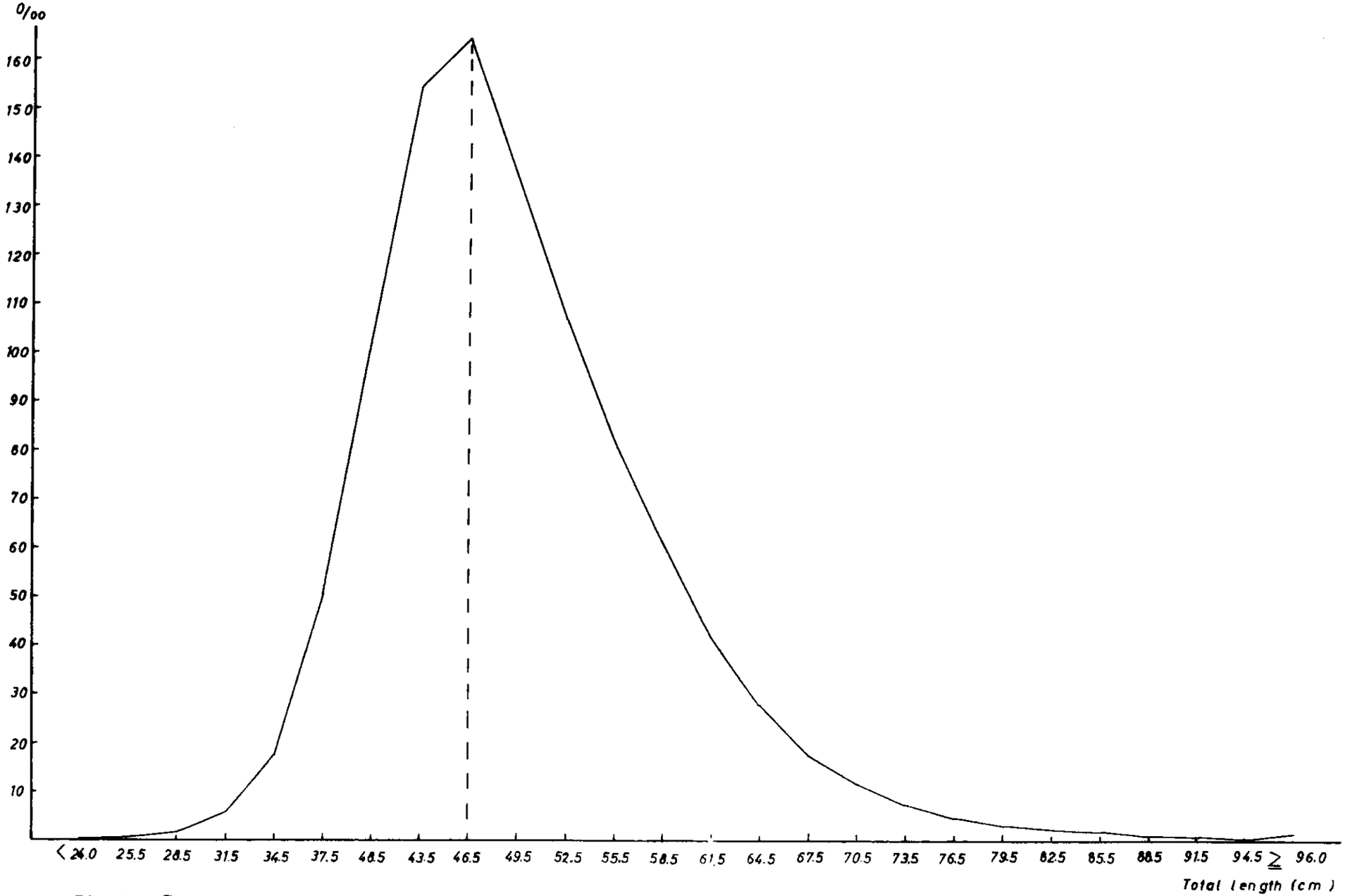

Fig. 2 : Relative length composition of the total cod catch (codend plus cover) in 3-cm-groups

(n = 98,007)

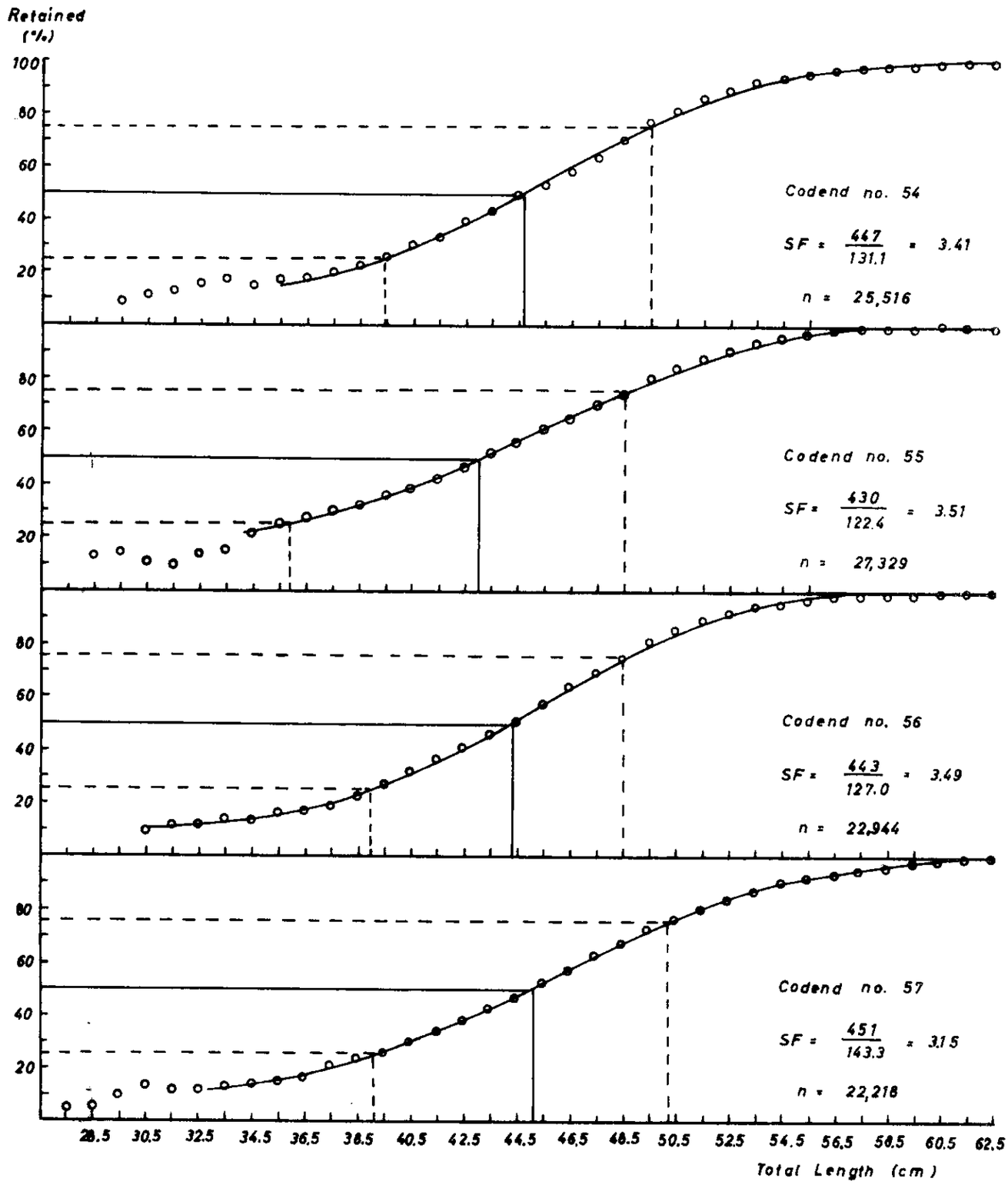

Fig. 3: Cod selection curves for combined hauls

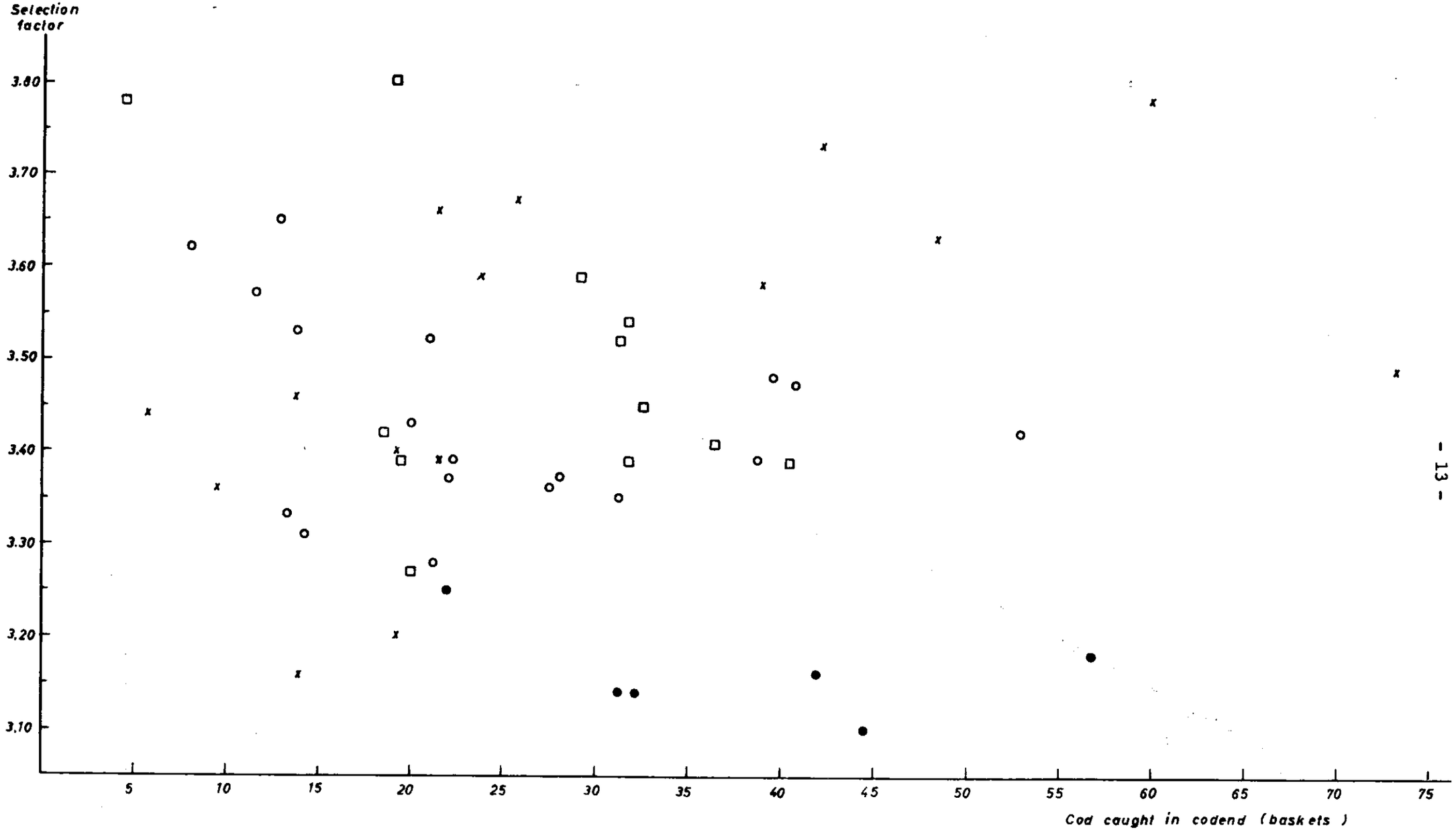

Fig. 4 : Relation between selection factor and catch size

○ Codend no. 54 □ Codend no. 56
× Codend no. 55 ● Codend no. 57

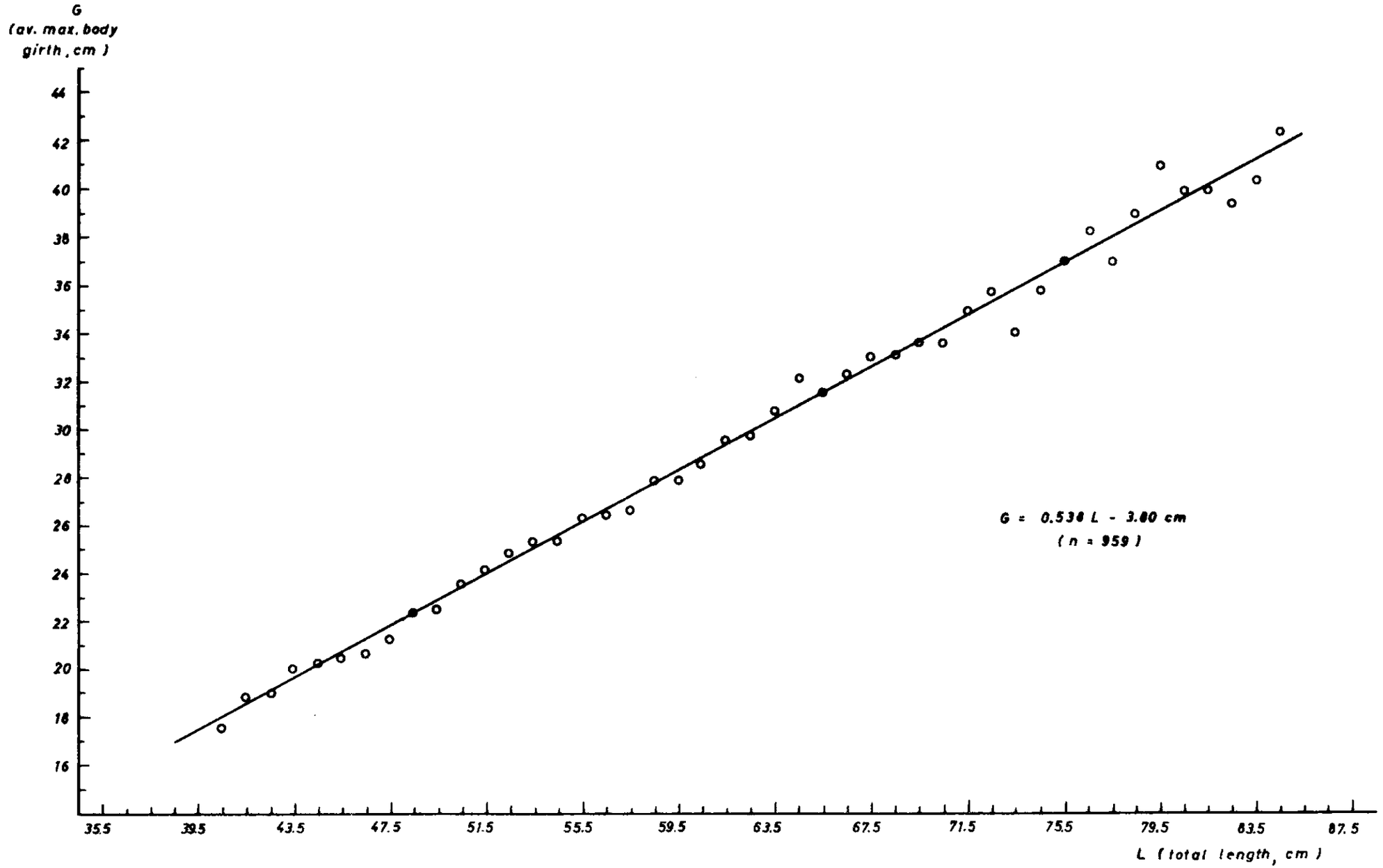

Fig. 5 : Cod girth/length relationship