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The Discreteness of the Flemish Cap Stock

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Introduction

The discreteness of the Flemish Cap cod stock has been demonstrated by the results of several techniques. Templeman (1962) stated that the vertebral numbers of Flemish Cap cod during the summer were on the average slightly lower than those of the neighbouring northeast corner of the Grand Bank. Stanek (1968) found that cod on the Flemish Cap possessed on the average about one additional fin ray in the second dorsal fin than did cod on the neighbouring eastern edge of the Grand Bank. Templeman (1979) stated that only one of 98 recaptures during and 6 of 40 recaptures after the tagging year from Canadian tagging of cod on Flemish Cap in 1964 were reported from west of Flemish Channel (over 1000 m deep) separating Flemish Cap from the eastern Grand Bank. In about 15,400 recaptures from taggings in other areas during 1962-66, only four were reported from Flemish Cap (Templeman, 1979). Of about 4,900 recaptures of cod from Canadian tagging during 1954-55 at 13 localities in the Newfoundland area (mainly in coastal areas) no recaptures were reported from the Flemish Cap (Templeman, 1974). From the USSR taggings of cod on the Flemish Cap during 1961-66 there were 15 recaptures, all from the Cap (Konstantinov, 1970). Also there were no records of tagged cod having migrated to the Flemish Cap from other areas from the 35,000 cod tagged by the USSR in Subareas 2 and 3 from 1960 to 1966 (Konstantinov, 1967).

Apart from meristics and tagging there are other pieces of evidence which suggest that the Flemish Cap cod stock is discrete from other stocks in our area. Thompson (1943) reported the average numbers of circuli in the first year of scales from a small sample of cod from Flemish Cap to be considerably greater (12.4) than from cod of the northern Grand Bank (9.6). Stanek (1967) found that while the growth rates of Flemish Cap cod were similar to those of ICNAF Div. 3L up to and including age 5, the average length increments for ages above 5 years were lower than those of the neighbouring areas of the Grand Bank. Bishop (1978) demonstrated that there has been a considerable increase in the growth rate of Flemish Cap cod in terms of the average length at age between 1968 and 1975.

Templeman, Squires and Fleming (1957) found no nematodes (*Terranova* (= *Porrocaecum*) *deciptens*) (3 of 5 nematodes found were examined for species and more were *Terranova deciptens*) in cod fillets of Flemish Cap although they were present in about 2% of the cod from the northeastern Grand Bank (16 of 22 found were examined and 12 were *Terranova deciptens*). There was no infection of cod at any length by the parasitic copepod, *Lernaeocera branchialis*, at Flemish Cap while cod on the neighbouring northeast Grand Bank were infected at low levels (0.6 - 2.3%) in the length range 21-70 cm (Templeman, Hodder and Fleming, 1976). Postolaky (1962) found the plerocercoids of the cestode, *Pyramicocephalus*

phocarium, to be absent in the cod of Flemish Cap but present in cod of Div. 2J and 3L (10% and 4% infestation respectively). Jamieson (1975) found highly significant differences in transferrin allele frequencies in blood sera between cod of Flemish Cap and those of the northeastern Grand Bank. Cross and Payne (1978) demonstrated that the cod population on Flemish Cap was distinct from those on other areas of the continental shelf, having a significant difference in allele frequencies at the PGL-2 locus (skeletal muscle phosphoglucose isomerase). They suggested that because of the dramatic genetic divergence between Flemish Cap and North American shelf cod populations, the cod population on Flemish Cap may have persisted in isolation since the last glaciation.

The purpose of this report is to provide further evidence on the discreteness of the Flemish Cap cod stock and to describe the seasonal migrations of cod on the Flemish Cap particularly in terms of depth of recaptures.

Methods and Materials

Vertebral counts of cod were collected from the eastern edge of the Grand Bank during 1949-61 and from Flemish Cap during 1961. To eliminate the factor of variation between year-classes the vertebral frequencies and averages from the eastern Grand Bank were compared with those of the same year-class from the Flemish Cap. The only year-classes which had sufficient numbers to allow comparison were the 1956, 1957, 1958 and 1959 year-classes from Div. 3L (unit areas U27 and V28) (Fig. 1) and Div. 3M. Vertebral counts do not include the urostylar half-vertebra. Ages were determined from otoliths.

Average lengths at age for Flemish Cap and Div. 3L cod were determined from samples collected in these areas by otter trawl during May 1978.

During 5-11 July 1964, adult Atlantic cod in good condition were tagged on the Flemish Cap (ICNAF Div. 3M) within the unit area Y29 (Table 1, Fig. 1). The tags used were Petersen discs and dangler tags in various combinations, mostly attached by stainless steel wire dorsally in front of the first or between the first and second dorsal fins, but some dangler tags were attached around the preopercular bone (Templeman, 1979).

Results and Discussion

Vertebral Averages

Bartlett's tests for homogeneity of variance (Sokal and Rohlf, 1969) revealed that for the northeastern Grand Bank (Div. 3L) the variances of the vertebral frequencies among year-classes 1956-59 inclusive were homogeneous ($0.3 < P < 0.5$). A similar result was obtained for the variances of the vertebral frequencies of these same year-classes for the Flemish Cap (Div. 3M) ($0.5 < P < 0.7$).

Analyses of the variances of vertebral frequencies for each individual year-class between Div. 3L and 3M revealed that for each of the year-classes 1956, 1957, 1958 and 1959 the variances were heterogeneous ($P < 0.05$) when they were tested using the F test of significance of difference between two variances (Sokal and Rohlf, 1969). For each of the four year-classes considered, the variance for Div. 3L was greater than that for the corresponding year-class in Div. 3M. This is possible because the temperature regime under which floating eggs of the Flemish Cap cod stock develop and in which the vertebral numbers are determined is less variable than those of the neighboring eastern Grand Bank.

The averages of the vertebral counts of each year-class were compared by area (Div. 3L versus 3M) using an approximate t-test (Sokal and Rohlf, 1969) because the variances were unequal. The vertebral averages for the 1957 and 1958 year-classes were different at the 0.05 level (Table 2) while those of the 1956 and 1959 year-classes were not statistically different.

Growth Rates

The average lengths at age of cod from Flemish Cap (Div. 3M) and the Grand Bank (mainly from the area of 46° to 48°N and 49° to 51°W plus a sample from southeast of Cape Race - Div. 3L) were determined from samples collected by otter trawl during May 1978. For the lower ages (3-4) the lengths at age were similar for both areas but for the intermediate ages (5-12) the average lengths at age for the Flemish Cap were higher than those of the Grand Bank (Table 3, Fig. 2). The increased growth rates for Flemish Cap during 1978 over those for earlier years and for Flemish Cap during 1978 over those for the northern and central parts of the Grand Bank for the same period is possibly due to the decreased stock abundance of cod on the Flemish Cap which is evident by the lower catch rates in recent years compared to those of the 1960's (Wells, 1978).

Tag Recaptures

There was a total of 141 recaptures of which 132 could be assigned to unit area. There was one recapture from Subarea 2 which had no position specified plus 8 others for which there were no recapture area indicated. All but 5 of the 132 recaptures were from the area around the Flemish Cap (Fig. 1). There were 2 returns from Div. 2J in the area of Hamilton Bank 2 from the northern Grand Bank and one from the eastern edge of the Grand Bank. Of the 127 returns from the Flemish Cap, 105 were from the unit area in which the fish were tagged. About 92% of the recaptures during the year of tagging were from the tagging area (Table 4). In the year following tagging about 47% of the recaptures were from the tagging area; during the second year following tagging 50%, and during the third year 25%. Thus while there is some movement to other areas on the Flemish Cap, there appears to be a tendency for cod to remain in the area in which they were tagged or to return back there if they migrate to other areas. It is evident that in the year following tagging that the cod are present in the tagging area during most of the year. Of the 17 Flemish Cap returns (excluding the year of tagging) for which exact positions were available the average distance travelled from the point of tagging was 35 nautical miles with a range from 6 to 74 nautical miles. There were 62 tags returned from the Flemish Cap-Flemish Channel area for which depths were reported. The patterns of return by month indicated that during July-October the cod on Flemish Cap were in the shallower water on the Cap (100-180 m) at a median depth of about 150 m (Fig. 3). Thereafter the cod appear to move deeper from about 300 to 450 m during November-March. By April and May there is an apparent migration into shallower water of 200-250 m. A somewhat similar seasonal distribution by depth was shown for cod tagged at St. Pierre Bank and the Southeast Shoal of the Grand Bank (Templeman, 1974).

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Table 1. Fork length distribution of Atlantic cod tagged on the Flemish Cap during 5-11 July 1964, by 1-cm and 3-cm length groups.

FL (cm)	No.	No.	FL (cm)	No.	No.
50	7	7			
1	9		7	3	
2	15	39	8	3	12
3	15		9	6	
4	10		90	3	
5	22	51	1	3	12
6	19		2	6	
7	29		3	4	
8	26	85	4	2	7
9	30		5	1	
60	32		6	1	
1	31	86	7	3	7
2	23		8	3	
3	28		9	2	
4	33	83	100	1	4
5	22		1	1	
6	26		2	2	
7	30	89	3		6
8	33		4	4	
9	27		5	3	
70	15	67	6	2	6
1	25		7	1	
2	16		8		
3	10	38	9		1
4	12		110	1	
5	17		11		
6	5	32	12		
7	10		13		
8	8		14		
9	13	33	15	1	1
80	12		16		
1	3		17		
2	10	18	18		1
3	5		19	1	
4	9				
5	6	19			
6	4				
			Total	704	704

Table 2. Vertebral averages (not including urostyle half-vertebra) of cod from the eastern edge of the Grand Bank (Div. 3L, unit areas U27 and V28) and Flemish Cap (Div. 3M) for the 1956, 1957, 1958 and 1959 year-classes

Year Class	Division 3L			Division 3M			t'_s	$t'_{.05}$
	N	\bar{X}	S.D.	N	\bar{X}	S.D.		
1956	58	53.8621	1.0505	82	53.7561	0.7787	0.652	1.998
1957	95	54.1789	0.9783	103	53.7767	0.7131	3.283*	1.988
1958	104	53.9327	1.0727	143	53.5594	0.7375	3.062*	1.985
1959	69	53.4638	1.0789	35	53.5429	0.7413	0.438	2.015

*denotes significantly different at .05 level.

Table 3. Average lengths (cm) at age of Atlantic cod from ICNAF Div. 3L and 3M, for May 1978. Gear: otter trawl. Samples from Div. 3L were mainly from the area 46° to 48°N and 49° to 51°W plus a sample from southeast of Cape Race.

ICNAF Division 3L			ICNAF Division 3M		
Age (years)	Average length (cm)	Number	Age (years)	Average length (cm)	Number
3	40.00	1	3	32.84	45
4	45.42	46	4	41.43	107
5	51.53	112	5	53.30	266
6	58.31	94	6	64.64	85
7	64.31	60	7	82.90	22
8	67.35	69	8	89.96	12
9	78.11	35	9	88.86	6
10	85.01	45	10	93.94	8
11	93.35	21	11	103.00	2
12	94.35	8	12	106.33	3
13	106.85	13	13	104.85	5
14	105.95	5	14	103.00	1
15	101.17	5	15	124.00	1
Total		514			563

Table 4. Areas of recapture by month and year of Atlantic cod tagged on Flemish Cap (ICNAF Div. 3M, unit area Y9) during 5-11 July 1964.

ICNAF Div.	Unit area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	NK	Total
1964															
2J	N15								1						1
3M	X28									3					3
	X29								3						3
	Y28									1					1
	Y29							10	47	16	14	4			91
1965															
2J	Q15		1												1
3L	T28							1							1
3M	X28				1										1
	X29							1							1
	X30				1										1
	Y27						1								1
	Y28				2							2			4
	Y29					3		1			2	1	1	1	9
1966															
3L	T28													1	1
	W28				1										1
3M	X29								1						1
	Y29				1				1		1				3
1967															
2				1											1
3L	V30			1											1
3M	W30			1											1
	X27				1										1
	X30			2											2
	Y29							1					1		2
1968															
3M	Y30				1										1

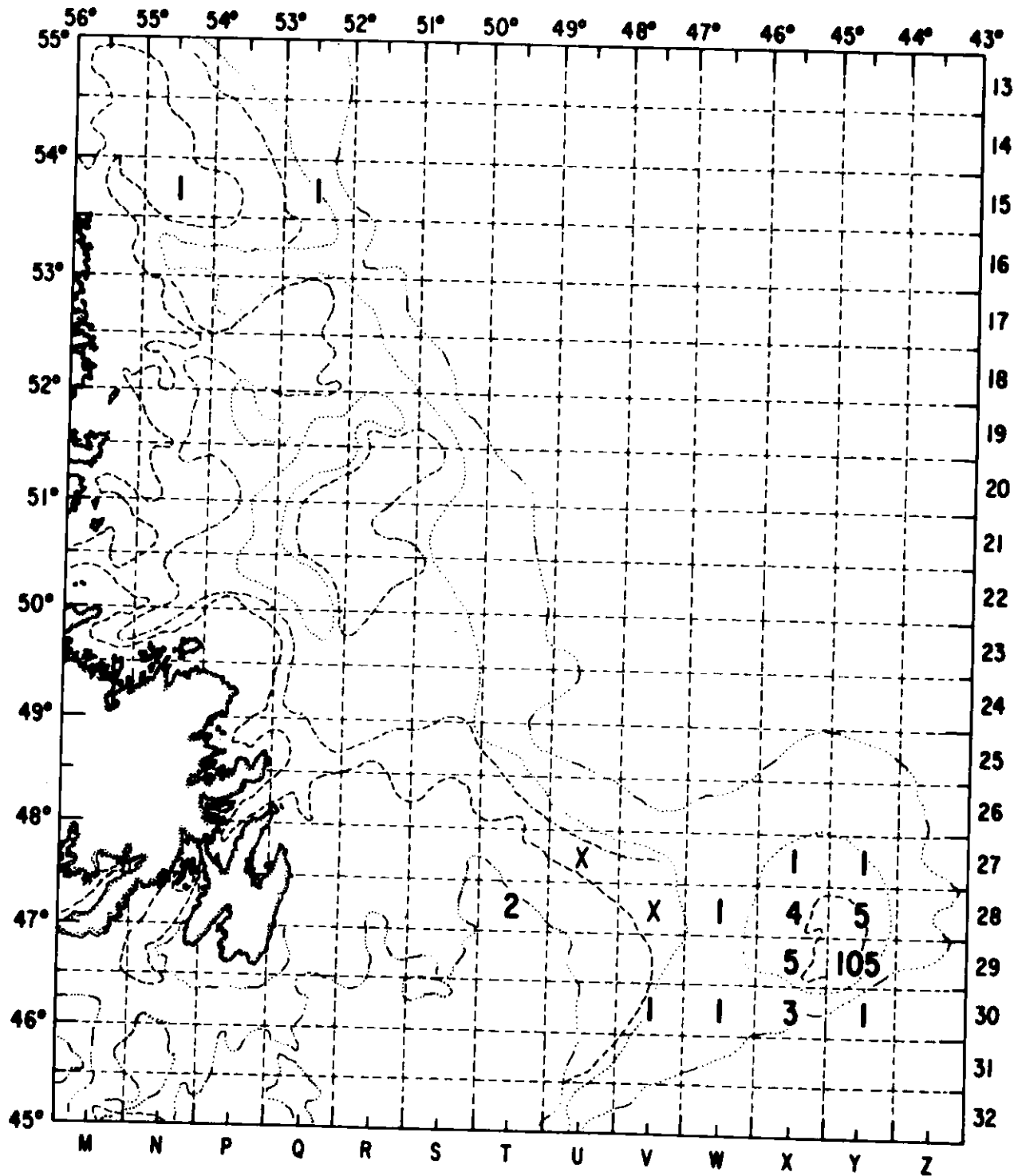


Fig. 1. Recaptures of cod tagged on the Flemish Cap in unit area Y29 during 5-11 July 1964. In addition there is one tag from Subarea 2 and 8 others for which no location was reported. "X"s denote the unit areas of Division '3L' from which vertebral averages were analyzed for this paper.

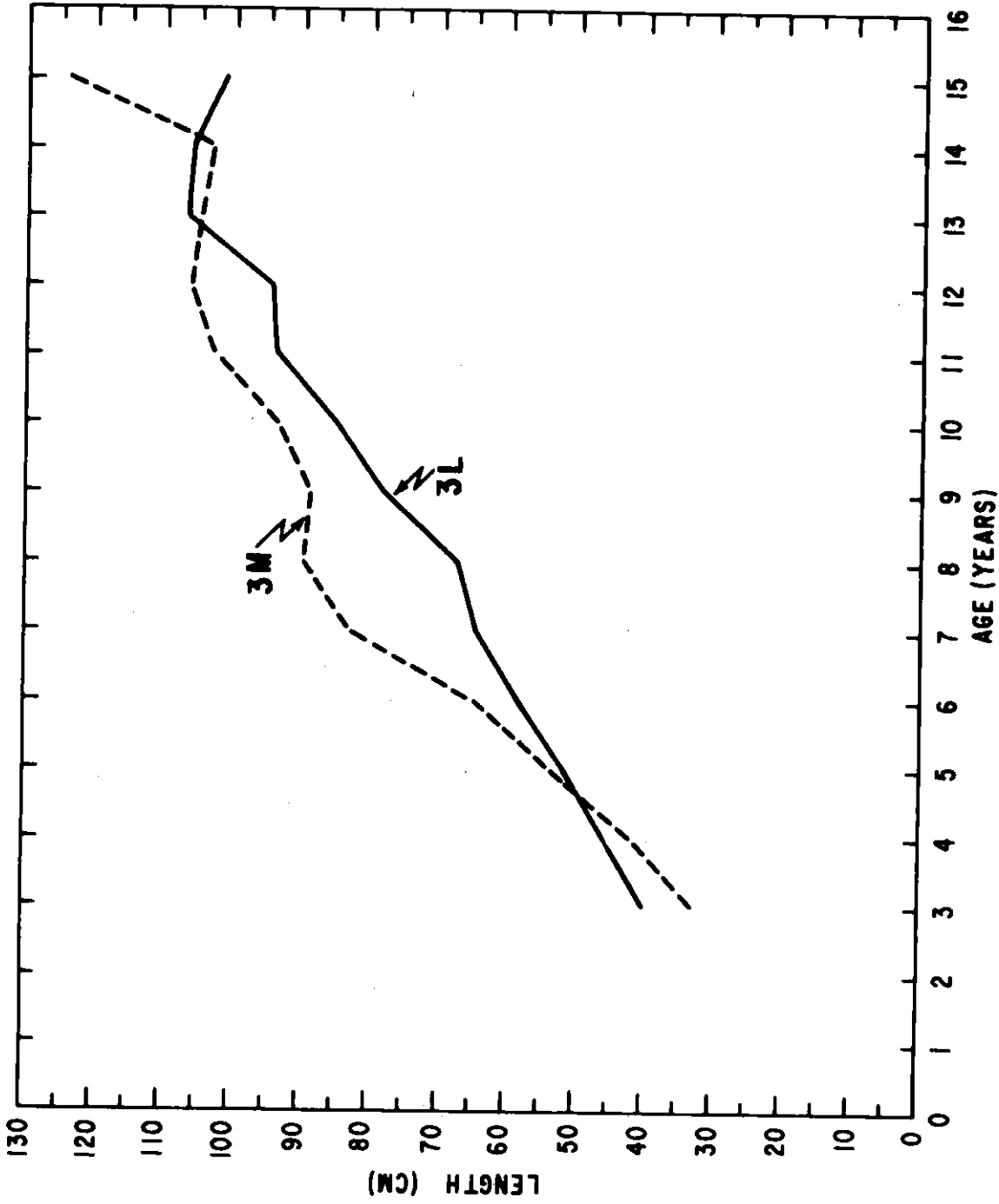


Fig. 2. Average lengths at age of cod from Flemish Cap (Div. 3M) and Grand Bank (Div. 3L) determined from otter trawl samples collected during May 1978. Samples from Div. 3L were mainly from the area of 46° to 48°N and 49° to 51°W plus a sample from southeast of Cape Race.

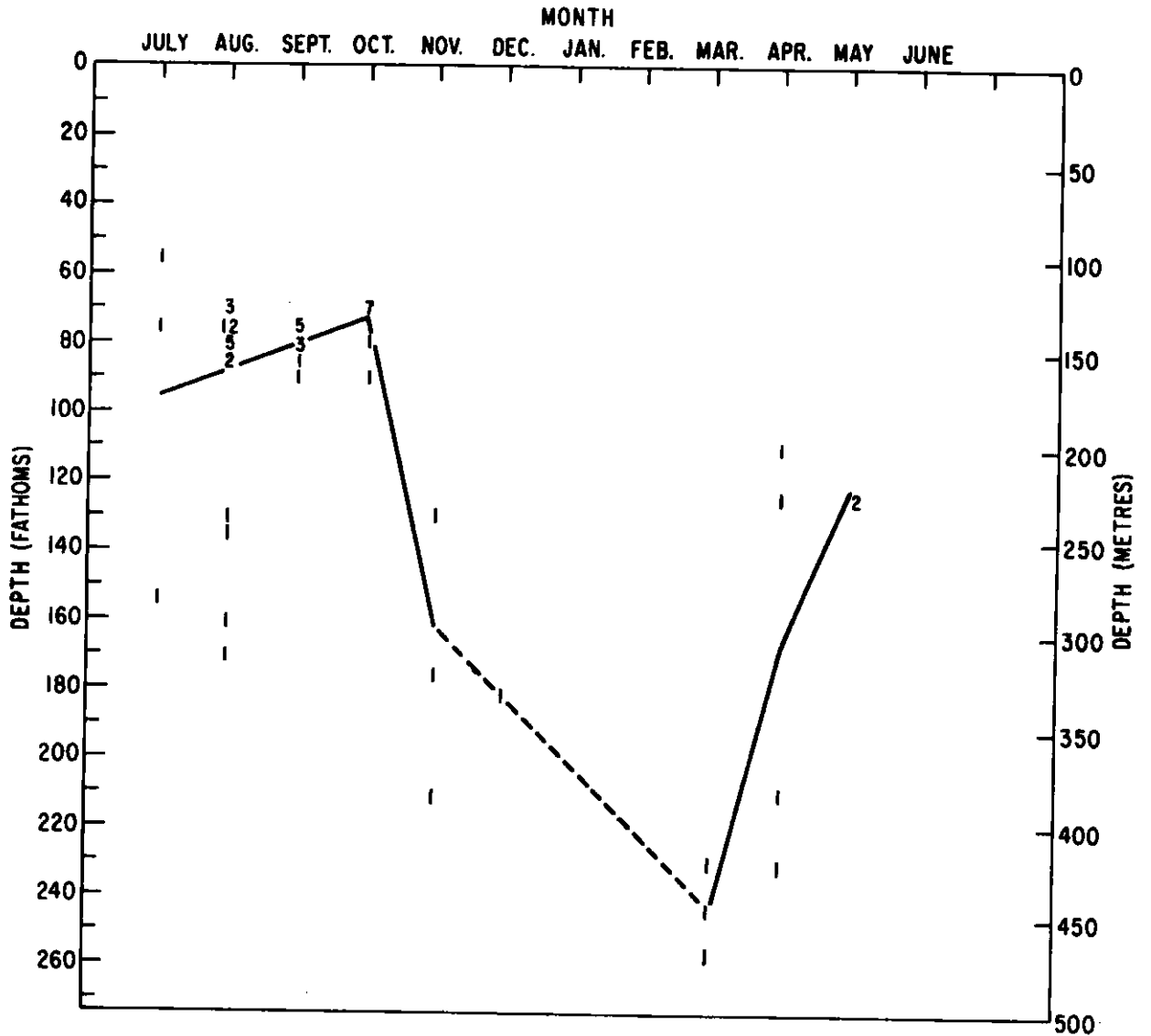


Fig. 3. Distribution of tag recaptures by depth and month from cod tagged on Flemish Cap during 5-11 July 1964. Numbers indicate the number recaptured at each depth while the solid line indicates the trend of average depth.

