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Observations on the Distribution, Abundance, Growth, Mortality and Sex and Maturity of Cod from the Flemish Cap

by

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Introduction

Random-stratified surveys were carried out on the Flemish Cap in January-February 1978 and 1979 by the R/V *Gadus Atlantica* and in January-February 1977 by the R/V *A. T. Cameron*. Fishing stations were selected for each stratum at random, with a limit of 1 station per rectangle (Res. Doc. 77/VI/29). The number of stations per stratum and the sampling intensity (number of sets per 350 square nautical miles) are shown in Table 1.

The R/V *A. T. Cameron* is a side trawler and uses a smaller trawl than that of the much larger stern trawler R/V *Gadus Atlantica*. To date no data are available to quantify the difference in fishing power between these two vessels. In November 1978, a small number of tows were made by the R/V *A. T. Cameron* on the Flemish Cap. The codends of the trawls included a small mesh liner for all tows.

Average Catch Per Tow from the Random-stratified Surveys

The average catch per tow by stratum and by depth zone is shown in Table 2. These data indicate that the largest concentrations of cod were at depths of 140-200 fathoms in 1977 and 1978, and at 100-140 fathoms in 1979. No large concentrations of cod were observed at depths greater than 300 fathoms.

Abundance and Biomass Estimates from the Random-stratified Surveys

Table 3 shows abundance and biomass estimates by stratum and by depth zone. Not all strata were occupied in 1977. Adjustments to include stratum 1 and strata 12, 13, and 15 in the estimates by depth zone were made on the basis of the estimates for stratum 2 and stratum 14 respectively. Making allowance for the presumedly lower fishing power of the R/V *A. T. Cameron* as compared to the R/V *Gadus Atlantica*, the abundance and biomass of the stock in 1977 and 1978 were relatively stable and there was a sharp decline in the 1979 estimates. Cod were most abundant in depths of 140-200 fathoms in 1977 and 1978 but in 1979 were most abundant at depths of 100-140 fathoms. The average weight per cod increased in the period 1977-79 from 0.9 kg to 1.2 kg. Insignificant numbers of cod are estimated for depths greater than 300 fathoms.

Estimates of Total Mortality

The catch at age for 1977-79 are given in Table 4. It is clear that the 1973 year-class is the dominant year-class in the series, comprising 58% of the total stock available to the research trawl in 1977 and 1978 and about 26% of the total stock in 1979. Between 1978 and 1979 the total mortality for this year-class is estimated from the abundance estimates as 1.9. Estimates of total mortality derived from the descending catch curves in per mille for 1977-79 and for 1978-79 ages 5-9 were 1.4 and 1.5 respectively. Their values are indicative of total mortalities on the stock for the 1970's. The catch curves are shown in Fig. 1 and 2.

Age and Growth

The age compositions for January-February 1977, January-February 1978, November 1978 and January-February 1979 are shown in Fig. 3-6. The total length composition is shown in each figure as well as the distribution of ages within the length frequency as calculated from the age-length keys derived from sampling on the respective cruises. The modal lengths in the frequencies corresponding to year-classes 1972-1975 can be followed through the winter series. In November 1978 and January-February 1977 it would appear that the 1977 year-class is relatively strong and that the 1976 year-class is quite poor.

The consistency of the year-class modes in the series is quite good. Confirmation of the consistency of age interpretation is given in Res. Doc. 79/IV/68.

The average lengths-at-age of cod for the winter cruises in 1977-79 are given in Table 5. The von Bertallanfy fit for the combined averages shows an L_∞ of about 137 cm. May et al (1965) estimated an L_∞ of 98 cm for this stock in the early 1960's. See also Fig. 7-8. Figure 8 would indicate that the average lengths for ages 3,4 and 5 fall below the fitted curve and those for ages 8, 9, 10 and 13 lie above the curve.

The average length-at-age for the November 1978 cruise and those for the January-February 1977 cruise are shown in Table 6. It is clear that the average length of cod of ages 1-6 increased from about 1.5 to 4.0 cm during the two or three month period.

Weight Changes with Respect to Length

From the cruises in 1978 and 1979, frozen samples were returned to the laboratory for detailed observations, among which were observations of weights of fish whole and gutted and in addition weights of various organs. The observed weights obtained are shown in Table 7 for the January-February 1978 cruise (R/V Gadus Atlantica trip 5), for males and females separately and for males and females combined. The regression parameters are shown in Table 8. In Table 7, the final column labeled "Total weight kg" is the total of the gutted weight plus all organs removed and should correspond with the observed round weight. The correspondence is good indicating that the weights can be accepted with confidence. The small but consistant differences can be explained by the loss of fluid involved upon dissection. In addition, weights of 1 gram or less were recorded as 1 gram, and therefore average liver and gonad weights for the smallest specimens are somewhat overestimated.

The logarithmic curves describe adequately the relationship between fork length and the whole and gutted weights and show a reasonably good fit for fork length and the weights of the various organs. The worst fits are those describing the relationship between fork lengths and gonad weight. For the males, testes weights averaged 1 gram or less up to 40 cm and increased from about 30 grams at 43 cm to 68 grams at 52 cm. From 55 cm to 76 cm the average weights were quite variable. There was a similar trend in average weights in the ovaries, with an average weight of about 50 grams at 46-49 cm followed by fluctuating but low average weights in specimens up to about 79 cm.

Sex and Maturity

The numbers of cod for which sex and maturity were observed in January-February 1978 and 1979 were as follows:

YEAR	MALES	FEMALES	TOTAL
1978	6496	6749	13245
1979	1584	1601	3185

The sex ratio is therefore about 1:1.

Anomalies in the percent mature at length for both females and males in January-February 1978 are at present under active consideration. For January-February 1979 the percent mature at length for males and females are shown in Table 9, and in Fig. 9 and 10. The lengths at which 50% of males and females are mature are about 50 cm and 52 cm, respectively. In

January-February 1979, cod greater than 51 cm were composed mainly of ages 6 and older (see Fig.6).

For the females, the column in Table 9 headed "Maturing this Year" includes mainly specimens having ovaries containing opaque eggs visible to the naked eye, and to a much lesser extent ovaries with some translucent or clear eggs. Those females listed as "spent last year showed no sign of developing opaque eggs. It is evident that these specimens, concentrated in the 60-70 cm fork length range, would not have spawned at the same time as those with opaque eggs already developed. Indeed those specimens perhaps would not have spawned at all in the year of capture, and the anomalous points at lengths 64-76 cm in Fig. 10 would be very much accentuated as in Fig. 11. Similar anomalies are present in the 1978 data.

Lilly (1979) is of the opinion that in the absence of intermediate-sized redfish on the Flemish Cap, cod may virtually stop growing at about 60-70 cm. The absence of food items of suitable size may also delay or restrict spawning in cod of this size presumably through a lowering of the energy reserves.

Conclusions

1. Cod on the Flemish Cap in Winter 1977, 1978 and 1979 were concentrated in depths of 100-140 fathoms. No large concentrations of cod were observed at depths greater than 300 fathoms.

2. The abundance and biomass of the cod in 1977 and 1978 were relatively stable but there was a sharp decline in 1979.

3. Total mortality Z in 1978 was estimated to be about 1.9.

4. The 1973 year-class has been dominant in the stock in the period 1977-1979. The 1977 year-class appears to be good while the 1976 year-class appears to be quite poor.

5. The parameters of the von Bertallanfy curve for the average length-at-age of cod for the winter period 1977-79 were: L_∞ = 137, K = 0.127 and T_0 = 0.783, representing a substantial increase in growth from the early 1960's

6. The relationship with length of weights of whole and gutted cod and of various organs were adequately described by logarithmic curves for the winter, 1978 data. There was considerable variation in the average gonad weights at fish lengths between 55 and 79 cm.

7. The sex ratio was about 1:1 in winter 1978 and 1979.

8. Anomalies in the percent of mature cod at lengths of 60-80 cm may perhaps be related to the absence of food items of suitable size.

References

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Table 1. Number of tows per stratum and by depth zone during research cruises on Flemish Cap, January-February 1977-79. (ATC = R/V A. T. *Cameron*; GADUS = R/V *Gadus Atlantica*).

		Number of tows				Sampling intensity		
Stratum	Depth range (fm)	ATC trip 257	GADUS trip 5	GADUS trip 17	Area of stratum	ATC trip 257	GADUS trip 5	GADUS trip 17
1	70- 80	-	4	4	341.8	0.0	4.1	4.1
2	80-100	5	11	6	837.9	2.1	4.6	2.5
3	100-140	4	10	6	627.8	2.2	5.6	3.4
4	100-140	2	6	4	347.8	2.0	6.0	4.0
5	100-140	3	10	6	703.4	1.5	5.0	3.0
6	100-140	3	8	6	496.1	2.1	5.6	4.2
7	140-200	2	8	6	821.8	0.9	3.4	2.6
8	140-200	4	9	6	646.1	2.2	3.9	3.3
9	140-200	2	4	4	314.3	2.2	4.5	4.5
10	140-200	4	14	6	951.3	1.5	5.2	2.2
11	140-200	4	11	6	806.1	1.7	4.8	2.6
12	200-300	-	5	6	670.4	0.0	2.6	3.1
13	200-300	-	4	4	248.6	0.0	5.6	5.6
14	200-300	2	8	6	602.0	1.2	4.7	3.5
15	200-300	-	7	4	665.7	0.0	3.7	2.1
16	300-400	-	4	6	634.1	0.0	2.2	3.3
17	300-400	-	4	3	215.7	0.0	6.5	4.9
18	300-400	-	2	3	209.7	0.0	3.3	5.0
19	300-400	-	5	3	413.9	0.0	4.2	2.5
Total		35	134	95	10554.5	1.2	4.4	3.2
1- 2	70-100	5	15	10	1179.7	1.5	4.5	3.0
3- 6	100-140	12	34	22	2175.1	2.0	5.5	3.5
7-11	140-200	16	46	28	3539.6	1.6	4.6	2.8
12-15	200-300	2	24	20	2186.7	0.3	3.8	3.2
16-19	300-400	0	15	15	1473.4	0.0	3.6	3.6
Total		35	134	95	10554.5			

Table 2. Average catch per tow of cod on Flemish Cap by numbers and weight in January-February 1977-79. Estimates are by stratum and by depth zone. (ATC = R/V A. T. *Cameron*; GADUS = R/V *Gadus Atlantica*).

	Numbers/tow			Weight/tow		
Stratum	ATC trip 257	GADUS trip 5	GADUS trip 17	ATC trip 257	GADUS trip 5	GADUS trip 17
1	141.90	53.50	-	-	191.09	49.82
2	72.60	53.82	20.50	74.55	54.27	76.27
3	118.75	56.60	29.50	46.08	53.62	8.60
4	43.50	49.33	21.00	12.48	34.35	4.37
5	33.00	99.60	56.67	16.19	103.74	72.19
6	67.67	225.25	191.00	37.68	217.07	180.31
7	66.50	137.75	36.17	31.78	117.36	35.94
8	50.00	172.44	25.50	32.91	148.61	15.96
9	33.50	426.65	26.75	93.75	496.22	38.02
10	50.25	103.64	27.33	33.14	111.33	37.61
11	299.50	112.64	41.50	367.97	94.93	48.20
12	-	47.00	14.33	-	73.73	25.65
13	-	57.50	6.50	-	97.61	14.87
14	48.50	77.38	14.50	54.48	104.19	26.18
15	-	122.29	16.00	-	150.01	28.15
16	-	3.00	0.00	-	5.22	0.00
17	-	10.20	0.67	-	13.56	0.38
18	-	1.00	0.00	-	1.13	0.00
19	-	1.60	1.33	-	2.00	2.42
Average	87.11	99.94	32.33	78.77	105.29	38.93
1- 2	(72.6)	77.3	33.7	(74.6)	90.8	65.7
3- 6	72.0	107.7	79.4	30.9	103.4	72.0
7-11	112.4	153.3	31.8	124.2	149.2	34.9
12-15	(48.5)	80.8	13.2	(54.5)	110.1	24.2
16-19	?	4.2	0.4	?	5.8	0.6

Table 3. Abundance, biomass, and average weight estimates of cod on Flemish Cap during January-February 1977-79. Estimates are given by stratum and by depth zone. (ATC = R/V A. T. *Cameron*; GADUS = R/V *Gadus Atlantica*).

Stratum	Abundance ('000's)			Biomass (tons)			Average weight per cod		
	ATC trip 257	GADUS trip 5	GADUS trip 17	ATC trip 257	GADUS trip 5	GADUS trip 17	ATC trip 257	GADUS trip 5	GADUS trip 17
1	-	3,643	1,373	-	4,906	1,279	-	1.35	0.93
2	4,567	3,385	1,290	4,689	3,414	4,798	1.03	1.01	3.72
3	5,598	2,668	1,391	2,172	2,528	406	0.39	0.95	0.29
4	1,136	1,289	549	326	897	114	0.29	0.70	0.21
5	1,741	5,256	2,990	854	5,474	3,809	0.49	1.04	1.27
6	2,519	8,386	7,111	1,403	8,082	6,713	0.56	0.96	1.06
7	4,103	8,500	2,232	1,961	7,241	2,218	0.48	0.85	0.99
8	2,425	8,362	1,237	1,596	7,206	774	0.66	0.86	0.63
9	790	10,056	631	2,210	11,696	896	2.80	1.16	1.42
10	3,587	7,399	1,951	2,366	7,947	2,685	0.66	1.07	1.38
11	18,120	6,815	2,511	22,263	5,743	2,916	1.23	0.84	1.16
12	-	2,364	721	-	3,708	1,290	-	1.57	1.79
13	-	1,075	121	-	1,824	278	-	1.70	2.30
14	2,192	3,496	655	2,462	4,708	1,183	1.12	1.35	1.81
15	-	6,113	800	-	7,500	1,407	-	1.23	1.76
16	-	143	0	-	248	0	-	1.73	-
17	-	165	11	-	220	6	-	1.33	0.55
18	-	16	0	-	18	0	-	1.13	-
19	-	50	41	-	62	75	-	1.24	1.83
Total	46,778	79,181	25,615	42,302	83,422	30,847	0.90	1.05	1.20
1- 2	(6,430)	7,028	2,663	(6,602)	8,320	6,077	(1.03)	1.18	2.28
3- 6	10,994	17,599	12,041	4,755	16,981	11,042	0.43	0.96	0.92
7-11	29,025	41,132	8,562	30,396	39,833	9,489	1.05	0.97	1.11
12-15	(7,962)	13,048	2,297	(8,943)	17,740	4,158	1.12	1.36	1.81
16-19	?	374	52	?	548	81	?	1.47	1.56
Total	54,411	79,181	25,615	50,696	83,422	30,847	0.93	1.05	1.20

Table 4. Cod in Div. 3M: estimates of total mortality (Z) from research vessel cruises in 1978-79.

	Numbers (000's)			Per mille age frequencies				
	1977	1978	1979	1977	1978	1979	'78-79	'77-79
1	12	-	-	-	-	-	-	-
2	2134	95	4675	46	1	183	184	230
3	10272	4755	1067	220	60	42	102	322
4	27208	15539	5610	581	196	219	415	996
5	5958	45671	5437	127	576	212	788	915
6	768	12139	6703	16	153	261	414	430
7	165	476	1713	4	6	67	73	77
8	13	181	108	-	2	4	6	6
9	177	65	55	4	1	2	3	7
10	40	154	20	1	2	1	3	4
11	13	71	30	-	1	1	2	2
12	-	18	10	-		-	-	-
13	25	32	52	1		2	2	3
14	-	37	29			1	1	1
15+	12	12	101			2	2	2
Total	46797	79245	25612	1000	998	997	1995	2995

Age 5+	58856	
Age 6+		8823
Ages 5-9	58532	
Ages 6-10		8601

Series	Ages	Slope	r	t
'78-79	5-9	1.54	0.98	8.6
	5-10	1.29	0.96	7.0
	5-11	1.11	0.95	6.6
	6-9	1.73	0.98	7.0
	6-10	1.30	0.94	4.6
	6-11	1.06	0.91	4.5
'77-79	5-9	1.40	0.96	6.1
	5-10	1.20	0.95	6.3
	5-11	1.08	0.95	7.1
	6-9	1.45	0.82	2.5
	6-10	1.17	0.92	4.1
	6-11	1.01	0.92	4.8

Estimates of Z for 1978/79

Ages	5/6	Z = 1.92
"	6/7	1.96
"	7/8	1.48
"	8/9	1.19
"	9/10	1.18
"	(5-9)/(6-10)	1.92
"	(5+)/(6+)	1.90

Table 5. Average length at age of cod on Flemish Cap as determined from research vessel cruises in January-February 1977-79.

Age	1977	1978	1979	Average 1977-79	Fitted Points
1	10.00			10.00	3.71
2	20.00	19.50	24.46	21.32	19.54
3	25.98	27.87	29.43	27.76	33.84
4	44.58	35.15	40.62	40.12	45.77
5	56.87	48.39	45.65	50.30	56.59
6	77.15	58.34	56.04	63.84	66.13
7	81.91	77.71	65.00	74.87	74.54
8	85.00	87.30	86.29	86.20	81.95
9	91.75	94.43	95.00	93.73	88.47
10	100.00	95.94	97.00	97.65	94.22
11	82.00	101.20	104.00	95.73	99.29
12		110.00	112.00	111.00	103.76
13	119.50	110.00	109.00	112.83	107.69
14		114.84	109.00	111.92	111.16
15		115.00	103.00	109.00	114.21
16			116.00	116.00	116.90
17			115.00	115.00	119.28
18			130.00	130.00	121.37
19	121.00	103.00	118.00	114.00	123.21

$K = 0.127$ $t_0 = 0.783$ $L_\infty = 136.9$

Table 6. Average length at age of cod on Flemish Cap as determined from research vessel cruises in November 1978 and January-February 1979. (ATC = R/V A. T. *Cameron*; GADUS = R/V *Gadus Atlantica*).

Age	ATC trip 284	GADUS trip 17	Growth increment by year-class
1	21.71	-	-
2	27.83	24.46	2.75
3	36.63	29.43	1.60
4	41.70	40.62	3.99
5	53.36	45.65	3.95
6	62.31	56.04	2.68
7	87.40	65.00	2.69
8	-	86.29	-
9	-	95.00	-
10	101.50	97.00	-
11	-	104.00	-
12	-	112.00	-
13	130.00	109.00	-
14	-	109.00	-
15	-	103.00	-
16	-	116.00	-
17	-	115.00	-
18	-	130.00	-
19	-	118.00	-

Table 7. Cod in Div. 3M: analysis of cod weights from RV *Gadus* Trip 5, February 1978.

Male + Female

			AVERAGES					
LENGTH	FREQ	ROUND WT KG	GUTTED WT KG	LIVER WT GM	GONAD WT GM	STOMACH WT GM	OTHER VISCERA WT GM	TOTAL WT KG
19	3	0.040	0.040	1.000	1.0000	1.0000	1.0000	0.0440
22	4	0.080	0.070	1.000	1.0000	2.5000	2.2500	0.0767
25	6	0.135	0.125	1.667	1.0000	2.6667	4.6667	0.1350
28	8	0.167	0.152	2.875	1.0000	4.1250	5.6250	0.1661
31	8	0.239	0.216	3.125	1.1250	3.5000	7.3750	0.2314
34	8	0.324	0.294	4.625	1.1250	7.1250	11.1250	0.3177
37	8	0.412	0.376	4.125	1.6250	6.6250	12.7500	0.4014
40	8	0.534	0.479	10.625	1.6250	12.0000	21.5000	0.5245
43	8	0.704	0.612	12.625	26.6250	13.6250	22.6250	0.6880
46	8	0.866	0.732	26.500	49.1250	17.6250	26.6250	0.8524
49	8	0.999	0.864	23.750	50.8750	18.3750	34.5000	0.9912
52	8	1.236	1.079	32.875	48.7500	22.0000	40.7500	1.2231
55	8	1.382	1.222	36.500	30.3750	27.8750	46.2500	1.3635
58	6	1.624	1.430	38.250	23.7500	51.5000	60.5000	1.6040
61	7	1.934	1.689	60.571	32.4286	46.0000	70.1429	1.8977
64	7	2.191	1.934	68.857	10.2857	65.7143	75.1429	2.1543
67	6	2.778	2.373	128.500	15.1667	124.5000	98.8333	2.7403
70	8	2.821	2.466	78.500	55.6250	87.7500	90.6250	2.7787
73	8	3.572	3.041	150.125	34.0000	179.5000	128.8750	3.5337
76	5	4.060	3.508	228.800	42.0000	112.4000	128.2000	4.0194
79	4	4.952	4.015	176.250	230.2500	273.7500	173.2500	4.8685
82	4	5.512	4.357	191.750	216.0000	442.7500	191.0000	5.3990
85	6	5.775	4.877	169.000	244.1665	159.6667	181.0000	5.6805
88	4	7.117	5.667	279.250	540.2500	384.2500	189.7500	7.0610
91	4	7.280	6.087	236.000	487.5000	199.2500	176.7500	7.1870
94	3	8.747	6.973	241.667	839.6665	303.6665	250.0000	8.6083
97	2	8.955	7.280	272.500	716.0000	315.5000	287.5000	8.8715
100	3	10.707	8.683	425.000	812.0000	367.6665	311.0000	10.5990
103	3	12.143	9.327	571.667	1324.0000	420.3333	355.3333	11.9980
106	2	13.480	10.485	610.000	1210.0000	552.5000	432.5000	13.2900
112	2	16.020	12.685	807.500	1190.0000	787.5000	453.0000	15.9230
121	1	18.900	15.100	1140.000	1525.0000	400.0000	530.0000	18.6950
	180							

Table 7. (Cont'd)

SEX= MALE

LENGTH	FREQ	ROUND WT KG	GUTTED WT KG	AVERAGES LIVER WT GM	GONAD WT GM	STOMACH WT GM	OTHER VISCERA WT GM	TOTAL WT KG
19	2	0.040	0.040	1.000	1.0000	1.0000	1.0000	0.0440
22	3	0.083	0.073	1.000	1.0000	2.6667	2.3333	0.0603
25	2	0.135	0.125	2.000	1.0000	3.0000	4.0000	0.1350
28	7	0.173	0.157	3.000	1.0000	4.4286	5.8571	0.1714
31	2	0.225	0.205	3.000	1.0000	4.0000	8.5000	0.2215
34	4	0.327	0.300	5.500	1.0000	7.2500	11.2500	0.3250
37	4	0.402	0.365	4.500	1.0000	8.2500	15.0000	0.3937
40	5	0.550	0.496	10.600	1.0000	12.6000	22.6000	0.5428
43	7	0.704	0.610	13.714	30.1429	12.4286	22.2857	0.6886
46	5	0.858	0.738	20.600	48.6000	13.0000	26.0000	0.8462
49	5	1.000	0.868	24.200	56.0000	16.6000	34.6000	0.9994
52	4	1.230	1.047	27.750	67.7500	19.5000	33.5000	1.1960
55	2	1.225	1.110	28.000	10.0000	26.5000	39.0000	1.2135
58	2	1.535	1.390	32.500	1.5000	26.0000	59.0000	1.5090
61	2	1.995	1.690	82.000	86.5000	44.0000	64.0000	1.9665
64	3	2.167	1.907	64.333	5.6667	72.6667	84.0000	2.1333
67	2	2.675	2.545	135.000	12.5000	70.5000	91.0000	2.8540
70	3	2.900	2.540	53.333	48.0000	110.6667	84.6667	2.8367
73	4	3.702	3.175	160.250	5.7500	169.7500	143.5000	3.6542
76	3	4.153	3.573	233.667	45.0000	125.0000	133.3333	4.1103
79	2	5.350	4.045	162.500	419.0000	421.5000	161.5000	5.2095
82	2	5.310	4.175	97.500	223.5000	537.5000	178.0000	5.2115
85	3	5.543	4.760	61.667	264.3333	144.3333	173.3333	5.4037
88	3	7.247	5.580	324.333	708.0000	405.0000	206.0000	7.2233
91	2	7.410	6.230	219.500	445.0000	253.0000	185.0000	7.3325
94	2	8.780	6.885	252.500	902.0000	377.5000	234.0000	8.6510
	85							

SEX= FEMALE

LENGTH	FREQ	ROUND WT KG	GUTTED WT KG	AVERAGES LIVER WT GM	GONAD WT GM	STOMACH WT GM	OTHER VISCERA WT GM	TOTAL WT KG
19	1	0.040	0.040	1.000	1.0000	1.0000	1.0000	0.0440
22	1	0.070	0.060	1.000	1.0000	2.0000	2.0000	0.0660
25	4	0.135	0.125	1.500	1.0000	2.5000	5.0000	0.1350
28	1	0.130	0.120	2.000	1.0000	2.0000	4.0000	0.1290
31	6	0.243	0.220	3.167	1.1667	3.3333	7.0000	0.2347
34	4	0.320	0.287	3.750	1.2500	7.0000	11.0000	0.3105
37	4	0.422	0.387	3.750	2.2500	5.0000	10.5000	0.4090
40	3	0.507	0.450	10.667	2.6667	11.0000	19.6667	0.4940
43	1	0.700	0.630	5.000	2.0000	22.0000	25.0000	0.6840
46	3	0.880	0.723	36.333	50.0000	25.3333	27.6667	0.8627
49	3	0.997	0.857	23.000	42.3333	21.3333	34.3333	0.9777
52	4	1.242	1.110	38.000	29.7500	24.5000	48.0000	1.2502
55	6	1.435	1.260	39.333	37.1667	28.3333	48.6667	1.4135
58	6	1.653	1.443	40.167	31.1667	60.0000	61.0000	1.6357
61	5	1.910	1.688	52.000	10.8000	46.8000	72.6000	1.8702
64	4	2.210	1.955	72.250	13.7500	60.5000	68.5000	2.1700
67	4	2.730	2.287	125.250	16.5000	151.5000	102.7500	2.6835
70	5	2.774	2.422	93.600	60.2000	74.0000	94.2000	2.7440
73	4	3.443	2.908	140.000	62.2500	189.2500	114.2500	3.4132
76	2	3.920	3.410	221.500	37.5000	93.5000	120.5000	3.8830
79	2	4.555	3.985	190.000	41.5000	126.0000	185.0000	4.5275
82	2	5.715	4.540	286.000	208.5000	348.0000	204.0000	5.5865
85	3	6.007	4.993	276.333	324.0000	175.0000	188.6667	5.9573
88	1	6.730	5.930	144.000	37.0000	322.0000	141.0000	6.5740
91	2	7.150	5.945	252.500	530.0000	145.5000	168.5000	7.0415
94	1	8.680	7.150	220.000	715.0000	156.0000	282.0000	8.5230
97	2	8.955	7.280	272.500	716.0000	315.5000	287.5000	8.8715
100	3	10.707	8.683	425.000	812.0000	367.6665	311.0000	10.5990
103	3	12.143	9.327	571.667	1324.0000	420.3333	355.3333	11.9980
106	2	13.480	10.485	610.000	1210.0000	552.5000	432.5000	13.2900
112	2	16.020	12.685	807.500	1190.0000	787.5000	453.0000	15.9230
121	1	18.900	15.100	1140.000	1525.0000	400.0000	530.0000	18.6950
	95							

Table 8. Statistics of lines of best fit for length-weight relationships of cod on Flemish Cap in January-February 1978. See Table 7 for the observed values.

Length vs.	Curve	Slope (m)	Intercept (b)	Correlation coefficient (r)	Student's (t)	Degrees of freedom
MALES AND FEMALES COMBINED						
Round wt.	AA	0.1356	- 4.9901	0.9028	28.0145	178
	LA	14.8361	- 22.7242	0.7952	17.4980	178
	AL	0.0252	- 1.3449	0.9765	60.4766	178
	LL	3.2047	- 5.4107	0.9990	295.5193	178
Gutted wt.	AA	0.1087	- 3.9299	0.9136	29.9729	178
	LA	11.9675	- 18.2711	0.8093	18.3823	178
	AL	0.0245	- 1.3630	0.9754	59.0791	178
	LL	3.1130	- 5.3146	0.9994	384.5636	178
Liver wt.	AA	5.7883	- 228.5356	0.8243	19.4242	178
	LA	618.9993	- 960.8690	0.7096	13.4351	178
	AL	0.0319	- 0.3311	0.9694	52.6789	178
	LL	4.0442	- 5.4588	0.9900	93.8180	178
Gonad wt.	AA	10.0688	- 428.1768	0.7573	15.4694	178
	LA	1036.6583	-1632.9971	0.6276	10.7552	178
	AL	0.0376	- 0.8277	0.9143	30.1082	178
	LL	4.6429	- 6.6574	0.9092	29.1259	178
Stomach wt.	AA	5.3803	- 205.7490	0.8453	21.1042	178
	LA	589.9397	- 911.5726	0.7461	14.9481	178
	AL	0.0299	- 0.1883	0.9721	55.2579	178
	LL	3.7443	- 4.9161	0.9814	68.1625	178
Remaining viscera wt.	AA	4.0233	- 143.4031	0.9169	30.6454	178
	LA	445.5607	- 678.8072	0.8174	18.9277	178
	AL	0.0248	0.1943	0.9642	48.4763	178
	LL	3.1833	- 3.8591	0.9965	159.6950	178
MALES						
Round wt.	AA	0.1033	- 3.3796	0.9334	23.6895	83
	LA	10.7524	- 16.0534	0.8491	14.6468	83
	AL	0.0274	- 1.4513	0.9781	42.8119	83
	LL	3.1986	- 5.3985	0.9987	175.7047	83
Gutted wt.	AA	0.0838	- 2.6932	0.9443	26.1426	83
	LA	8.7642	- 13.0445	0.8632	15.5742	83
	AL	0.0266	- 1.4678	0.9774	42.1504	83
	LL	3.1069	- 5.3035	0.9992	230.0892	83
Liver wt.	AA	3.3843	- 115.0650	0.8274	13.4235	83
	LA	353.1584	- 531.7039	0.7543	10.4683	83
	AL	0.0322	- 0.3616	0.9559	29.6502	83
	LL	3.7643	- 5.0058	0.9753	40.2331	83
Gonad wt.	AA	6.5486	- 246.6568	0.6850	8.5662	83
	LA	643.9209	- 986.3403	0.5885	6.6308	83
	AL	0.0376	- 0.8620	0.8040	12.3190	83
	LL	4.2572	- 6.0558	0.7963	11.9914	83

Table 8. (Cont'd)

Length vs.	Curve	Slope (m)	Intercept (b)	Correlation coefficient (r)	Student's (t)	Degrees of freedom
Stomach wt.	AA	5.0366	- 180.9565	0.7912	11.7855	83
	LA	514.1289	- 781.7019	0.7056	9.0712	83
	AL	0.0327	- 0.3200	0.9805	45.4825	83
	LL	3.6885	- 4.8135	0.9674	34.7945	83
Remaining viscera wt.	AA	3.0553	- 96.5473	0.9514	28.1610	83
	LA	322.2492	- 478.4572	0.8767	16.6055	83
	AL	0.0269	0.0876	0.9640	33.0174	83
	LL	3.1722	- 3.8418	0.9945	86.7916	83
FEMALES						
Round wt.	AA	0.1554	- 6.1320	0.9092	21.0529	93
	LA	17.9854	- 28.0590	0.7999	12.8519	93
	AL	0.0239	- 1.2719	0.9772	44.3728	93
	LL	3.2156	- 5.4321	0.9986	179.8219	93
Gutted wt.	AA	0.1240	- 4.7988	0.9190	22.4784	93
	LA	14.4268	- 22.4313	0.8131	13.4715	93
	AL	0.0232	- 1.2894	0.9756	42.8971	93
	LL	3.1216	- 5.3308	0.9989	203.4720	93
Liver wt.	AA	7.1766	- 302.4903	0.8491	15.5029	93
	LA	814.9172	-1287.6538	0.7330	10.3930	93
	AL	0.0312	- 0.2993	0.9619	33.9153	93
	LL	4.2161	- 5.7620	0.9870	59.2590	93
Gonad wt.	AA	12.3115	- 563.2420	0.7853	12.2313	93
	LA	1348.5217	-2166.4439	0.6539	8.3356	93
	AL	0.0368	- 0.8511	0.9383	26.1655	93
	LL	4.7808	- 6.9570	0.9256	23.5831	93
Stomach wt.	AA	5.6958	- 231.2540	0.8449	15.2334	93
	LA	659.0951	-1034.7816	0.7433	10.7160	93
	AL	0.0282	- 0.1198	0.9577	32.0933	93
	LL	3.8022	- 5.0415	0.9801	47.5849	93
Remaining viscera wt.	AA	4.5983	- 175.2105	0.9203	22.6936	93
	LA	538.7100	- 835.5215	0.8197	13.8027	93
	AL	0.0235	0.2676	0.9625	34.1992	93
	LL	3.1964	- 3.8838	0.9943	89.7601	93

AA = arithmetic X, arithmetic Y
LA = logarithmic X, arithmetic Y
AL = arithmetic X, logarithmic Y
LL = logarithmic X, logarithmic Y

Table 9. Maturity stages at length for cod taken on Flemish Cap in January-February 1979 by research vessel.

	Male				Female				
Length	Immature	Maturing this year	Total	% mature	Immature	Spent last year	Maturing this year	Total	% mature
16	2	-	2	-	2	-	-	2	-
19	6	-	6	-	7	-	-	7	-
22	85	-	85	-	74	-	-	74	-
25	211	-	211	-	178	-	-	178	-
28	60	-	60	-	57	-	-	57	-
31	17	-	17	-	22	-	-	22	-
34	27	-	27	-	27	-	-	27	-
37	83	-	83	-	81	-	-	81	-
40	193	2	195	1	200	-	1	201	0.5
43	170	12	182	7	153	-	3	156	2
46	100	25	125	20	155	-	5	160	3
49	66	61	127	48	100	2	25	127	21
52	27	90	117	77	24	5	47	76	68
55	14	101	115	88	18	12	90	110	84
58	6	72	78	92	7	14	63	84	92
61	5	33	38	87	4	35	40	79	95
64	8	20	28	71	4	29	7	40	90
67	1	18	19	95	3	31	11	45	93
70	2	11	13	85	4	22	5	31	87
73	-	13	13	100	-	9	-	9	100
76	-	5	5	100	1	7	3	11	91
79	-	5	5	100	1	3	1	5	80
82	-	6	6	100	-	-	4	4	100
85	-	3	3	100	-	-	1	1	100
88	-	2	2	100	-	1	1	2	100
91	-	1	1	100	-	-	-	-	-
94	-	3	3	100	-	-	1	1	100
97	-	1	1	100	-	-	1	1	100
100	-	3	3	100	-	-	1	1	100
103	-	3	3	100	-	-	3	3	100
106	-	-	-	-	-	-	2	2	100
109	-	-	-	-	-	-	1	1	100
112	-	1	1	100	-	-	1	1	100
118	-	-	-	-	-	-	1	1	100
124	-	-	-	-	-	-	1	1	100
130	-	-	-	-	-	-	2	2	100
Total	1,083	491	1,574		1,122	170	311	1,603	

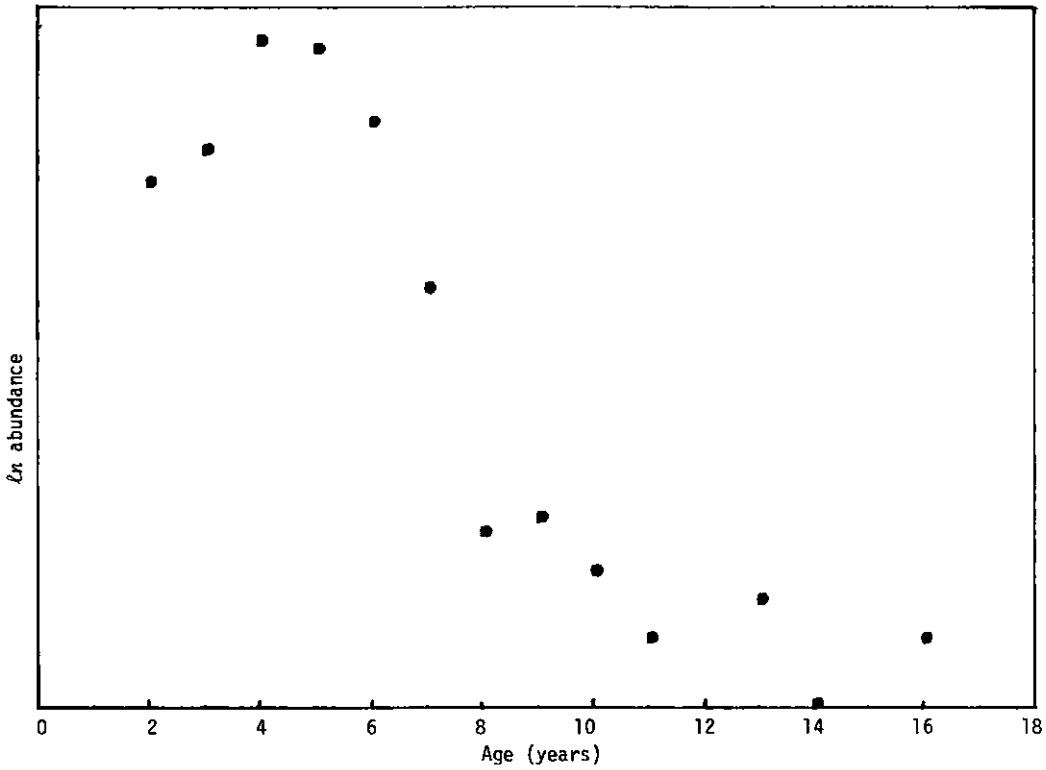

Fig. 1. Natural log of abundance against age (research surveys 1977-79)

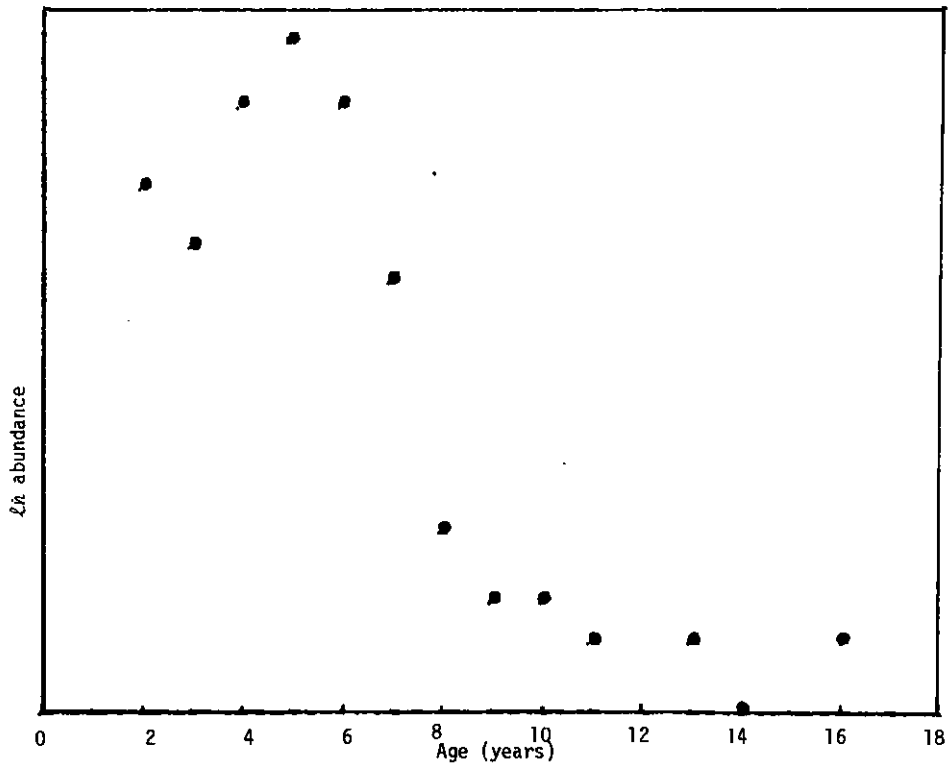

Fig. 2. Natural log of abundance against age (research surveys 1978-79)

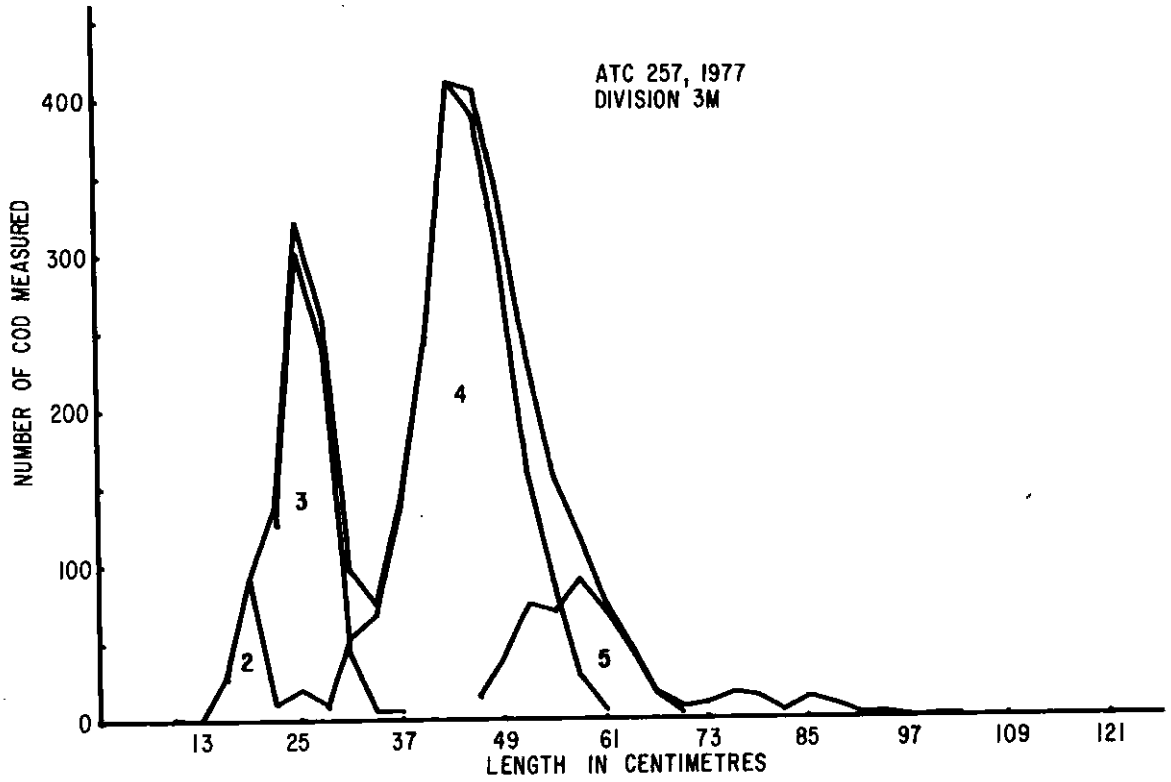

Fig. 3. Age composition of cod in Division 3M January-February 1977 (Research)

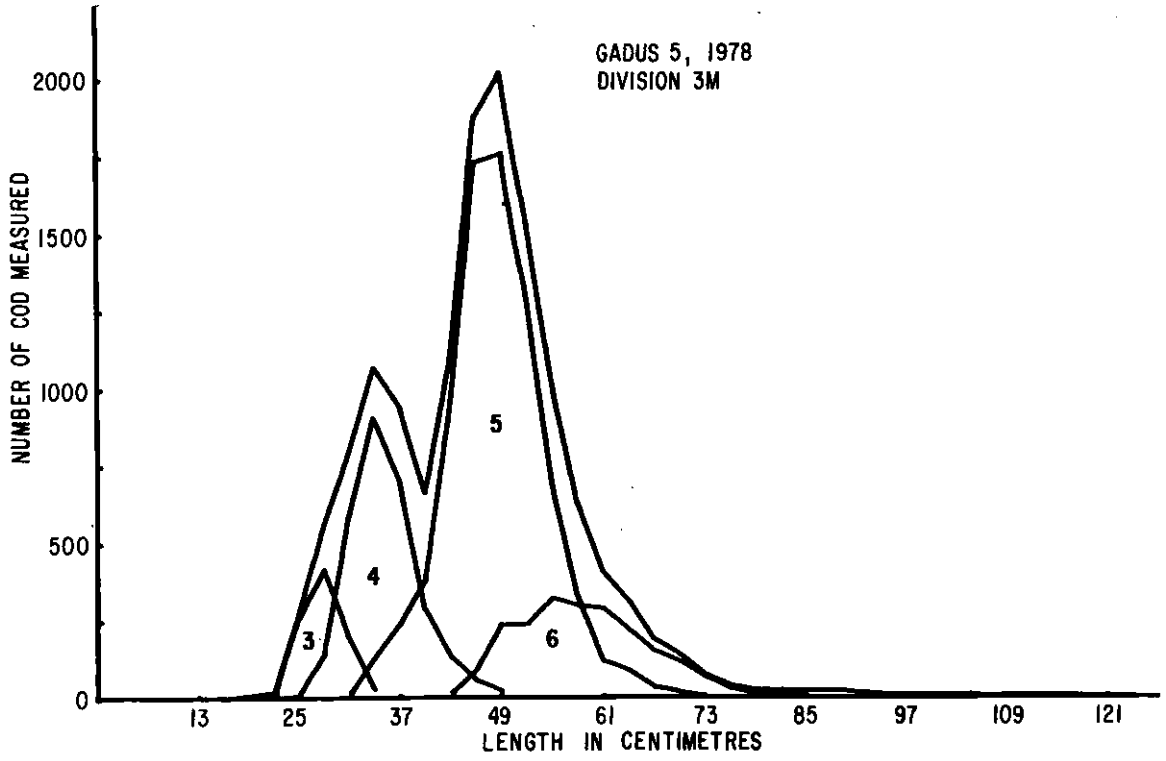

Fig. 4. Age composition of cod in Division 3M in January-February 1978 (Research)

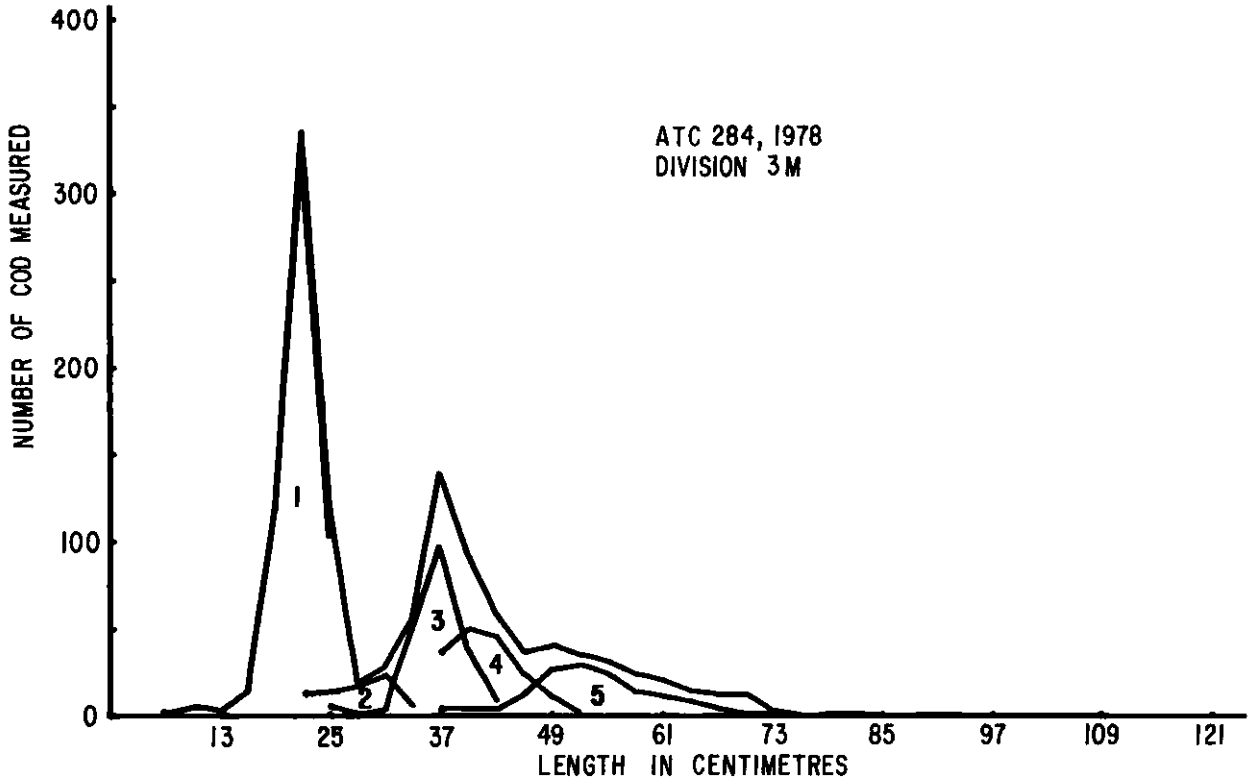

Fig. 5. Age composition of cod in Division 3M November, 1978 (Research)

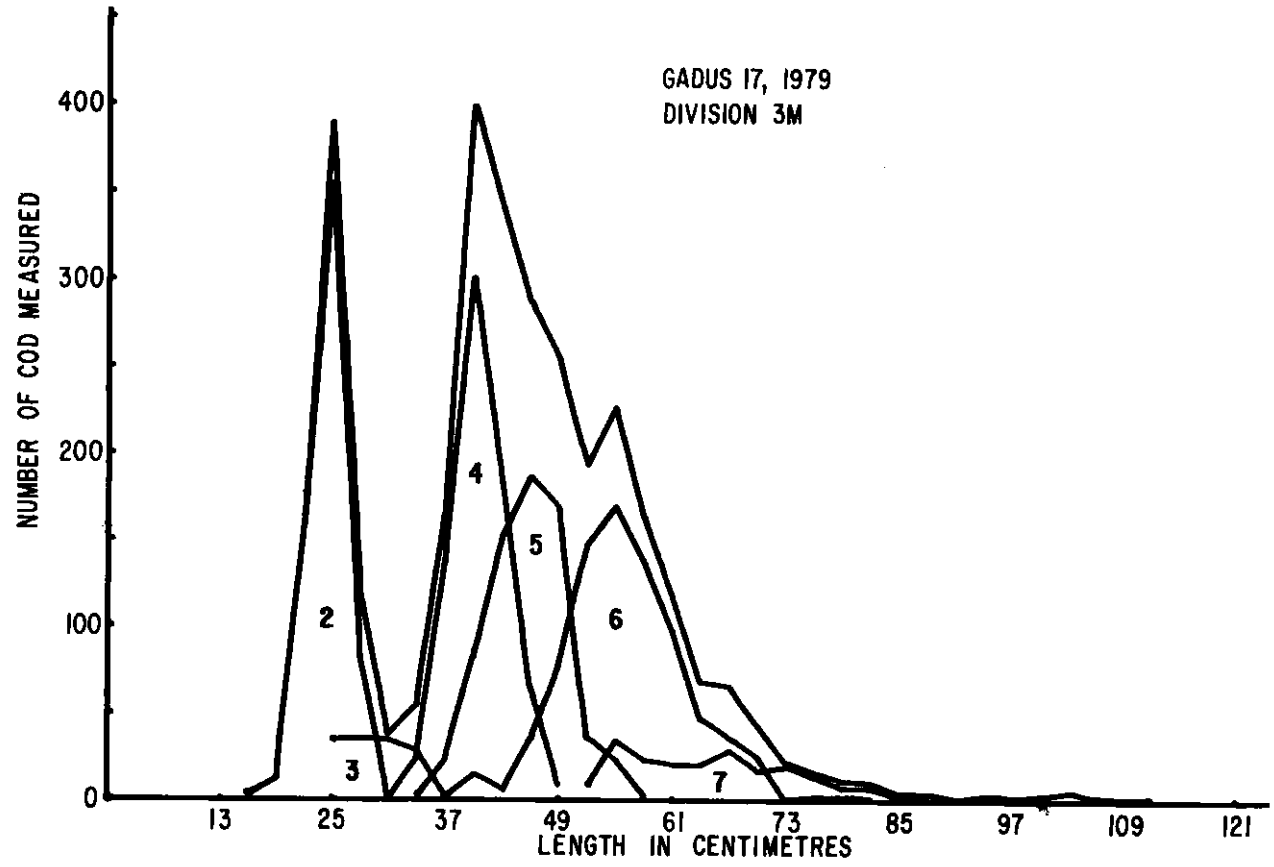

Fig. 6. Age composition of cod in Division 3M January-February 1979 (Research)

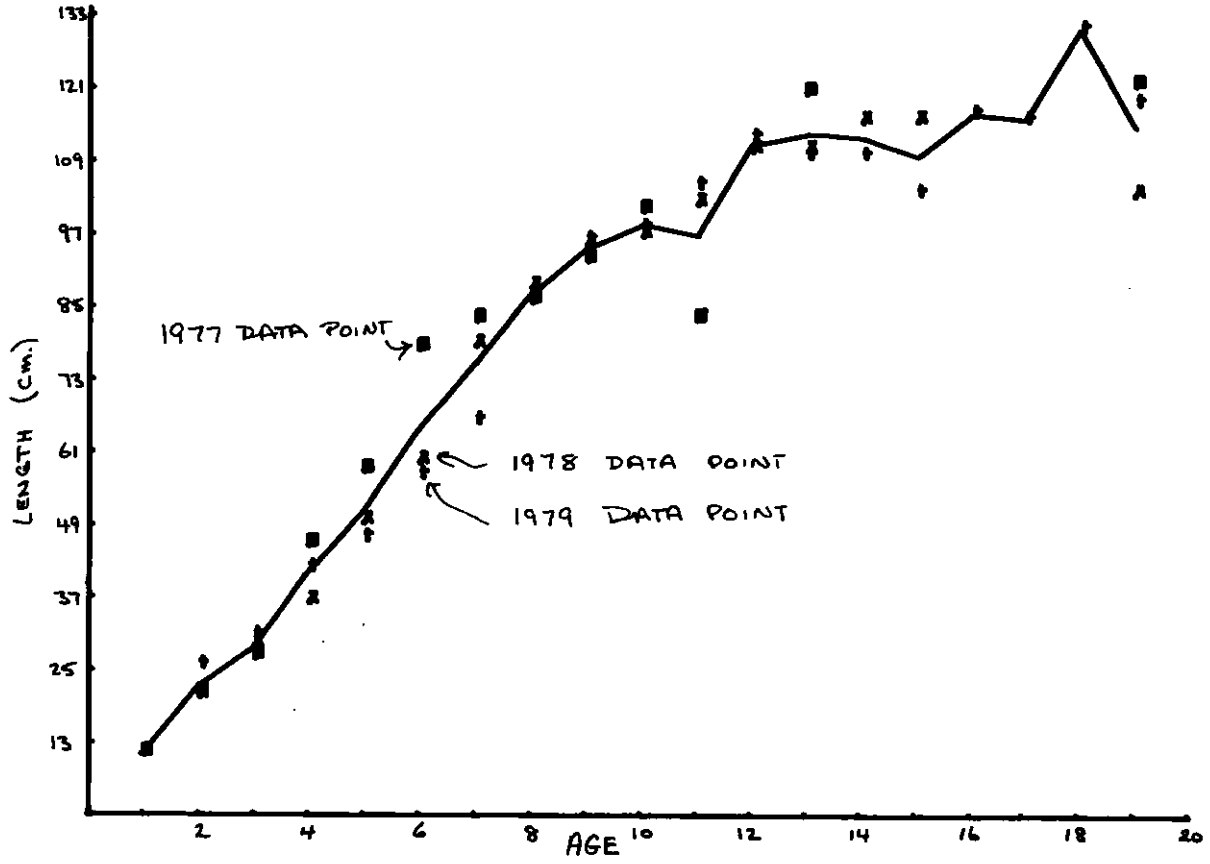

Fig. 7. Growth of Cod in Division 3M

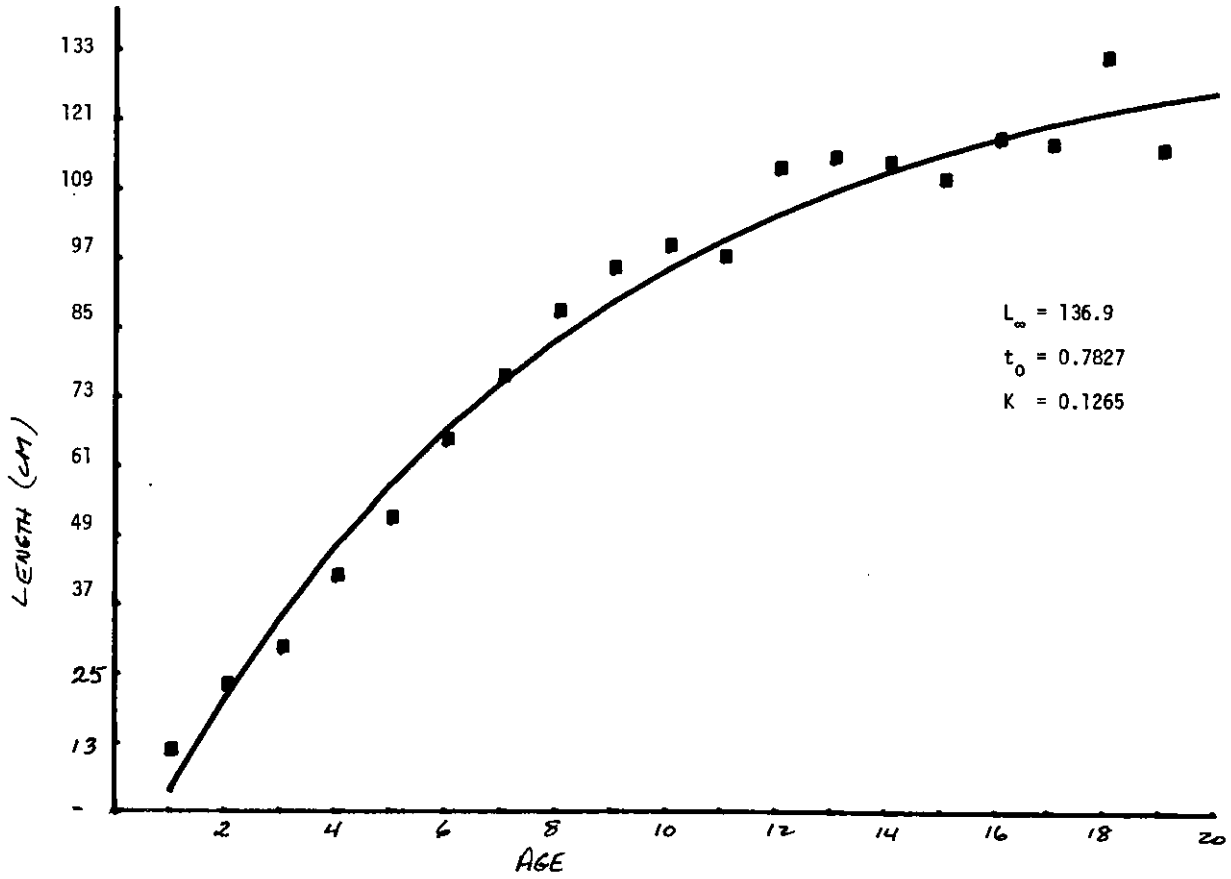

Fig. 8. Growth of Cod in 3M with fitted curve

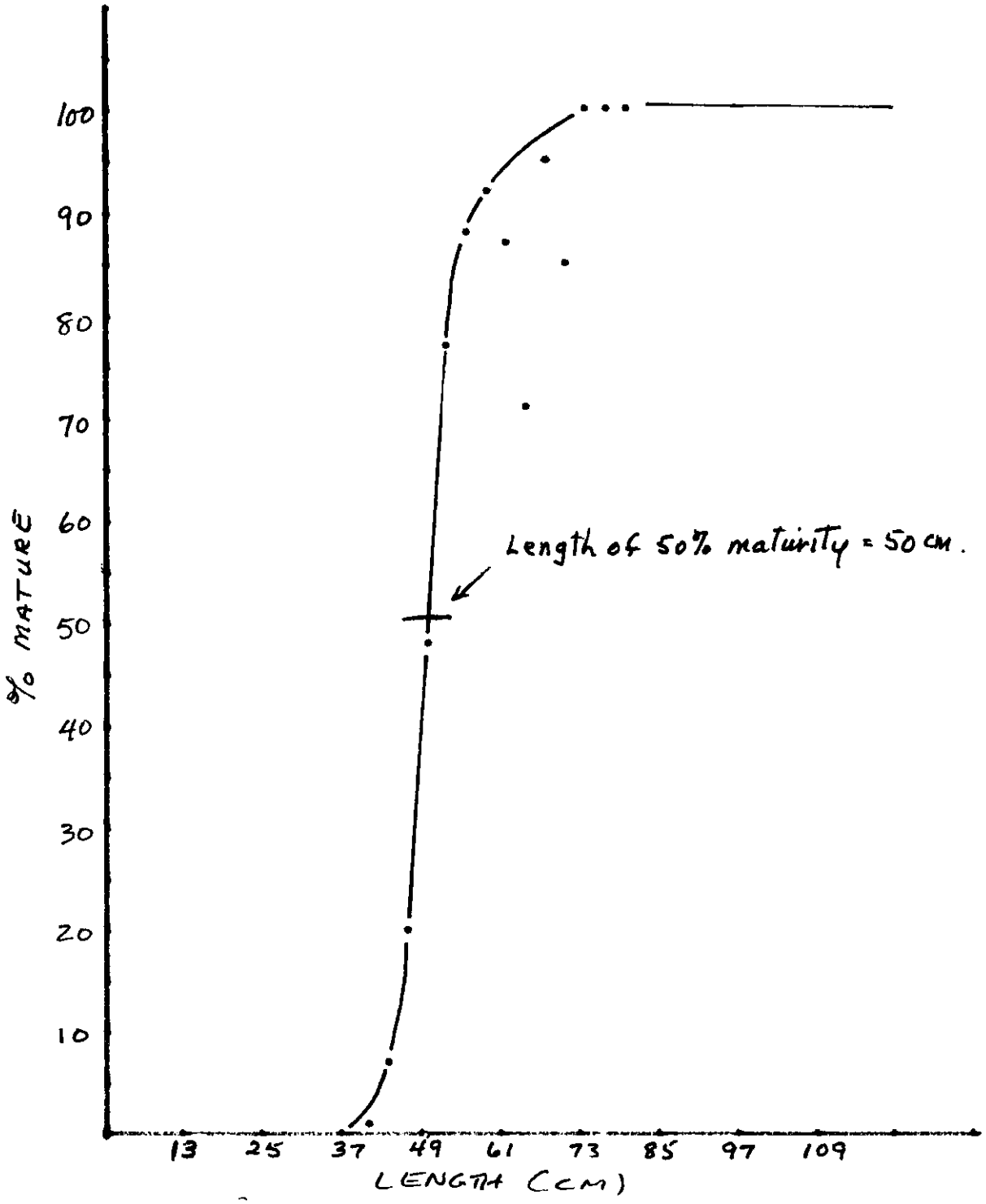

Fig. 9. Percent mature at length of male cod from Flemish Cap in Jan-Feb 1979.

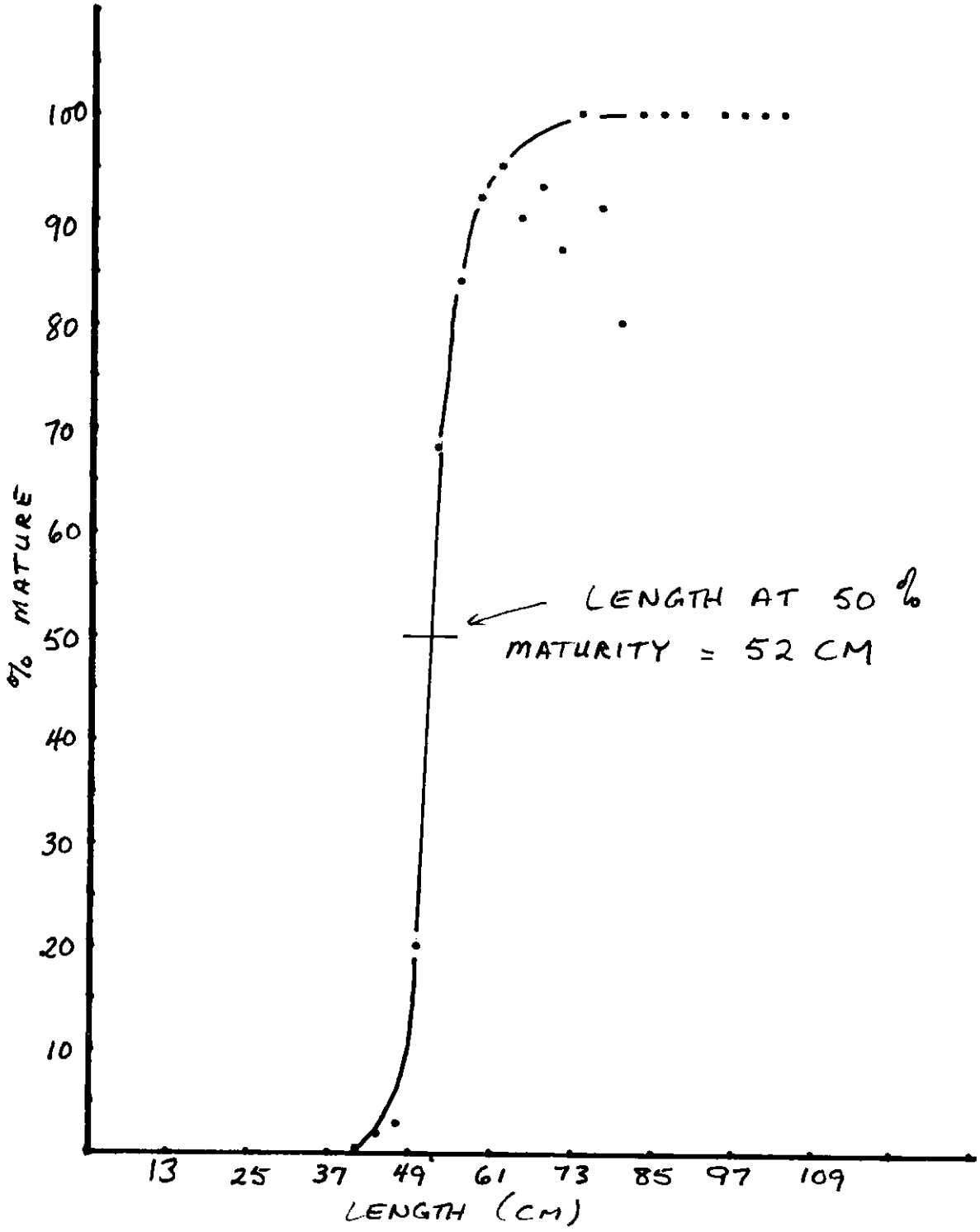

Fig. 10. Percent mature at length of female cod from Flemish Cap in Jan-Feb 1979.

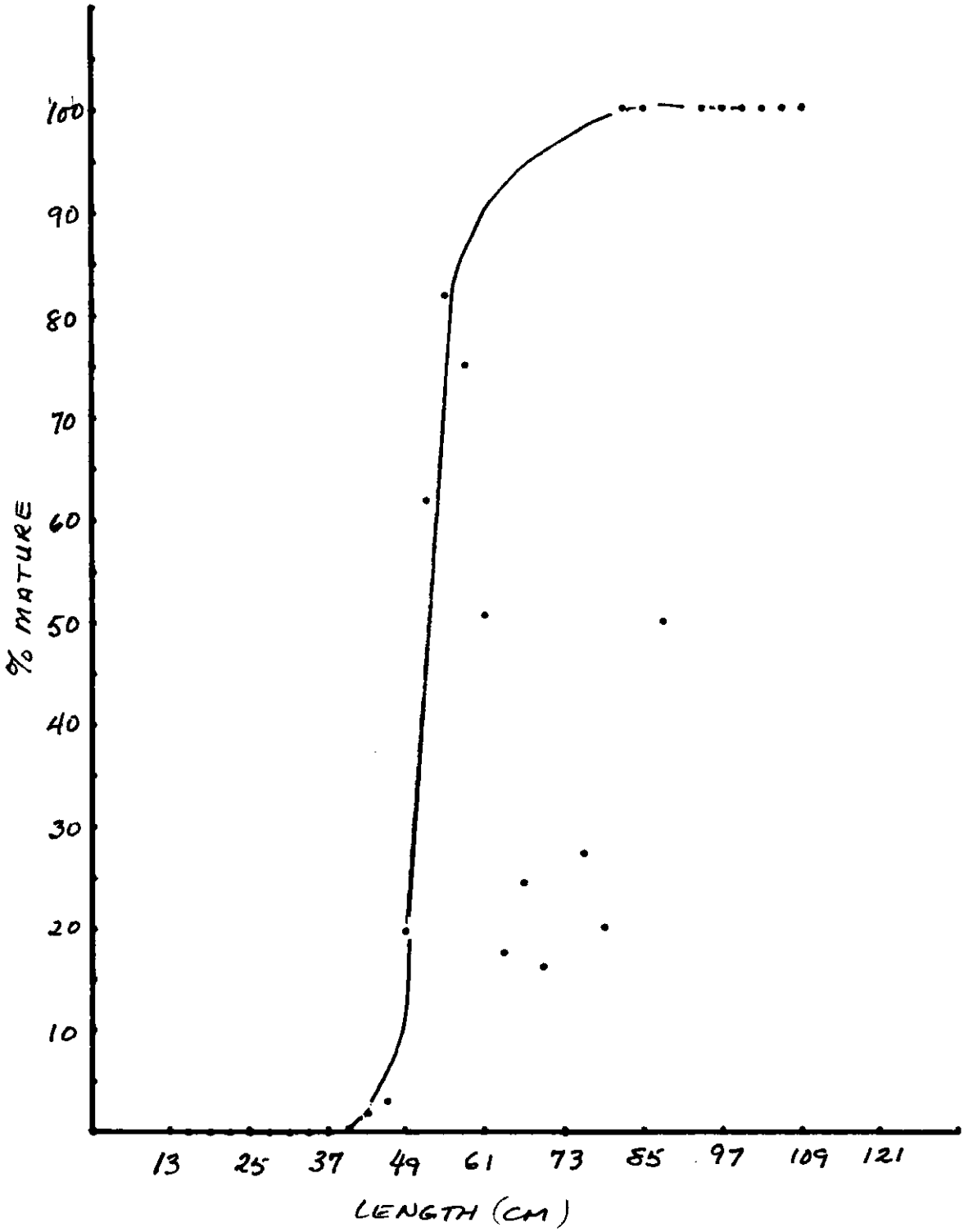

Fig. 11. The percent of female cod maturing to spawn in the present year with respect to fork length. Samples taken from Flemish Cap, Jan-Feb 1979.