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SELECTIVITY EXPERIMENTS WITH DANISH SEINE ON COD AND HADDOCK IN NORTHERN NORWAY IN 1982

by

T. Jakobsen
Institute of Marine Research
P.O. Box 1870, 5011 Bergen-Nordnes,
Norway

ABSTRACT

In August-September 1982 selectivity experiments on cod and haddock with Danish seine were carried out in northern Norway. Results from twelve hauls with more than 100 cod and one haul with haddock are presented. Selection factors were estimated to be 3.6 for cod and 3.3 for haddock. These values are clearly lower than found for trawl in the Barents Sea.

INTRODUCTION

Selectivity experiments with Danish seine in northern Norway have previously been carried out only once, in August 1967 (Annaniassen and Hylen, 1967). Selection factors of 3.2 for cod and 2.3 for haddock were found. However, the data base for calculating the selectivity for haddock was clearly deficient. These values are considerably lower than the values found for trawl in the Barents Sea, where selection factors of 3.96 for cod and 3.63 for haddock have been used in recent assessments (Anon. 1979). Thorsteinsson (1980) reported from selectivity experiments in Iceland in 1972-1976. A selection factor of 3.48 for cod was found in Danish seine, compared to 3.24 in trawl.

Selectivity experiments on haddock in the North Sea have given selection factors in the range 3.5-4.4 for Danish seine with cod-end made of cotton (Anon. 1971) whereas selection factors for trawl with cod-ends of cotton were 3.1-3.6 (Margetts, 1955, 1956). Comparisons between Danish seine and trawl suggested that for mesh sizes in the range used in the experiments (59-105 mm), for equivalence in haddock selectivity the cod-end mesh in deep sea trawl should be about 10 mm greater than that of the Danish seine (Graham, 1954, Graham et al. 1954, Lucas et al. 1954).

In northern Norway a minimum legal mesh size of 110 mm for trawl and Danish seine was introduced in 1954. The trawl mesh size has subsequently been increased first to 120 mm and later to 125 mm while the mesh size in Danish seine has remained at 110 mm. However, from 1 January 1983 minimum mesh size for both trawl and Danish seine was increased to 135 mm.

Partly because of the planned increase in mesh size and partly because of a need for more information about the selectivity in Danish seine, it was decided to carry out an experiment in August-September 1982. However, at that time the increase in mesh size had already been decided and the results from the experiments have not influenced that decision.

MATERIAL AND METHODS

For the experiments a 51 feet long commercial Danish seiner "Lars Senior" was used. The cruise, which also comprised tagging and biological sampling, started 2 August 1982. The selectivity experiments were carried out from 15 August to 8 September.

Two seine nets were used. One had been used by "Lars Senior" in commercial fishing for several years and should according to specifications from the producer have a mesh size of 110 mm. The other net was new and was ordered with a mesh size of 135 mm. Both nets were made of courlene in the wings and the foremost part of the funnel and nylon in the rest of the funnel

and in the cod-end. For the selectivity experiments a bag-shaped cover of nylon with 60 mm meshes was used. It was 13.5 m long (with meshes stretched) and its opening was fastened around the seine net 9.5 m from the end. Thus the end of the cover was 4 m behind the end of the seine net. The diameter and accordingly the circumference of the cover was about 1.4 times that of the seine net with 110 mm meshes. The 135 mm net had a smaller, but variable diameter, on the average about half of the diameter of the cover.

It was intended to make some alternate hauls with and without cover to control that the cover did not significantly impair the fishing operation. Also a comparison of the 110 mm and 135 mm nets without covers was planned. However, it soon became evident that the size composition of the fish frequently would change considerably from one haul to the next with no change in the gear, which made comparison difficult. It was therefore decided to give priority to hauls with cover.

Except for three hauls, all fish in the cod-end and in the cover were measured. At St. 24 only half of the fish in the cover were measured. The rest were put in boxes which were counted and compared with the number of boxes containing the measured fish. The raising factor to total number in the cover should therefore be quite reliable. Also at St. 36 only about half of the fish in the cover were measured, and at St. 27 about 11% and 30% from cover and cod-end respectively were measured. On these stations, the amount of the rest of the fish was estimated while still contained in the nets and although the crew were very skilled in assessing catches, the raising factors cannot be considered as very reliable.

For each haul, the time from start of hauling until the wings of the net were parallel was registered, likewise the remaining time of the hauling, i.e. until the winch was stopped. Table 1 gives details of all hauls containing more than 100 fish. For cod there were six hauls with "110 mm" and six hauls with "135 mm". For haddock there was only one haul with "135 mm" which also contained a large number of cod.

Selection curves were drawn using the following procedure: The fraction retained was plotted for each cm length group. The data were then pooled into 3-cm groups so that the fraction retained at length L was assumed to be equal to the fraction retained for the sum of length groups L-1, L and L+1. The percentages thus obtained were then similarly grouped into 3-cm groups and the percentage for the middle cm group was set equal to the average percentage. Using only nearest whole percentages, this procedure was repeated until there was no further change in the percentages. The selection curve was then drawn through these points. This procedure has the advantage that it avoids the subjectivity involved in drawing a selection curve by eye and it gives a unique set of points which do not necessarily fit any preconceived formula. On the other hand, a formula is often needed for further calculations. Another disadvantage is that the selection curve tends to be a little too much extended at the ends. However, this will normally not influence the estimation of the usual reference points on the curve. The selection curves resulting from the different hauls are shown in Figs 1-13.

RESULTS

Table 2 shows the length distribution in cod-end and cover for each of the twelve hauls. There was a large variation in the size of the fish between hauls and accordingly also in the fraction of the catch retained in the cod-end. However, the length interval 30-60 cm which covers most of the total selection range is reasonably well represented in most of the hauls.

At the start of the cruise, preliminary measurements were made of the meshes in the cod-end. This indicated that the meshes in both nets were close to the sizes given by the producers, i.e. 110 mm and 135 mm. However, after the first hauls with cover, it became clear that the difference in selection between the nets was much smaller than expected. A more detailed measurement of the meshes was therefore carried out. This showed that in the "110 mm" net, only the 23 meshes in the

cod-end were close to 110 mm, with an average size of 109,2 mm and a range from 104 mm to 112 mm. In the nylon part of the funnel (about 20 m), the meshes were much larger, averaging 129.9 mm and ranging from 128 mm to 133 mm. In the "135 mm" net, the 26 meshes in the cod-end averaged 134.3 mm with a range from 129 mm to 139 mm. The nylon part of the funnel had an average mesh size of 141.3 mm, ranging from 139 mm to 144 mm. The large mesh size in the funnel of the "110 mm" net had not been noticed by the crew although it had been used for some years in commercial fishing. However, they had noticed that the net tended to catch relatively little of the smaller fish. After the cruise, blueprints of the nets were obtained from the producers. For the "135 mm" net the increase in mesh size was in accordance with the blueprint (135 mm - 140 mm). The blueprint for "110 mm" also showed an increase (110 mm - 114 mm) but much less than observed.

The change in meshes within the net clearly complicates the calculations of selection. In Table 3, selection factors based on the two mesh sizes in each net are given. The table also gives the values l_{25}, l_{50} and l_{75} and the selection ranges $l_{50}-l_{25}$ and $l_{75}-l_{50}$. The selection factors for the two nets are in much better accordance when based on the funnel meshes than when based on the cod-end meshes. Using the funnel meshes, selection factors for cod in the "135 mm" net are 2.92 - 4.13, averaging 3.55. For the "110 mm" net, the range is 3.25 - 3.70 and the average is 3.52. Using the cod-end meshes, the average selection factors are 3.74 and 4.19 respectively for "135 mm" and "110 mm". The selection factor for haddock (funnel meshes) is 3.33 which can best be compared with the value 3.66 for cod in the same haul. The selection range is not significantly different for the two nets. On the average $l_{50-25}=5.6$ cm and $l_{75-50}=5.2$ cm, but the averages are influenced by a couple of extreme values. If these are disregarded, $l_{50-25}=5.4$ cm and $l_{75-50}=4.5$ cm. For haddock $l_{50-25}=4.2$ cm and $l_{75-50}=3.4$ cm, compared to 5.4 cmand 3.4 cm respectively for cod in the same haul.

Hauls where only part of the fish were measured are included in Table 3 (St. 24, 27, 36). However, the calculations are not

very sensitive to errors in the raising factor to total numbers caught. At St. 27 an error of ±20% in the raising factor would have changed the selection factor only by ±0.05. It is probably an equally great source of error that the length frequency distribution from these hauls may not be quite representative of the whole catch. However, a test made on St. 48 indicated that also this would be relatively unimportant. The values at St. 24 and St. 27 are not significantly different from other stations, and the high selection factor at St. 36 is likely to have been caused by the fact that one of the wings got stuck.

DISCUSSION

Differences in age and construction of the nets may give them different selective properties. Unfortunately, there is little basis for estimating to what extent this has influenced the results of the experiments. On the assumption that the selection factor in reality is the same for both nets, the results can only be explained if nearly all the selection has taken place in the funnel, before the cod-end. In this case, the selection factors should be calculated on the basis of the meshes in the funnel and will not be significantly different for the two nets. For the "135 mm" net the difference in mesh size is only 7 mm (5%) and the selection factor for each haul is defined inside a range of about 0.2 (Table 3), regardless of where selection takes place. The producer of the "135 mm" net presently dominates the market and the selective properties of this net should therefore be the one which is most representative for the Norwegian fleet of Danish seiners.

There is no evidence that the size of the catch or the size composition of the fish have had any influence on the selection. There is a slight indication that the time interval from start of hauling until the wings are parallel may be of some significance. At least on St. 36 where one of the wings got stuck and the time interval was about three times the average, the selection factor is much higher than in any other haul.

The variation in selection factor from haul to haul is caused partly by inadequate data, but other factors are almost certainly also involved. Particularly the currents may have a large effect on the fishing operation. If the selection factor is based on the funnel mesh and disregarding the extreme values, a value of about 3.6 would seem to be appropriate for cod (Table 3). For haddock, both the selection factor found in the haul and the comparison with cod in the same haul indicate that the selection factor is about 3.3. This is also in agreement with the difference found between cod and haddock in trawl selection experiments in the Barents Sea (Anon. 1979).

Selectivity factors for cod and haddock of 3.6 and 3.3 respectively are approximately 0.35 lower than the values used for trawl in the Barents Sea, but are higher than the values of 3.2 and 2.3 found by Annaniassen and Hylen (1967). The latter experiment used a heavier cover which was fastened further back on the net, and it is possible that this has caused the difference for cod. Also, for some reason, the selection curve for cod approached a straight line. For haddock the data were clearly inadequate, and the selection curve was only established for lengths with more than 75% retention.

Direct comparison with the North Sea experiments is difficult because this is a different area and because cotton cod-ends were used. However, it is probably significant that the North Sea experiments in contrast to the northern Norway experiments gave higher selection factors for Danish Seine than for trawl (Graham 1954, Graham *et al.* 1954, Lucas *et al.* 1954). One explanation may be that according to fishermen Danish seine in northern Norway is used quite differently from the way it is used in the North Sea. Also the Danish seine experiments in the North Sea were carried out at greater depths, according to Graham (1954) 38-43 fathoms and Lucas *et al.* (1954) 45-55 fathoms, compared to 18-32 fathoms in the recent Norwegian experiments. This difference in depth means that the hauls in the North Sea probably took longer time, which may have given the fish more opportunities to escape, and accordingly the selection factor would tend to increase.

The Icelandic experiments (Thorsteinsen, 1980) gave a selection factor of 3.48 for cod which is only slightly below the value from northern Norway, whereas the Icelandic selection factor for trawl of 3.24 is considerably lower than values from the Barents Sea. The reasons for this discrepancy are not clear.

The experiments in northern Norway indicate that the selectivity in Danish seine is variable, but can be reasonably well established for a single vessel and a single gear. However, it is questionable to what extent the results can be taken as representative for the fishery. Although the "135 mm" net was of the type most commonly used, there are regional differences in rigging and individual differences between skippers in the way they fish. Probably of larger importance is the size of the vessel and its engine power. Bigger vessels can fish with Danish seine at considerably greater depths. If the time factor is important for the selectivity, fishing at greater depths will probably change the selectivity of the gear. However, increased engine power may work the other way and more experiments are needed to get a full understanding of the selectivity in Danish seine.

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Table 1. Danish seine hauls with total catch (cod-end + cover) of more than 100 fish during the selectivity experiments in August-September 1982.

St.No.	Date	Position		Depth (fathoms)	Mesh size	Duration of the haul(min.)			Species	Catch in number			Catch in weight(kg)[a]		
						t_1	t_2	t_1+t_2		Cod-end	Cover	Total	Cod-end	Cover	Total
24	15.8	N 71°03'	E 27°17'	20	"135 mm"	9.15	7.45	17.00	Haddock	497	780	1277	613	621	1234
"	"	"	"	"	"	"	"	"	Cod	68	718	786	57	363	420
27	17.8	"	"	"	"110 mm"	7.45	9.45	17.30	"	1779	3659	5438	1896	2626	4522
36	25.8	N 70°53'	E 28°48'	18	"135 mm"	23.00[b]	7.00	30.00[b]	"	112	2008	2120	119	1358	1476
38	27.8	N 71°06'	E 26°05'	28	"	7.30	10.00	17.30	"	317	409	726	457	347	804
41	30.8	N 71°03'	E 26°15'	"	"110 mm"	6.45	11.15	18.00	"	534	230	764	963	210	1173
42	"	"	"	"	"	5.30	10.30	16.00	"	165	153	318	229	131	360
43	"	"	"	32	"135 mm"	7.15	10.45	18.00	"	142	95	237	179	91	270
44	"	"	"	"	"	9.00	10.00	19.00	"	41	86	127	57	79	137
46	1.9	N 71°06'	E 26°05'	28	"	5.45	9.15	15.00	"	406	984	1390	625	575	1200
47	2.9	"	"	24	"110 mm"	7.00	9.30	16.30	"	138	1008	1146	104	356	460
48	"	"	"	"	"	6.30	10.15	16.45	"	374	1681	2055	408	833	1241
49	"	"	"	"	"	4.45	9.45	14.30	"	211	457	668	185	205	391

t_1= time from start of hauling until wings are parallel, t_2= time from wings are parallel until hauling stops.

a) Weight calculated from length distribution ($W(g) = 0.01 \cdot L^3(cm)$).

b) One wing got stuck at the bottom.

Table 2. Length distribution of haddock and cod in cod-end (A) and cover (B).

Length (cm)	Haddock St. 24 "135 mm" A	Haddock St. 24 "135 mm" B	Cod St. 24 "135 mm" A	Cod St. 24 "135 mm" B	Cod St. 27 "110 mm" A	Cod St. 27 "110 mm" B	Cod St. 36 "135 mm" A	Cod St. 36 "135 mm" B	Cod St. 38 "135 mm" A	Cod St. 38 "135 mm" B	Cod St. 41 "110 mm" A	Cod St. 41 "110 mm" B	Cod St.42 "110 mm" A	Cod St.42 "110 mm" B	Cod St.43 "135 mm" A	Cod St.43 "135 mm" B	Cod St.44 "135 mm" A	Cod St.44 "135 mm" B	Cod St.46 "135 mm" A	Cod St.46 "135 mm" B	Cod St.47 "110 mm" A	Cod St.47 "110 mm" B	Cod St.48 "110 mm" A	Cod St.48 "110 mm" B	Cod St.49 "110 mm" A	Cod St.49 "110 mm" B
<25			1																	1		13		1		1
25								2														20		3	1	3
								6												3		41		11		1
				8			1	12												11		48	1	25		9
				28		9		8						1						28	1	75		37		15
30		2		64		177	1	44	1					2					1	31	1	72	3	58		12
				32		75	2	104		1				3					3	54	4	114	5	100	3	33
		2	2	54		47	1	102		6	1	1		5		1			2	81	7	141	2	129	3	35
	1	2	6	76		84		118	1	6		5	1	3		3		1	3	64	6	97	6	145	8	49
		12	6	66	3	121	1	132	2	7	1	2		12		2		5	1	82	7	88	5	151	13	45
35	2	16	3	114	7	196	2	120	3	21	1	4	2	5	1	4		3	4	79	12	77	8	155	13	36
		16	3	42	7	121	1	120		19	4	10	3	6		3		4	3	54	13	50	13	154	9	39
	4	24	1	20	7	159	2	74	3	22	3	7	1	3	1			2	4	57	13	48	9	135	10	39
	3	60	2	20	13	280	3	68	3	19	1	14	1	6	3	4	1	4	3	52	6	47	15	102	11	37
	5	60	2	24	40	224	2	52	6	18	1	3		5	2	3	1		5	43	6	25	10	98	15	38
40	17	64	3	38	110	261	5	122	4	29	3	9	2	5	7	1		1	8	34	4	16	11	62	13	21
	13	70	4	24	57	289	5	176	9	20	3	11	1	7	5	1	1	7	2	34	4	9	15	48	7	9
	24	88	4	18	107	243	4	110	13	29	11	15	6	6	7	7	1	4	9	34	3	7	8	39	8	7
	26	66	3	16	143	299	6	102	10	25	7	25	2	9	3	11	1	8	6	23	5	9	15	45	6	7
	29	92	2	30	150	168	6	118	12	22	13	16	8	10	6	5	2	9	12	25	5	2	15	41	7	6
45	47	92	8	20	193	271	11	104	13	31	13	23	4	8	9	9	3	6	3	30	6	1	18	28	4	2
	40	34	1	4	153	224	7	72	13	22	17	14	8	11	12	5	1	5	19	30	6	3	26	29	9	4
	32	22	3	6	113	131	8	58	11	25	27	17	8	10	6	4	3	3	21	20	3	2	20	23	8	2
	26	24	2	4	107	131	5	54	17	24	23	11	8	5	10	4	2	7	13	25	2	1	16	18	7	4
	33	14			100	47	7	22	12	13	19	8	4	4	4	6	2	3	23	27	4	1	15	12	5	1
50	25	4	3	2	137	65	7	52	24	17	21	11	14	10	12	4	2	4	18	12	3	1	17	3	11	2
	16	2		6	90	19	4	22	15	12	39	8	12	6	6	8	3	4	30	16	1		20	14	7	
	30	8	3		77	9	4	16	13	10	34	6	16	2	12	4	2	2	14	6			19	5	4	
	17		1	2	30	9	6	6	13	5	24	2	9	2	5	2	3		16	8	4		16	4	5	
	17				33		2	2	14	3	23	4	15	2	4	3	3		23	7	2		10	2	4	
55	30	2	3		53		2	6	16		22	2	12	2	3	1		1	17	4	1		8	3	4	
	14						2	2	12	2	31	1	6	2	7		3	1	23	2	4		12	1	4	
	7				13		1		17	1	18		8	1	6		1	1	16	1			6		1	
	6	4			17		1		9		19		6		3		4		9	4			7		2	
	14				3				9		24	1	2		3		1		12	1	1		6		1	
60	8		2		3		1	2	13		23		1						11		1		2		2	
	2				7		1		6		18								15				4		1	
	2				3				5		8				3				5	1	1					
	2								6		13		2					1	7						1	
	2								2		5								5						1	
65	1						1		3		6		1						6				1		1	
>65	2				3				7		58		2		2		1		10				3			
																			24		2		7		2	
Total	497	780[a]	68	718[b]	1779[c]	3659[d]	112	2008	317	409	534	230	165	153	142	95	41	86	406	984	138	1008	374	1681	211	457

a) Measured 390 b) Measured 359 c) Measured 534 d) Measured 392

Table 3. Selection parameters for Danish seine.

St.No.	Species	Mesh size	l_{25} (cm)	l_{50} (cm)	l_{75} (cm)	$l_{50}-l_{25}$ (cm)	$l_{75}-l_{50}$ (cm)	Selection factor: Cod-end mesh	Selection factor: Funnel mesh
24	Haddock	134.3/141.3mm	42.9	47.1	50.8	4.2	3.4	3.51	3.33
24	Cod	134.3/141.3mm	46.3	51.7	55.1	5.4	3.4	3.85	3.66
36	"	"	54.2	58.4	63.5	4.2	5.1	4.35	4.13
38	"	"	41.5	49.9	54.0	8.4	4.1	3.72	3.53
43	"	"	36.2	41.2	54.3	5.0	13.1	3.07	2.92
44	"	"	45.5	51.3	55.8	5.8	4.5	3.82	3.63
46	"	"	43.4	48.6	53.1	5.2	4.5	3.62	3.44
27	Cod	109.2/129.9mm	41.4	47.4	51.5	6.0	4.1	4.34	3.65
41	"	"	40.4	46.3	50.6	5.9	4.3	4.24	3.56
42	"	"	41.1	48.1	52.6	7.0	4.5	4.40	3.70
47	"	"	38.9	43.2	48.2	4.3	5.0	3.96	3.33
48	"	"	42.1	47.1	52.0	5.0	4.9	4.31	3.63
49	"	"	36.7	42.2	47.2	5.5	5.0	3.86	3.25

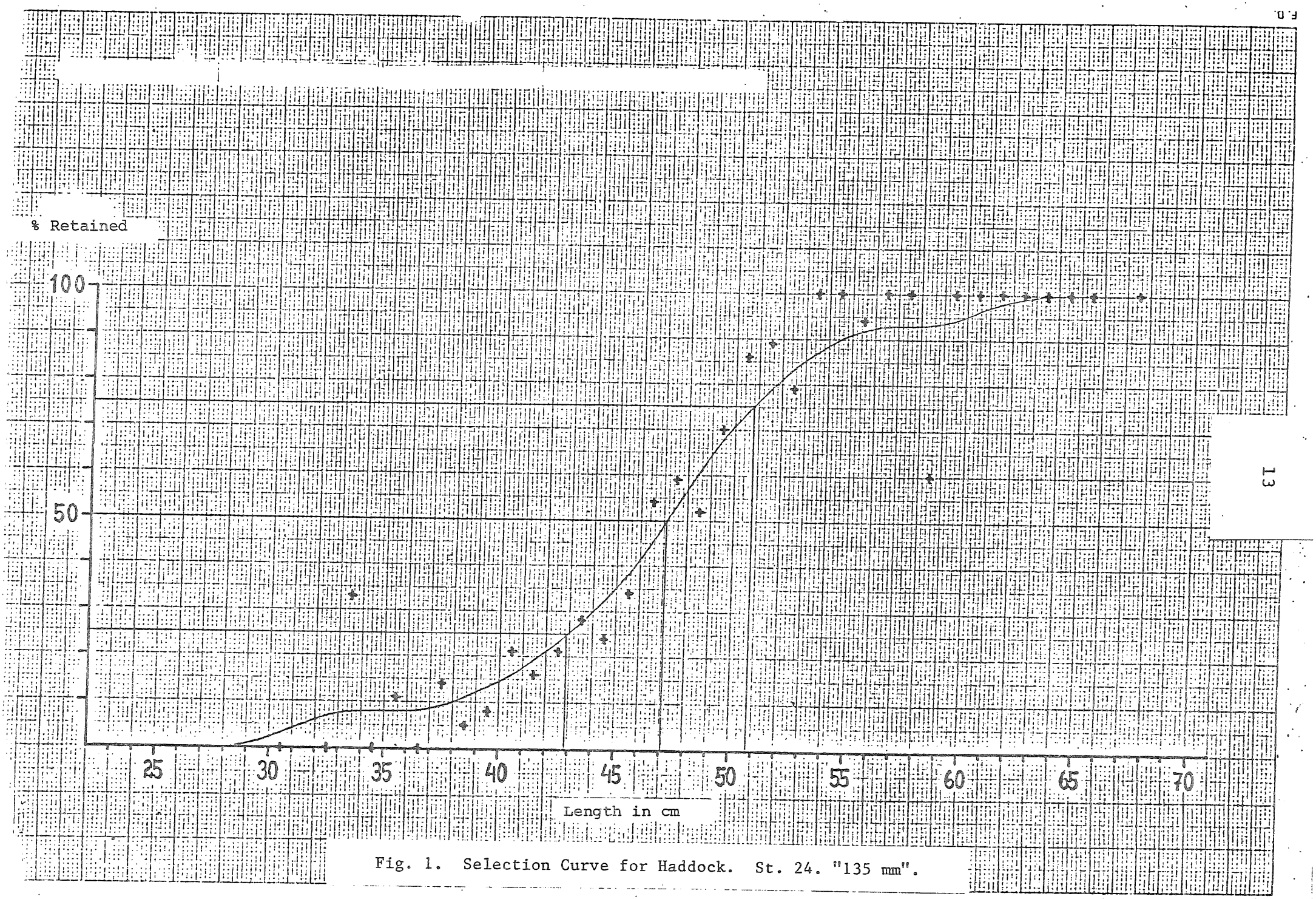

Fig. 1. Selection Curve for Haddock. St. 24. "135 mm".

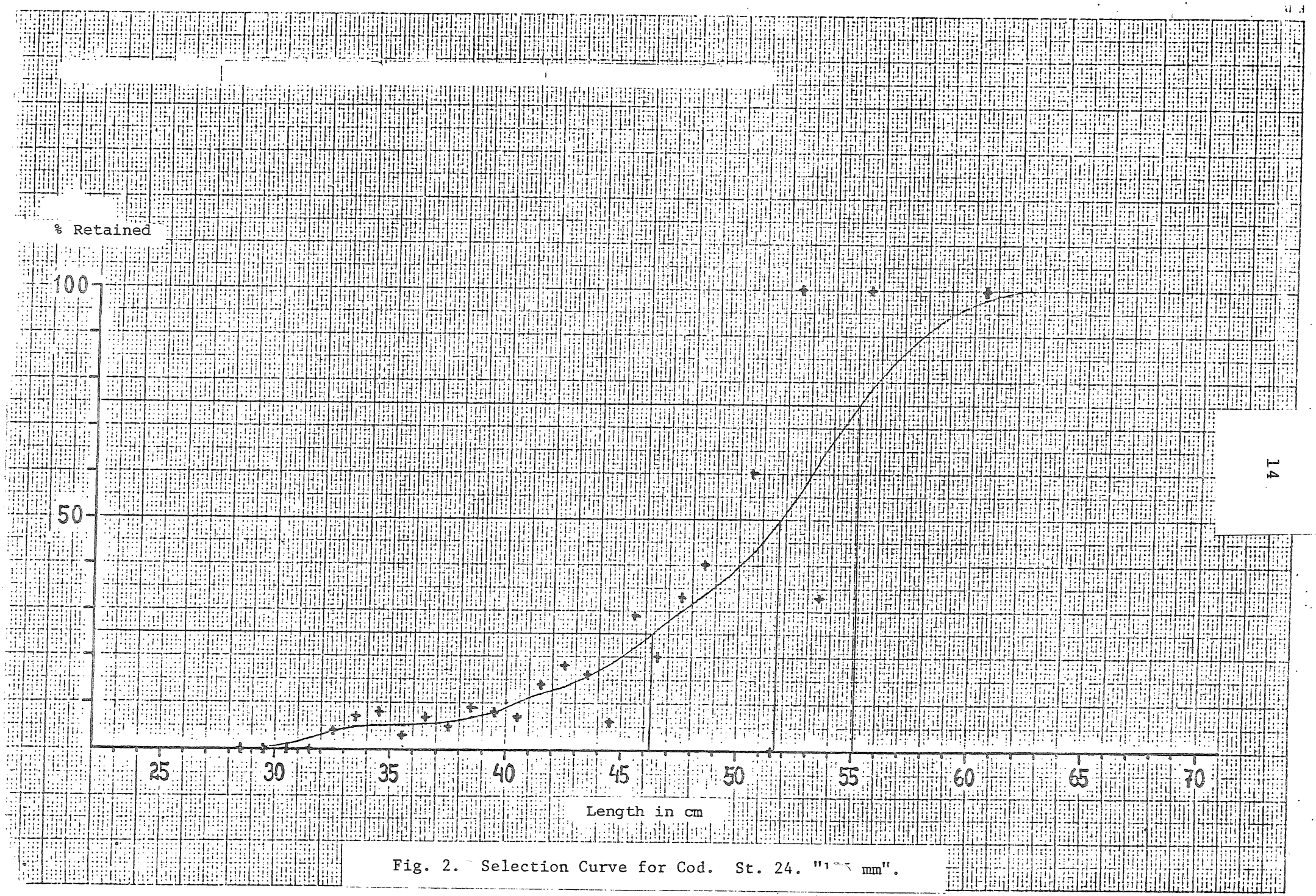

Fig. 2. Selection Curve for Cod. St. 24. "[illegible] mm".

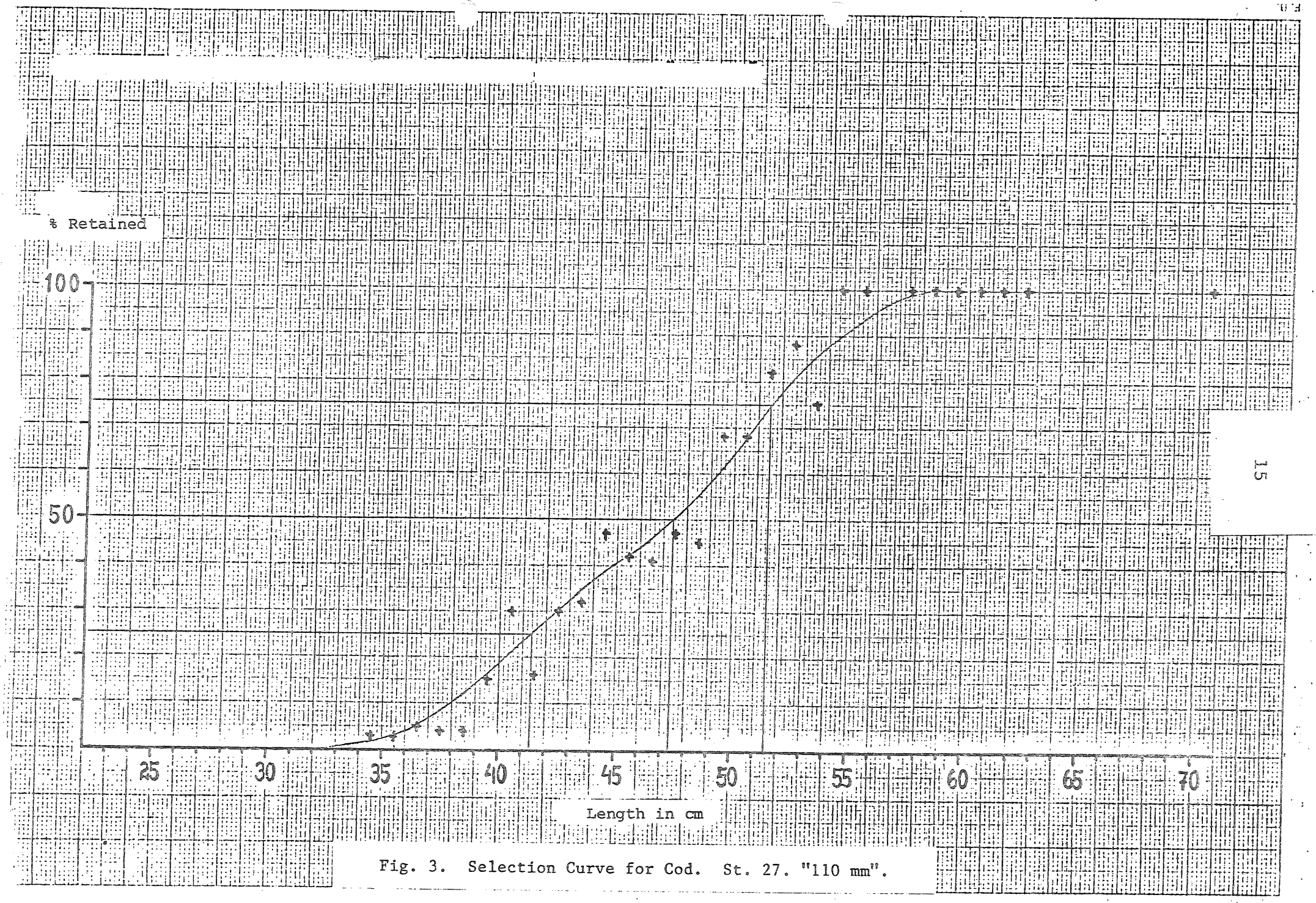

Fig. 3. Selection Curve for Cod. St. 27. "110 mm".

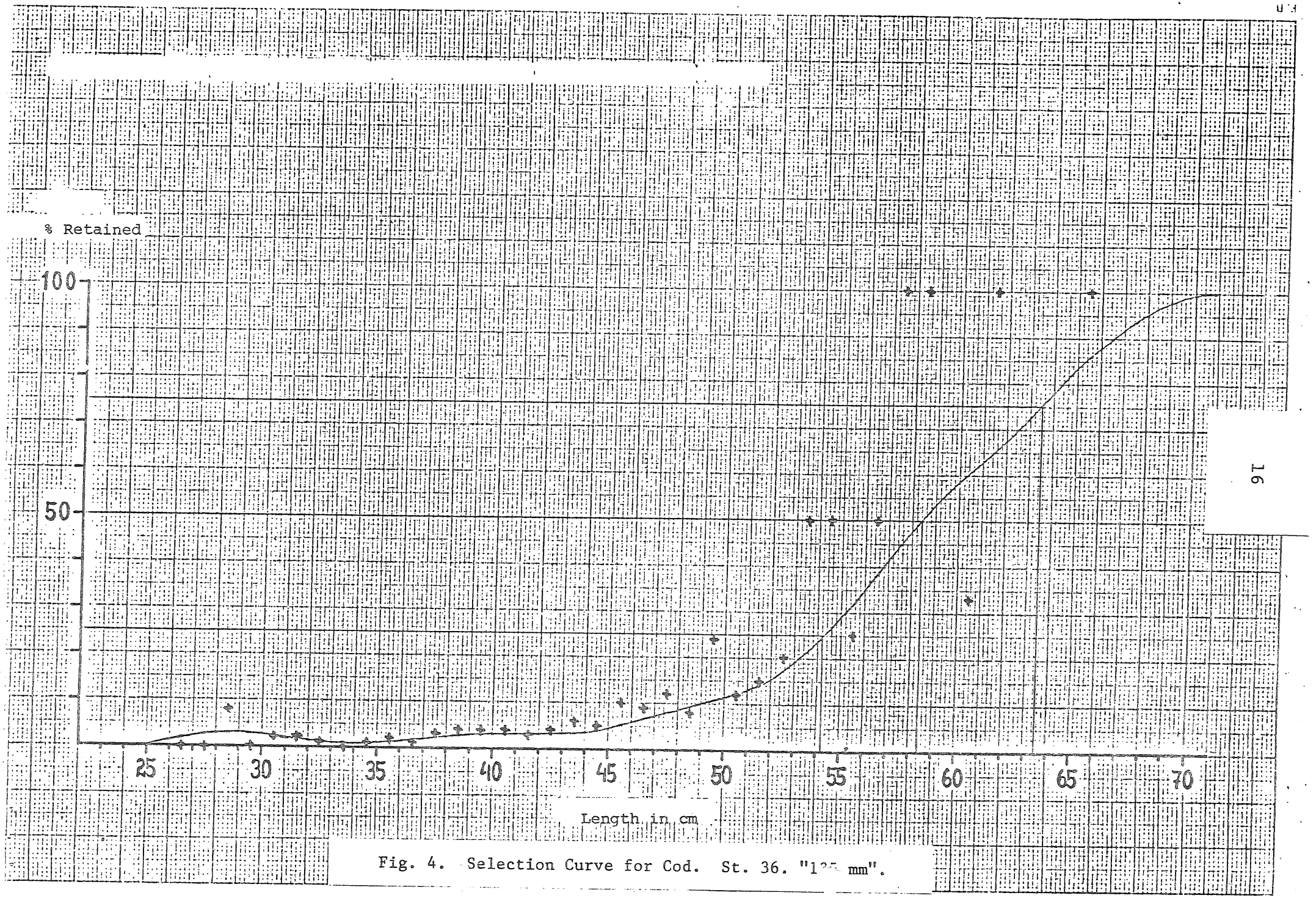

Fig. 4. Selection Curve for Cod. St. 36. "1[illegible] mm".

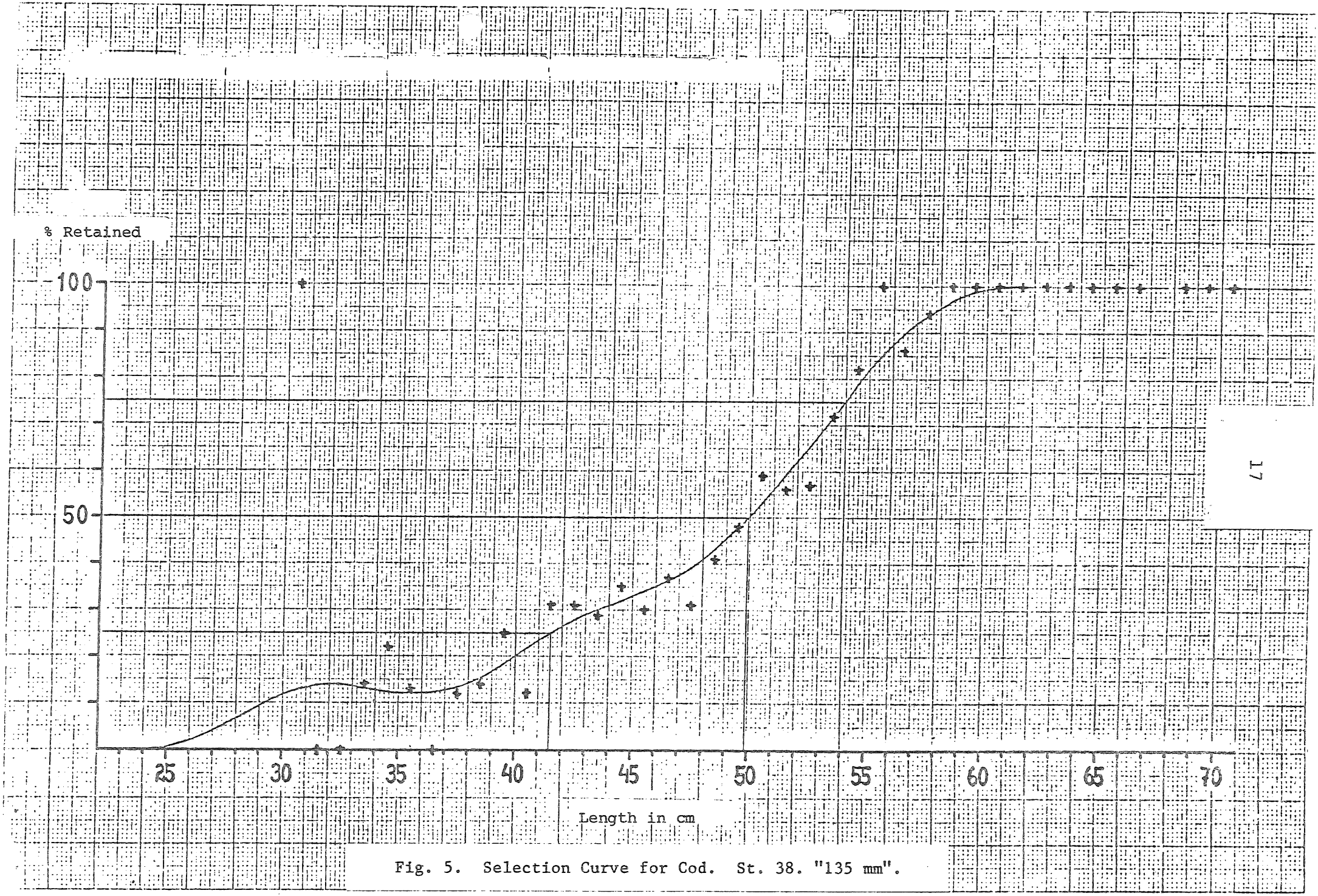

Fig. 5. Selection Curve for Cod. St. 38. "135 mm".

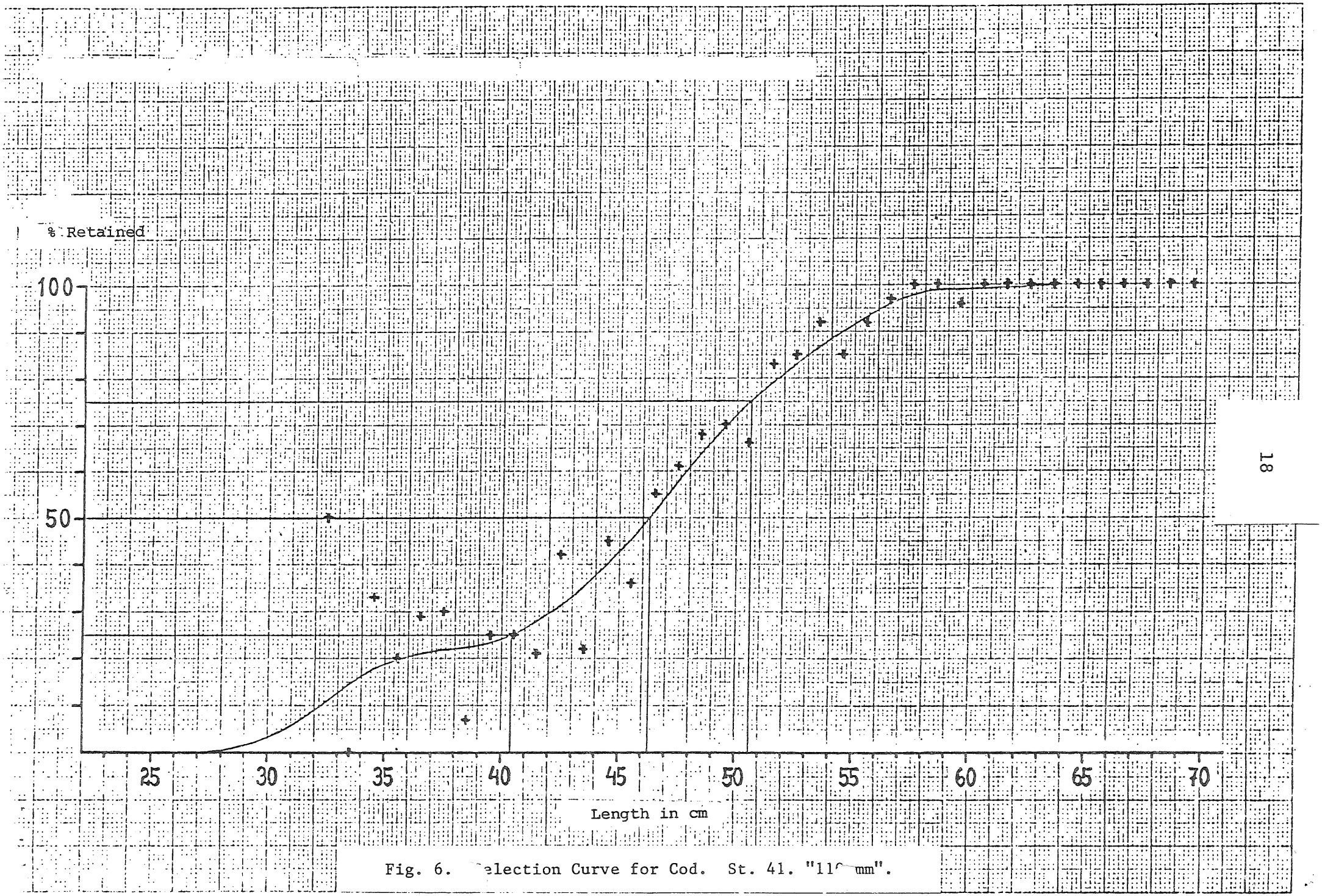

Fig. 6. Selection Curve for Cod. St. 41. "11[illegible] mm".

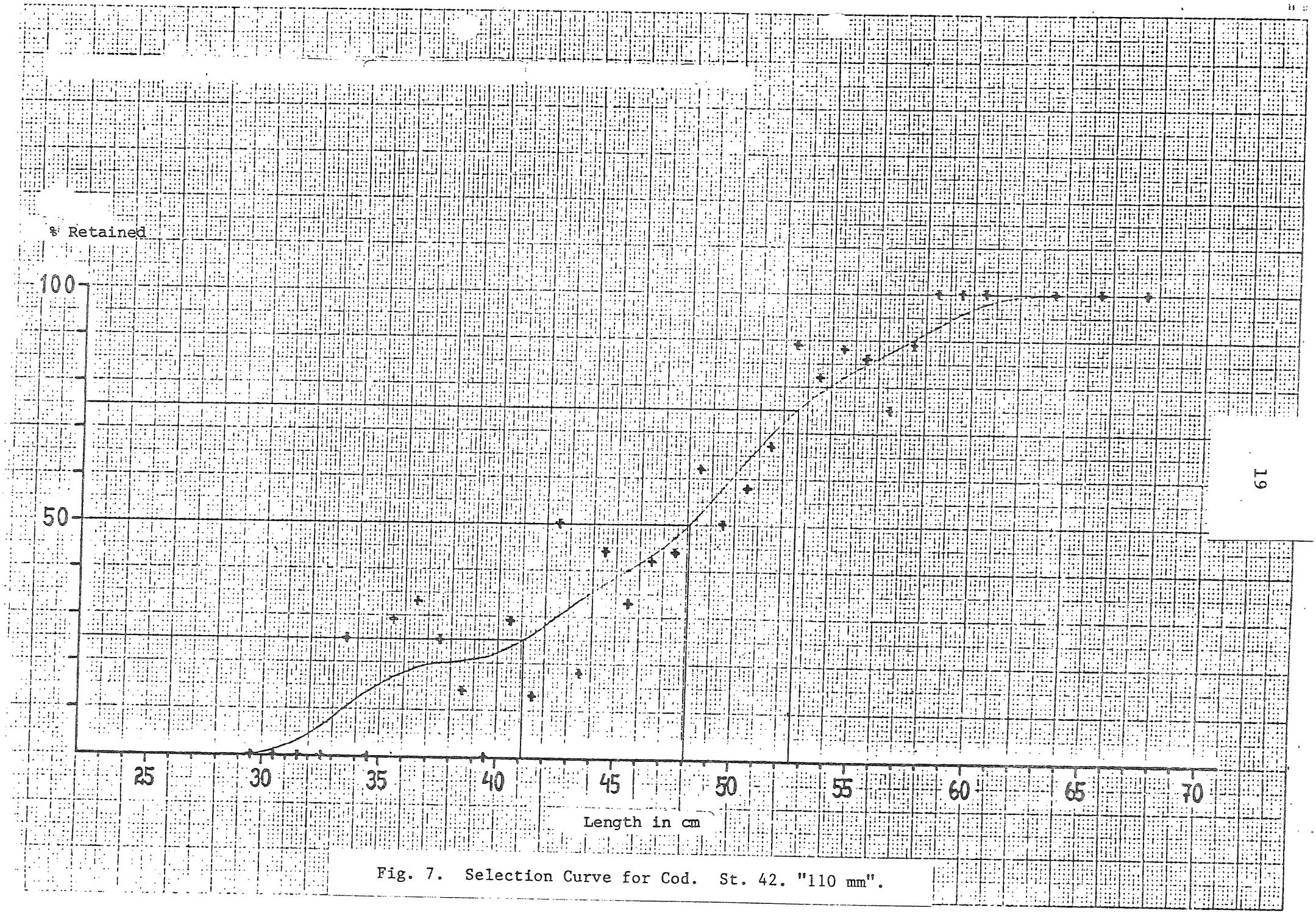

Fig. 7. Selection Curve for Cod. St. 42. "110 mm".

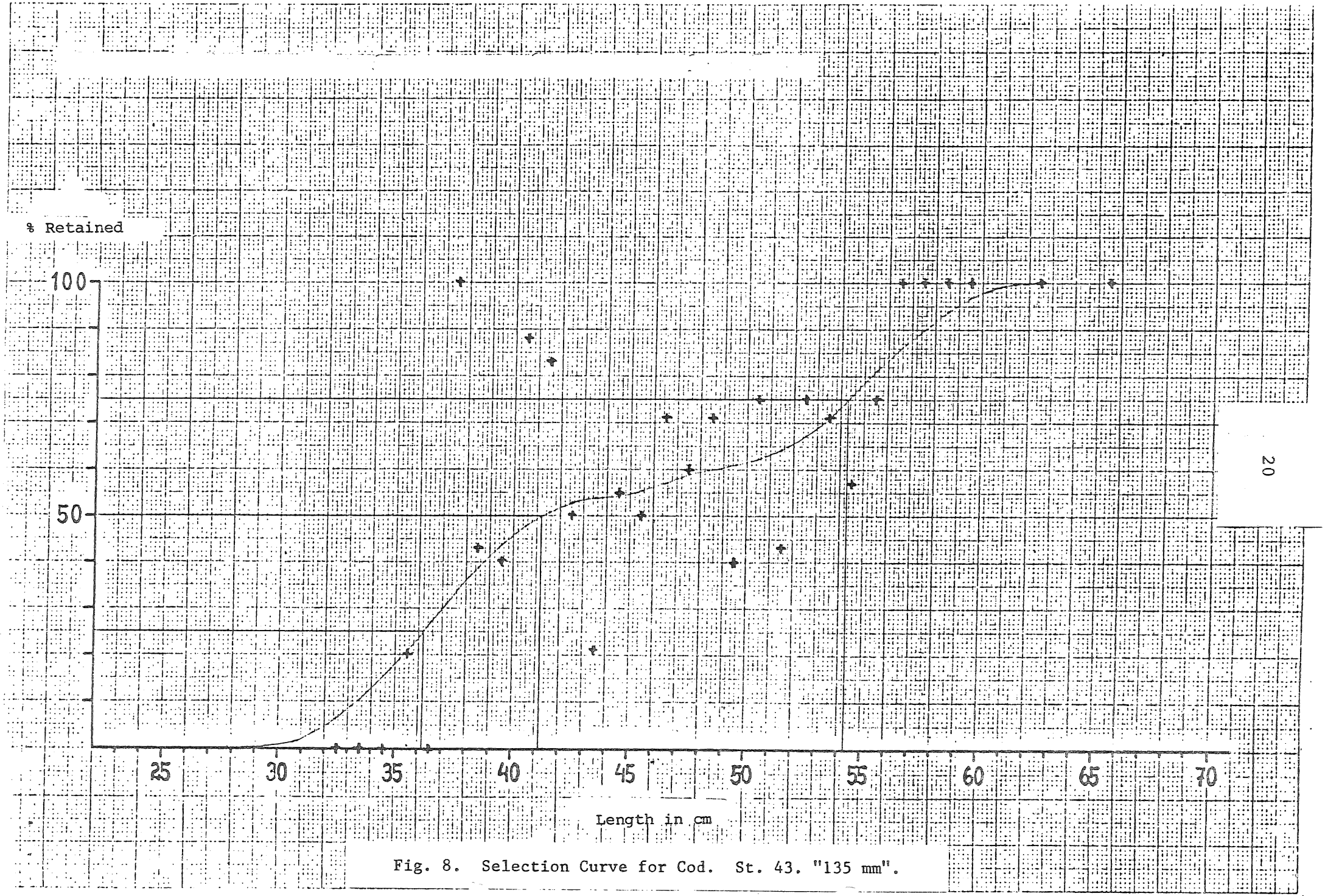

Fig. 8. Selection Curve for Cod. St. 43. "135 mm".

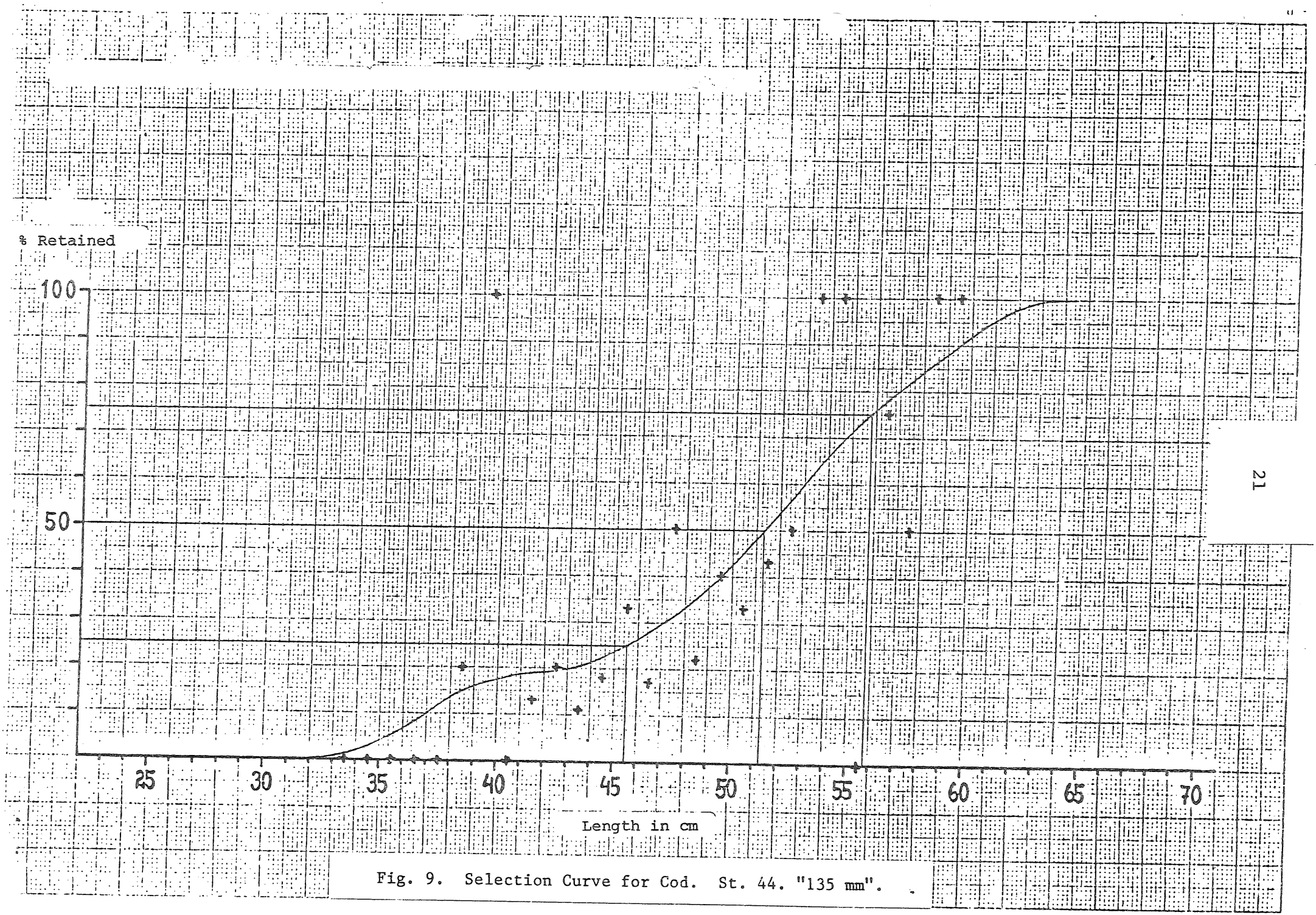

Fig. 9. Selection Curve for Cod. St. 44. "135 mm".

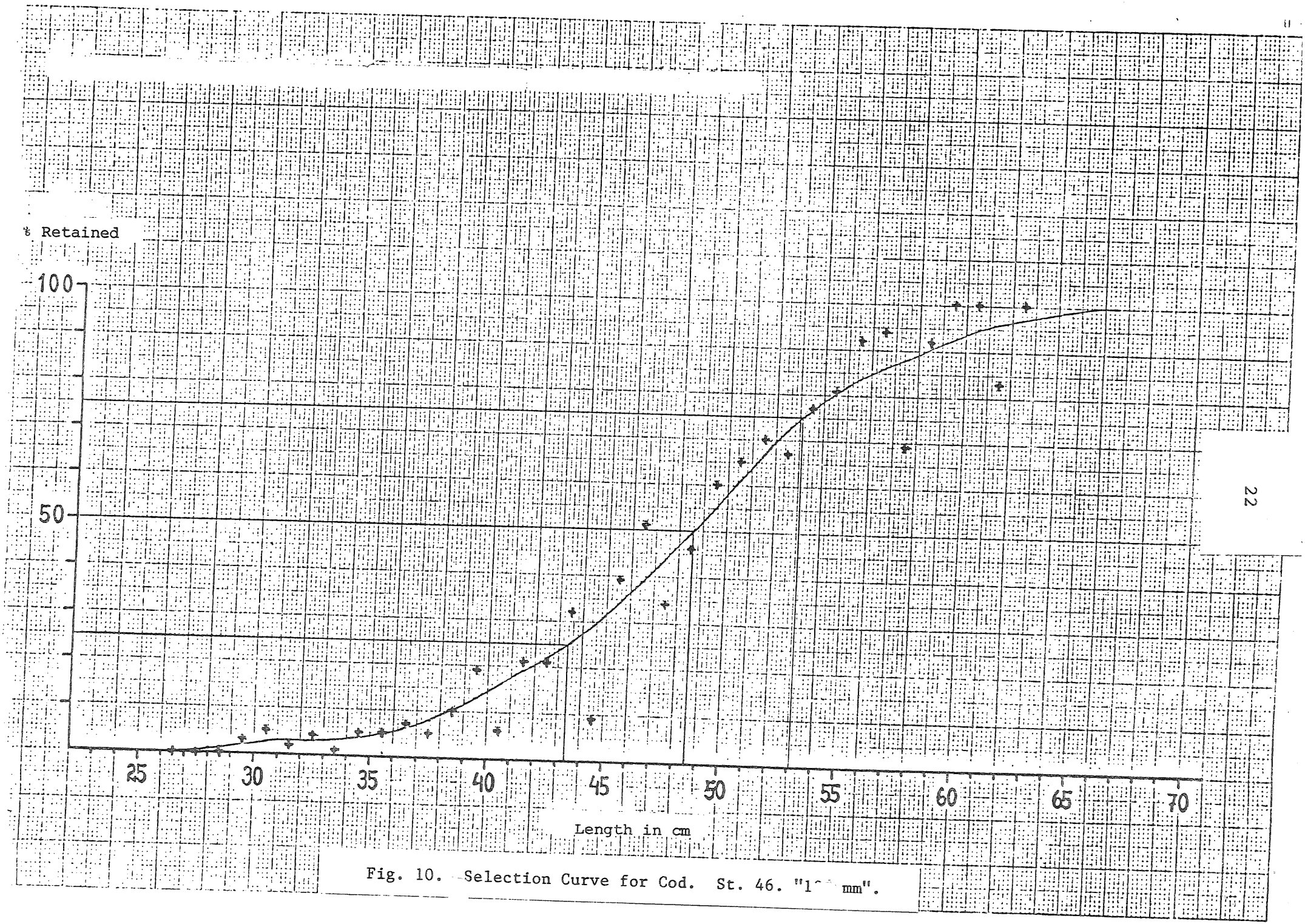

Fig. 10. Selection Curve for Cod. St. 46. "1[illegible] mm".

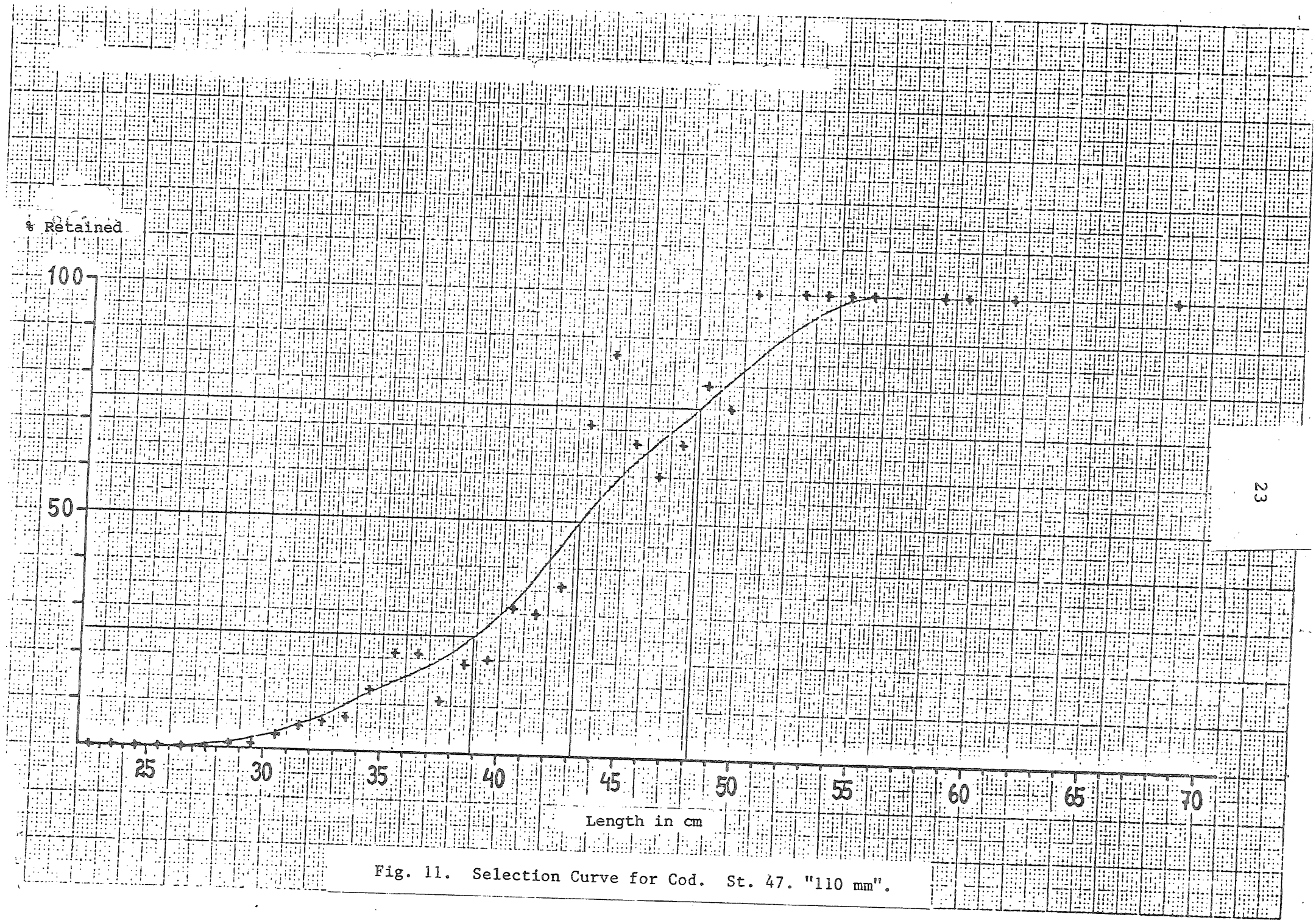

Fig. 11. Selection Curve for Cod. St. 47. "110 mm".

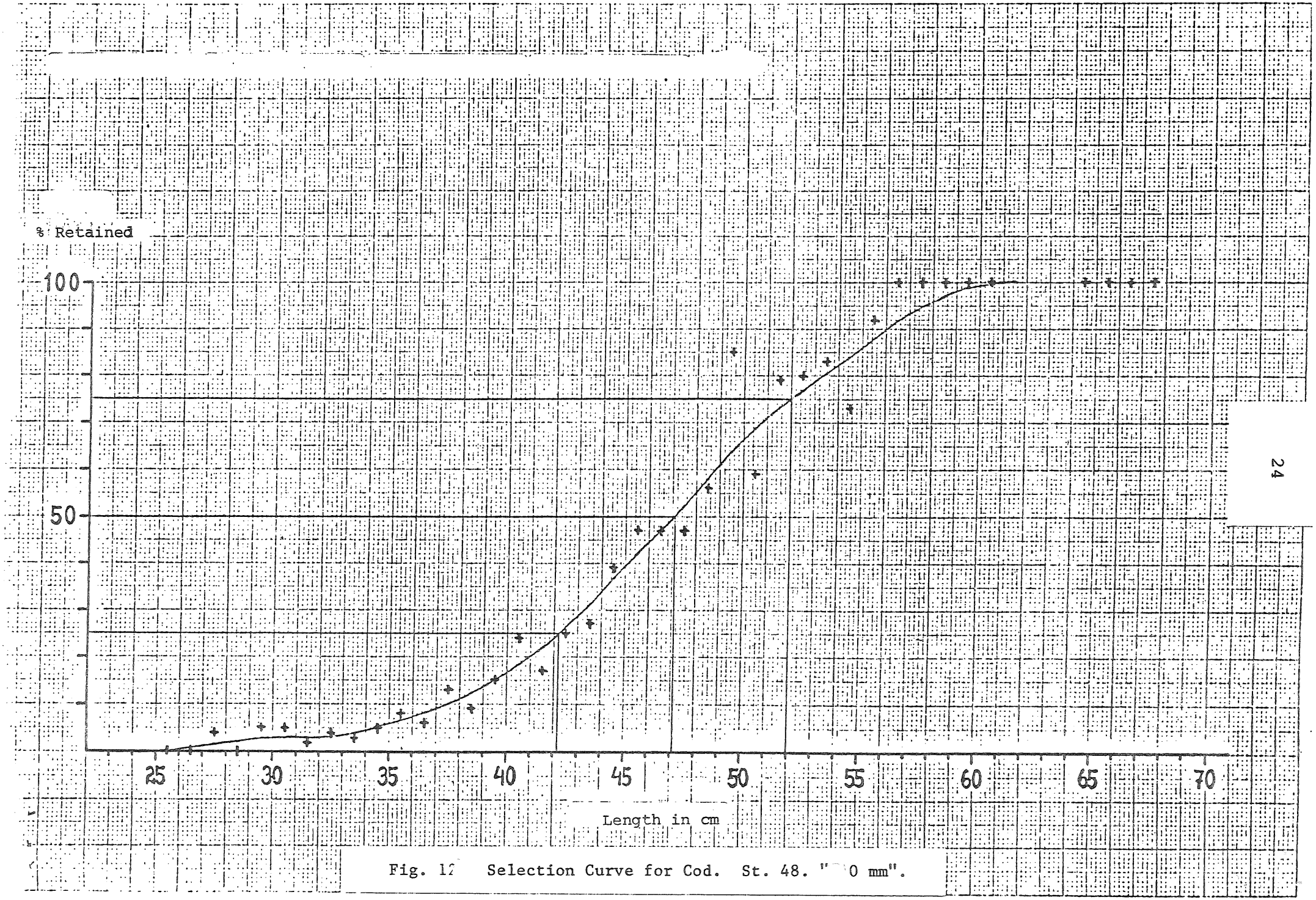

Fig. 12 Selection Curve for Cod. St. 48. "[illegible]0 mm".

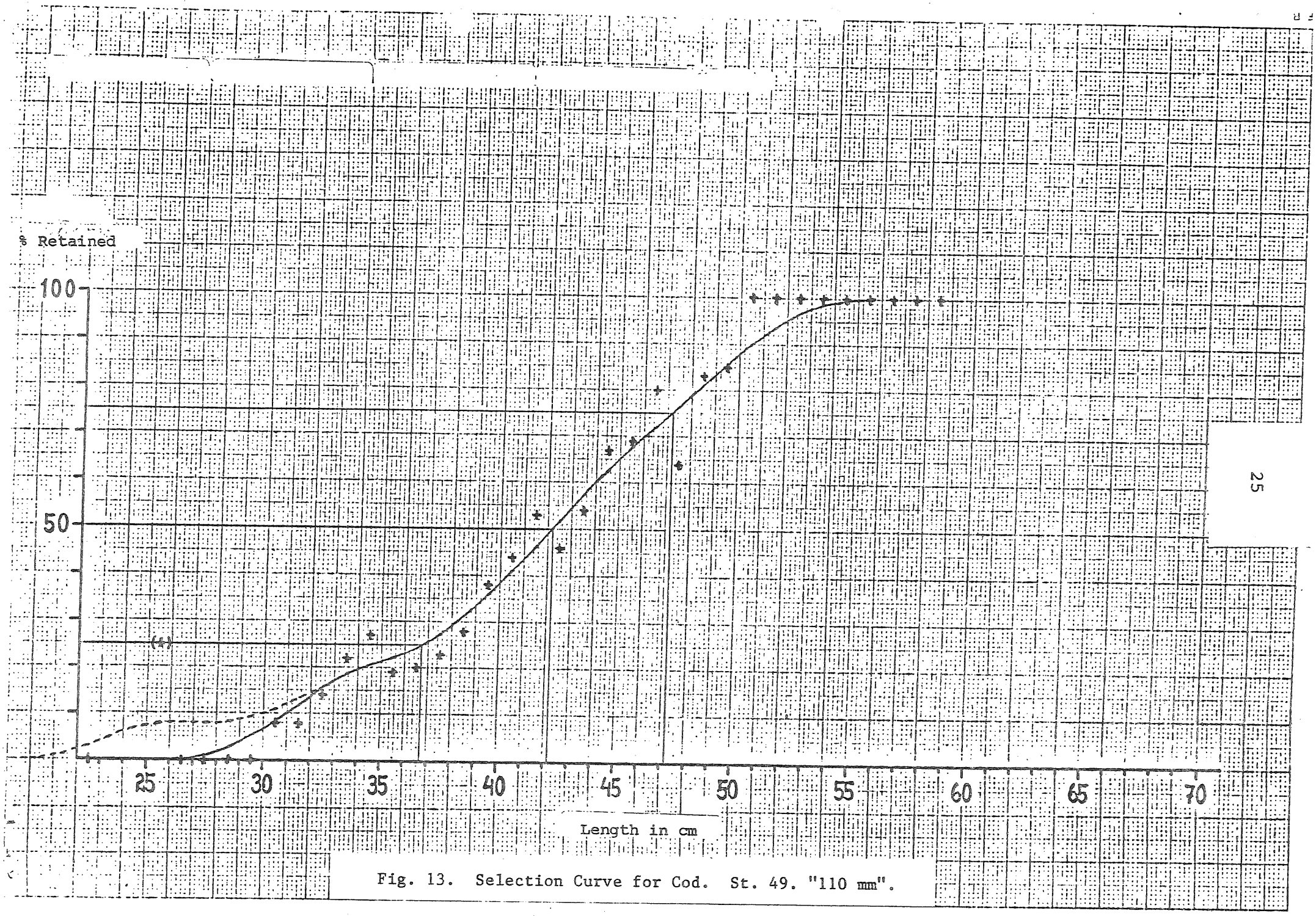

Fig. 13. Selection Curve for Cod. St. 49. "110 mm".