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Comparative selection experiments with polypropylene and polyamide cod-ends [1]

by H. Bohl

Introduction

During the 79th cruise of FRV ANTON DOHRN experiments with a conventional bottom trawl were carried out to obtain further information about the selectivity of polypropylene cod-ends. Some additional hauls conducted on the same occasion with a "Perlon" cod-end made it possible to compare directly the selectivities of polypropylene and polyamide cod-ends. Manila has not been brought into the trials, because all the cod-ends nowadays used in the German deep-sea fishery are made of polyamides.

With respect to the Commission's interest in the selectivity of polypropylene cod-ends this paper, although dealing with studies prosecuted outside the Convention area, may be an expedient ICNAF document.

Methods and materials

The investigations were conducted between 22-27 June, 1964, off Straumnes (Northwest Iceland, 66°37'N; 23°30'W) in depths of about 80 m, and on 4 July off Portland (South Iceland, 63°26'N; 19°30'W) in depths of 55-70 m. The technique of topside covers and underside blinders has been applied. The covers (rigged in accordance with the ICES specification) as well as the blinders were made of light nylon netting (23 tex x 11 x 3) having a mesh opening of about 60 mm.

The cod-ends used in the experiments should resemble each other as much as possible concerning the physical properties of the twines. But it can be seen from the following compilation that several properties differed widely.

Fibre	polypropylene multifilament	polyamide multifilament
Specific gravity (g/cm^3)	0.91	1.14
Braiding	double twine	double twine
Twine construction	plaited	plaited
R tex	4905	4760
Runnage (m/kg)	204	210
Wet knot breaking strength (kg)	124	104
Diameter, wet (mm)	3.6	3.1
Extension, wet (%) at a load		
of 6 kg	1.7	4.0
12 kg	2.4	6.2
30 kg	4.5	10.7
knot breaking strength	15	27
Resistance against deformation, wet (Flexibility, g)	50	16

The latter has been determined by means of the "Lotzener Methode", described by A.v. BRANDT and P.J.G. CARROTHERS in Modern Fishing Gear of the World 2, pp. 19-20, London, 1964.

1 This paper was presented in a provisional form to the ICES comparative Fishing Committee at the ICES Council Meeting 1964.

Some of these differences could be easily diminished or compensated. Having the same runnage, as in the given instance, the wet knot breaking strength of a modern polyamide twine is known to be equal or even superior to that of a polypropylene twine. In explanation of the strange difference shown above, it must be stated that, unfortunately, ar old-fashioned twine has been used in knitting the polyamide cod-end. The marked difference between the observed flexibilities is thought to be, at least partly, a corollary of different twine constructions. Especially the densities of the plaiting were not the same in both cod-ends.

The remaining differences, however, are inevitable. The polypropylene twine is thicker than the polyamide twine, because of the lower specific gravity of the polypropylene. The relatively low extensibility of the polypropylene twine and the relatively high extensibility of the polyamide twine are well-known peculiarities of these net materials.

The mesh measurements were made with the ICES gauge exerting a pressure of 4 kg. A complete line of meshes running along the medium part of the upper cod-end panel (consisting of 47 and 48 meshes respectively) was measured immediately after every haul.

As to the fish measurements, the total length and the maximum body girth were taken. The former was recorded to the nearest centimeter, the latter to the nearest millimeter.

Selection data were collected for haddock and, as occasion arose, also for cod and whiting.

Bad fishing conditions were found off Straumnes. The catches were poor in quantity and very mixed, but uniformly composed during the period of investigations. Per two hours' fishing time there were caught $8\frac{1}{2}$ - $17\frac{1}{2}$ baskets[2]) of fish (avg. 13 baskets) with the polyamide cod-end and its cover, and 9 - 22 baskets (avg. $12\frac{3}{4}$ baskets) with the polypropylene cod-end and its cover. A good deal of these catches consisted of haddock:

		Haddock (baskets) per haul	average	No. of hauls
Polyamide	cod-end	3 - $10\frac{1}{2}$	$4\frac{3}{4}$	8
	cover	$\frac{1}{2}$ - 3	$1\frac{1}{4}$	
Polypropylene	cod-end	3 - 10	$5\frac{1}{2}$	14
	cover	$\frac{1}{2}$ - $3\frac{1}{2}$	$2\frac{1}{4}$	

The cod-end by-catches consisted of cat-fish, cod, coal-fish, plaice, lemon sole, dab, rough dab, megrim and small halibut. In the by-catches of the cover small redfish were predominant.

Off Portland considerably more fish could be caught. The total catches (cod-end plus cover) per one hour's fishing time amounted to $46\frac{1}{2}$ - $63\frac{3}{4}$ baskets (avg. 55 baskets) in the case of the polyamide cod-end, and to $21\frac{1}{2}$ - 51 baskets (avg. 34 baskets) in the case of the polypropylene cod-end. The share of haddock in these quantities was as follows:

		Haddock (baskets) per haul	average	No. of hauls
Polyamide	cod-end	14 and 14	14	2
	cover	$4\frac{3}{4}$ and 5	$4\frac{3}{4}$	
Polypropylene	cod-end	$3\frac{3}{4}$ - $11\frac{1}{2}$	$8\frac{1}{2}$	4
	cover	$\frac{3}{4}$ - $2\frac{1}{4}$	$1\frac{1}{2}$	

The voluminous by-catches of the cod-ends were composed of cod, coal-fish, whiting and flatfish (mainly plaice and dab) and those of the covers of whiting and dab.

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2 1 basket = 50 kg approximately

Results and discussion

Due to the small quantities caught off Straumnes it has not been possible to calculate the selection data for individual hauls. The data obtained from the pooled hauls are given in Table 1.

Table 1: Selection data collected off Straumnes

	Haddock		Cod
Cod-end	Polyamide	Polypropylene	Polypropylene
Number of hauls	8	14	11
Avg.duration of tow (minutes)	116	120	120
Number of fish caught (total)	3140	4752	2035
cod-end	1577	2472	741
cover	1563	2280	1294
25-75% selection range (cm)	8.4	7.0	10.1
No. of fish in sel.range (total)	940	490	461
cod-end	465	252	208
cover	475	238	253
50% retention length (cm)	47.9	41.6	43.6
Mesh size: mean ±s.e. (mm)	131.5±0.22	125.4±0.09	125.3
range (mm)	122-141	120-132	120-132
No. of measurements	376	670	528
Selection factor	3.64	3.32	3.48

The haddock data collected off Portland could be analysed by individual hauls: The selection factors were found to be 3.44 and 3.59 for the polyamide cod-end (two hauls), and 3.04 (?), 3.22, 3.37 and 3.38 (?) for the polypropylene cod-end (four hauls). The resulting mean selection factors 3.52±0.07 for the polyamide cod-end and 3.25±0.08 for the polypropylene cod-end do not differ significantly. No special importance, however, should be attached to this finding, because at least two out of the above-mentioned six selection factors could not be determined with an adequate degree of exactness.

The selection data derived from the combined hauls, which henceforth will only be referred to, are given in Table 2.

Table 2: Selection data collected off Portland

	Haddock		Whiting
Cod-end	Polyamide	Polypropylene	Polypropylene
Number of hauls	2	4	4
Avg. duration of tow (minutes)	60	60	60
Number of fish caught (total)	1631	2161	3907
cod-end	932	1523	1313
cover	699	638	2594
25-75% Selection range (cm)	10.0	7.9	9.3
No. of fish in sel. range (total)	749	720	2122
cod-end	391	328	927
cover	358	392	1195
50% retention length (cm)	46.7	40.8	45.2
Mesh-size: mean ±s.e. (mm)	132.6±0.44	124.4±0.18	124.4±0.18
range (mm)	123-143	119-131	119-131
No. of measurements	94	192	192
Selection factor	3.52	3.28	3.63

According to Tables 1 and 2 the haddock selection factors 3.32 (Straumnes) and 3.28 (Portland) were calculated for the polypropylene cod-end. In comparison with these figures the selection factors for the polyamide cod-end were found to be 9.6% higher off Straumnes (3.64) and 7.3% higher off Portland (3.52). Since the selectivity on roundfish of polyamide is known to be about 10% higher than that of manila, the data at hand suggest that there is no marked selectivity difference between polypropylene and manila. This indirect result is supported by the fact that the selection factors for the polypropylene cod-end (3.28 and 3.32) are

very similar to the average selection factors for manila cod-ends obtained from the International Iceland Trawl Mesh Selection Experiment 1962 (3.35) as well as from previously available data for the Icelandic area (3.2) [N.N., 1965].

What are the sources of the selectivity difference between polyamide and polypropylene? If this question can be answered at all, then only by means of the above compilation of the physical properties of the netting twines. It can be seen there, and more distinctly from the load-elongation curves in Fig. 1, that the polyamide twine is much more extensible than the polypropylene twine. That means that the mesh size of the polyamide cod-end increases markedly with increasing strain, whereas that of the polypropylene cod-end increases in a less degree. Thus, postulating that during the tow considerably higher pulling forces act on the mesh bars than it is the case during the mesh measurement (4 kg), the selectivity difference is caused to a certain extent by the different extensibilities of the netting twines. As a result of the different twine diameters the knots of the polypropylene cod-end are conspicuously thicker than those of the polyamide cod-end (Fig. 2). This may also help to explain the selectivity difference in so far as the thick knots, which lap into the mesh, reduce the effective mesh opening. The different flexibilities of the netting twines are supposed to be a further source of the selectivity difference. Yet, in this connexion it must be recalled that the stiffness of the used polypropylene twine is rather due to the dense plaiting than to the net material itself. Therefore, future experiments conducted with polypropylene and polyamide cod-ends of about the same flexibility could possibly result in a somewhat slighter selectivity difference than stated above.

Taken all in all, there is every appearance that the selectivity of polypropylene is much more similar to that of manila than to that of polyamide.

Selection data for cod (Table 1), which are considered rather unreliable, and for whiting (Table 2) could be obtained only from the polypropylene cod-end.

The length-girth relationships of the three species studied are represented as regression equations in Table 3 and as regression lines in Fig. 3.

Table 3: Relation between length and girth

Species	Area	No. of measurements	Regression equations*
Haddock	Straumnes	1,419	G=0.531 L + 0.31 (G=0.523 L + 0.4)
Haddock	Portland	854	G=0.578 L - 2.72 (-)
Cod	Straumnes	850	G=0.515 L - 0.146 (G=0.511 L - 1.5)
Whiting	Portland	886	G=0.488 L - 0.42 (-)

*where L = total length in cm, and G = maximum body girth in cm.
in brackets: A.T. CAMERON, North Iceland, July 1962

From Table 3 it becomes obvious that the haddock and cod measurements conducted off Straumnes in June, 1964, and those carried out on board the Canadian research vessel A.T. CAMERON off North Iceland in July, 1962 (N.N., 1965), yielded practically the same length-girth relationships.

It can be seen from Fig. 3 that, in the time of our experiments, the small and medium-sized haddock were markedly thicker in the Northwest than in the South. This fact, however, is not reflected in the selection results. Quite the contrary, the selection factors were found to be somewhat higher off Straumnes than off Portland (comp. Tables 1 and 2). That suggests that some factors other than girth of fish have given rise to the regional differences in haddock selectivity. As things stand, it is likely that both the relatively large catches and the relatively short towing durations have favoured the retention of small haddock within the Portland area.

References

BOHL, H. MS, 1964. Preliminary results from selection experiments with polypropylene cod-ends and top-side chafers. ICES, C.M. 1964, No. 149 (mimeographed).

N.N. 1965. Report of the 1962 Iceland Trawl Mesh Selection Working Group. ICES, Coop. Research Rep., No. 3 (in press).

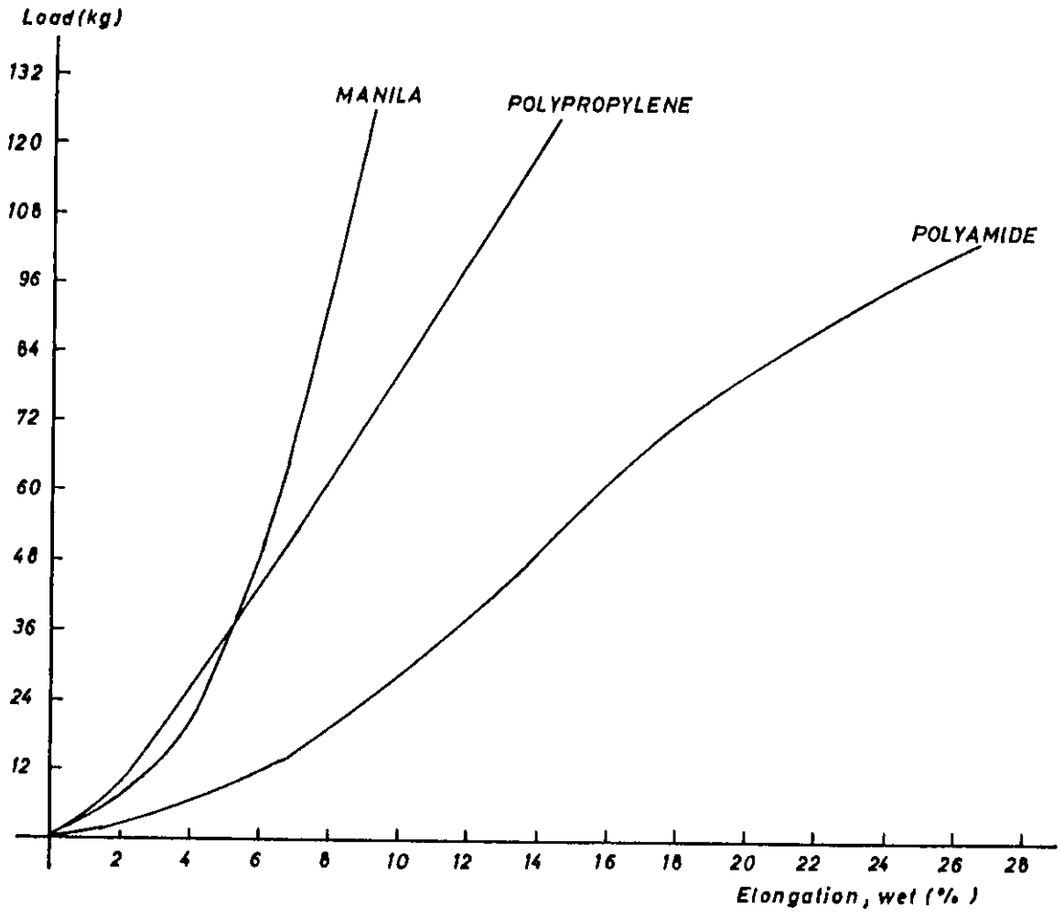
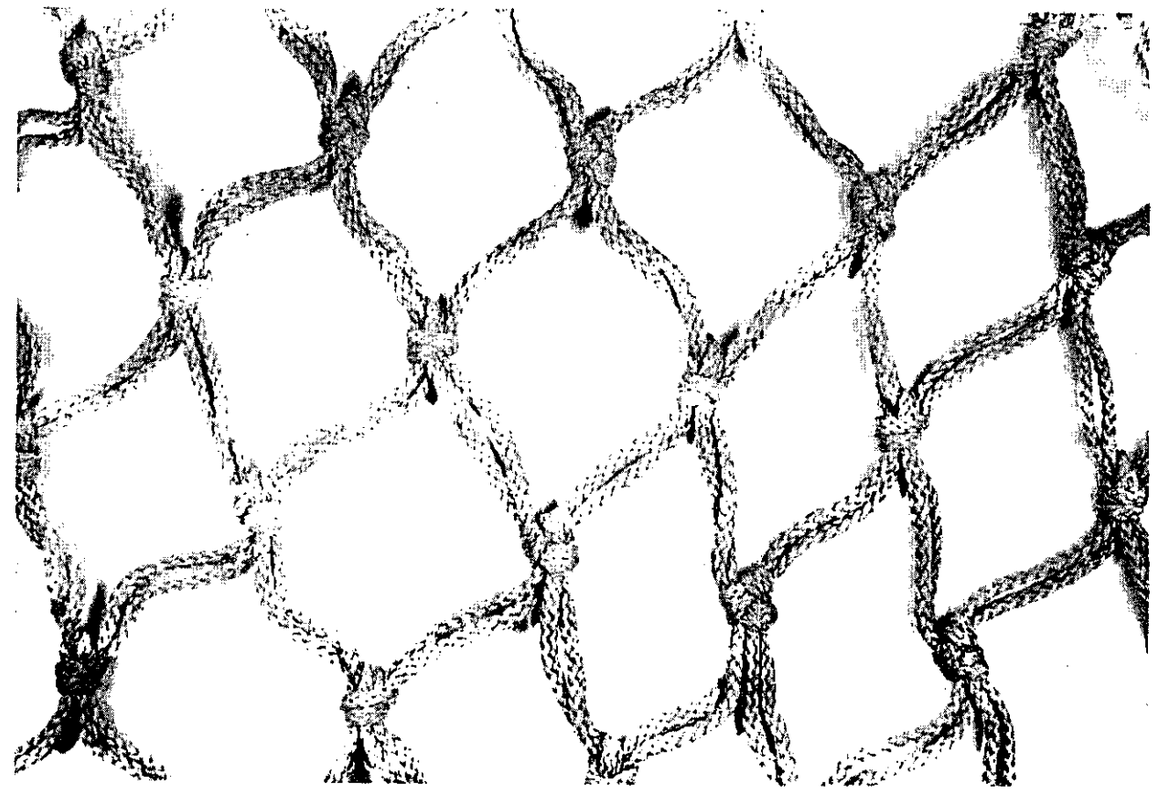


Fig. 1 : Load-elongation curves for the twines used and for a comparable manila twine



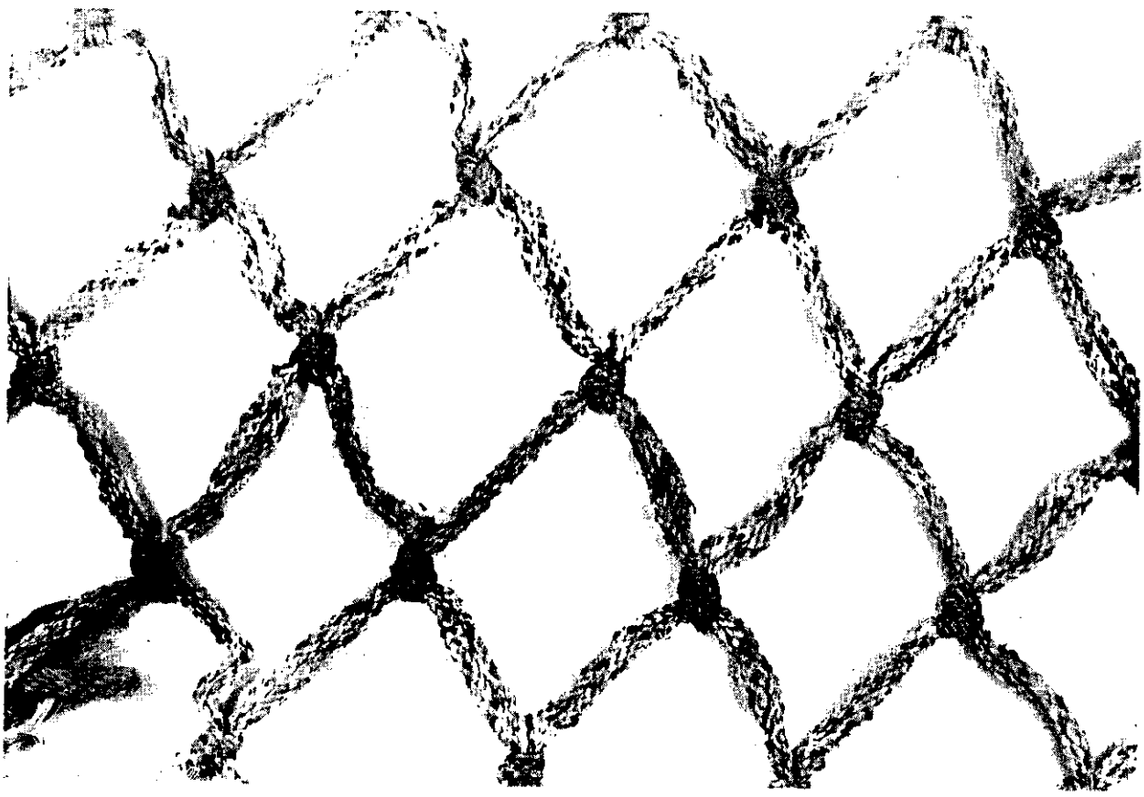


Fig. 2: Photographs of cod-end nettings used, demonstrating different knot sizes. Above: polypropylene netting; below: polyamide netting (Scale 1:2)

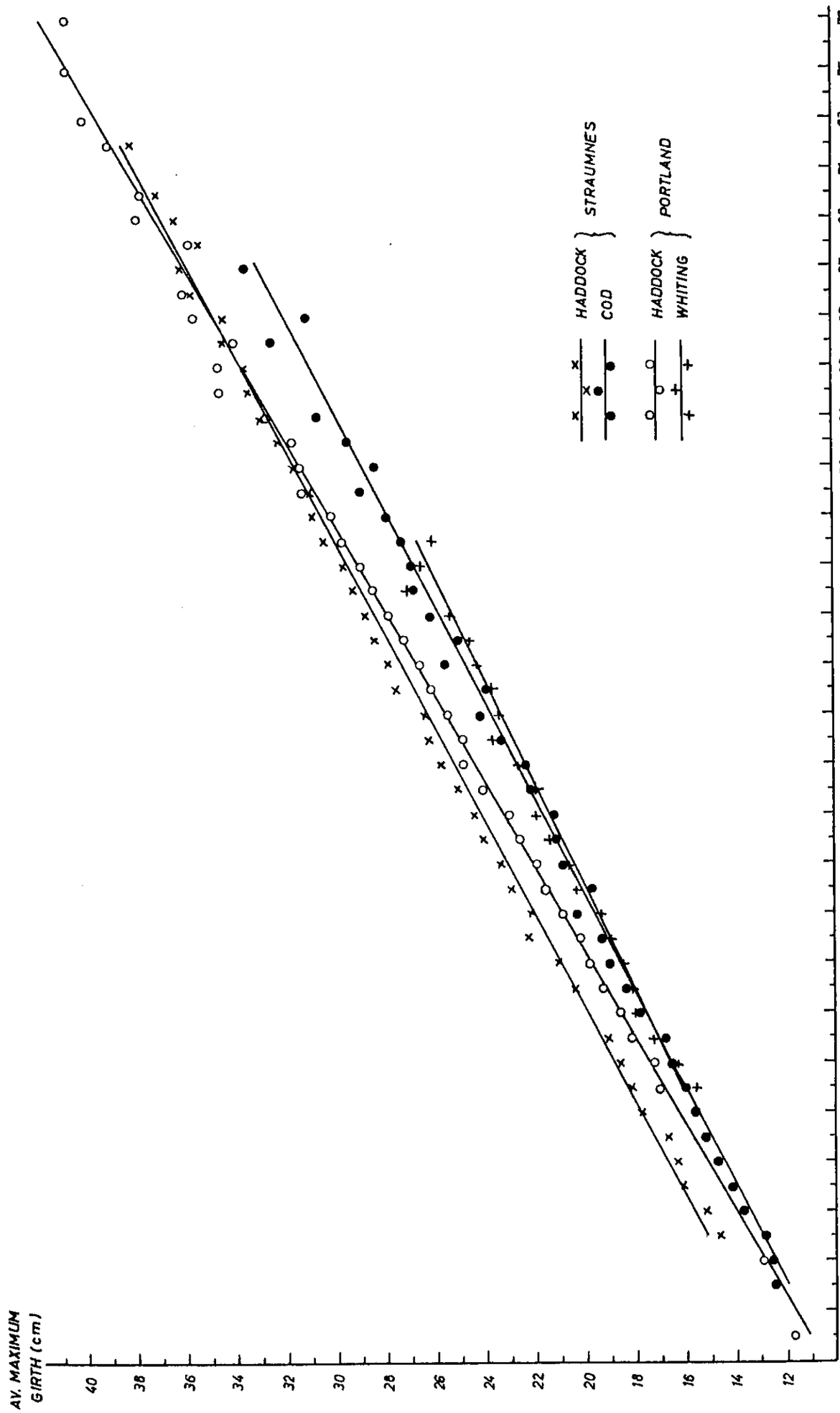


FIG. 3 : LENGTH-GIRTH RELATIONSHIP OF HADDOCK, COD AND WHITING