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Wadge Bank Trawl Fishery Studies

Part IV An analysis of the length frequency measurements of the sea bream (*Lethrinus nebulosus*) made in 1949 and 1953 to 1958

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INTRODUCTION

The sea bream† *Lethrinus nebulosus* (Forskal)) is, economically, the most important species of the resident stock of the Wadge Bank (Sivalingam 1969). The purpose of this study is to examine its distribution by depth, recruitment, growth and change in the annual average length with continuous fishing on the Bank. This information is helpful in interpreting changes in catch per unit of fishing effort and drawing up management programmes.

ACKNOWLEDGEMENTS

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MATERIALS AND METHODS

All data used in this analysis were obtained from the commercial catches of the trawlers operated by the Government of Ceylon (Sivalingam and Medcof 1957). Where a particular trawler trip covers portions of two adjacent months, the data were assigned to the month with the largest number of fishing days, otherwise they were assigned to their respective months.

In commercial practise all specimens of the resident stock which were 30 cm. or less were separately classified and stored as category " smallfish ". The larger ones of the same species were classified as category " bigfish ". The two categories were measured separately and individual specimens were not sexed.

All length measurements recorded since 1953 were in the nearest whole centimeter. Individual specimens were measured with the help of a measuring board from the tip of the snout to the median portion of the caudal fork. The 1949 measurements were standard lengths i.e. from tip of snout to the base of the caudal fin and are available in 5 cm. groupings.

Length and species composition data by depth were obtained on board the trawlers from individual hauls while commercial operations were in progress. Length measurements for the rest of the analysis were made from the random samples obtained from trawler landings while unloading was in progress. The fish was stored in the pens of the fishhold of the trawler. Up to June 1957,

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† Sinhalese—mivatiya, Tamil—villaimeen

they were unloaded one category at a time in baskets from the fishhold on to the waiting lorries A limited number of baskets of fish as they came out of the fishhold were measured. Species that were not being studied if found in the basket were discarded. After June 1957 the fish was unloaded, mixed and conveyed to the cold rooms mechanically (Anon 1958). They were sorted out in the coldrooms by commercial categories into push-carts. A cartload of this sample was taken for measurement. The sample was first sorted out by species, measured and then all specimens of the same species were weighed in bulk to obtain average weights.

DISTRIBUTION BY DEPTH

Size Distribution

The data obtained were analysed and details of distribution by size and depth are given in Table I. and Figure 1. It will be seen that there is a definite increase in average length with increase in depteh Although the range of lengths overlap to a great extent the modes indicate that the smaller sizts predominate in lower depths and the bigger sizes in deeper areas. The increase in size with depth is not attributable to the different dates of sampling. Figure 2 shows a close correlation through out the year between the shallowest depth fished during a trip as shown by the trawler records and the smallest specimen of this species sampled from the landings of that trip.

TABLE I

SIZE DISTRIBUTION OF SEA BREAM BY DEPTH ON THE WADGE BANK

Depth fms.	*Dates sampled*	*No. of hauls sampled*	*Total number measured*	*Length*	
				Range cm.	*Average cm.*
15–20	Sept. 1957	1	78	20–52	34.83
21–30	Sept. 1953, Oct. 1953, Jan. 1954	11	383	20–63	40.49
31–40	Oct. 1953, May 1954	9	197	25–63	45.55
41–50	Oct. 1953	3	46	32–60	47.74

Further in working out the general distribution of *L. nebulosus* in the waters around Ceylon, it has been observed by the author that the younger specimens of this species up to about 15 cm in length are caught in abundance by fishermen who fish primarily for this species in large bays, where the depth of the water is less than two fathoms (Fig. 1). This was true irrespective of the season and the larger specimens were conspicuous by their absence in these bays.

It is evident that the smaller specimens first appear in shallower waters and then there is a general movement of individuals of this species to deeper waters with increase in size.

Density

Malpas (1926) showed that up to 45 fathoms the total catch was greatest between 21–45 fathoms. During observations made in 1953–54 (Table II) thd greatest number of **L. nebulosus** was found in the 21–30 fathoms range.

TABLE II

SPECIES COMPOSITION OF CATEGORY BIGFISH AT DIFFERENT DEPTHS

Depth	Date	No. of hauls sampled	*Lethrinus nebulosus*		*Epinephelus undulosus*		*Plectorhynchus pictus*		*Lutianus dodecanthus*		*Lutianus malabaricus*		*Pristiopomoides typus*		Total no. sampled
fms.			no.	%	no.	%	no .	%	no.	%	no.	%	no.	%	
21–30	Jan. 1954	7	257	30	267	31	162	19	110	13	61	7	—	—	857
31–40	May 1954	7	122	18	230	33	106	15	196	28	34	5	1	—	689
41–50	Oct. 1953	2	34	8	27	6	33	7	253	56	5	1	96	21	448

INTERPRETATION OF THE LENGTH FREQUENCIES

Recruitment

Percentage length frequency distribution for the period December 1953 to September 1958 is given in Figures 3–6. It will be noted that the smallest recorded size for this species is 15 cm. while specimens smaller than 15 cm. of other species have been recorded in the catches, those of sea bream were not recorded. This species therefore enters the fishing grounds only when they are 15 cm. or larger in size, keeping to the shallower areas not visited by the trawlers when they are smaller (Fig. 1).

It will be seen that specimens of 20–25 cm. sizes are regularly present in the catches. This confirms the earlier observation (Sivalingam 1969) that recruitment of this species to the fishing grounds is continuous and throughout the year. There is no evidence either from the percentage composition (Sivalingam 1969) or from the frequency distribution (Figs. 3 & 4) of any abundant or prominent year class having entered the fishery during the period under study.

Frequency distribution

A detailed study of the Figures 3–6 shows that no single year class can be traced from its entry to the fishing grounds till it reaches the maximum size recorded for this species with a high degree of certainity. But in the bigfish category there are three conspicuous modes, each mode often with more than one peak. The first (A) between 30 and 40 cm. is the most common, the second (B) between 40 and 50 cm. is very rare and the third (C) between 50 and 60 cm. is also rare but more frequent than the second. While short progressions of the peaks within the above ranges can be identified, that of one mode into the other is obscure.

The presence of three distinct modes could be the result of fishing in three different depths. In order to check this possibility the frequencies for March 1954 with two clear modes and a conspicuous wide trough between them was chosen and the depth records studied. The data for March

1954 were obtained from three samples from both the trawlers " Braconglen " and " Maple Leaf ". The frequencies of individual samples were similar and the depth of the trawl hauls for all three trips combined were as follows :

Depth range	*Number of hauls*
15 — 20 fathoms	nil
(15 — 30 fathoms)	(2)
21 — 30 fathoms	80
(21 — 40 fathoms)	(13)
31 — 40 fathoms	36
41 — 50 fathoms	4
Total	120 (15)

A major percentage of the hauls were made between 21 and 40 fathoms without an intervening gap showing that the presence of the two modes separated by a trough is not due to fishing in two different depth ranges which are far apart. This observation rules out the above possibility.

Continuous recruitment would explain the regular presence of the first group of peaks (A) between 30 and 40 cm. Lack of progression of these peaks beyond 40 cm. could be the result of recruitment and growth being balanced by one or both of the following factors :—

(i) selective migration by size.

(ii) fishing mortality.

Movement to deeper waters with increase in size has already been discussed. This does not explain presence of conspicuous troughs and lack of continuity of progression of modes. Another probable cause of selective migration by size is spawning. But examination of the gonads showed that females in the advanced stage of maturity and ready to spawn condition have been recorded in all sizes available on the Bank, including the smallfish categoty. Spawning is not limited to any particular size group eliminating this factor as a possible cause of selective migration by size away from the fishing grounds. In the absence of other possibilities, fishing mortality appears to be the main cause of the lack of progression of the mode beyond 40 cm. Fishing effort has increased more than fourfold since 1949 (Sivalingam 1967).

With the data available it is not possible to offer a satisfactory explanation for the presence of the other two modes and the lack of progression of one into the other. A possible explanation however is that fishing is limited to particular areas of the Bank and occasionally when the catches are poor the skippers look around outside their normal area. Such fishing in new grounds occasionally could explain the presence of either one or both of the modes (B) and (C). This appears to be the case for the three months sampled in 1958. The frequencies for the three samples have a single mode (B). It so happened that the three samples were all obtained from the catch landed by a skipper who started operations on the Bank only in May 1958 and in all probability fished in an area not frequented by the others. Unfortunately he failed to record positions of the hauls and it is now not possible to check on the positions.

Growth

Under the circumstances discussed above, with continuous recruitment, lack of a dominant brood, movement to deeper waters with increase in size and commercial nature of the fishery from which samples were obtained, it is not possible to expect to be in a position to trace a perfect continuous growth line with the help of the progression of modes from the time the species enters the fishing grounds till it reaches its maximum size.

However, certain short " progressions " of the peaks can be traced with some degree of certainty. As will be expected, these progressions are better defined for the smaller sizes specially up to 40 cm. than for the bigger sizes. By extrapolation of these short sections and interpolation of modal lengths, which are conspicuous, but not in serries with adjacent months, the " growth lines " in Figure 7 have been constructed.

The short sections fit into longer lines when extrapolated. These longer lines are parallel to one another. These points justify the acceptance of these progressions, at least tentatively, as indications of " growth lines " of this species. On this basis it may be stated that this species enters the fishing grounds as "smallfish" when they are 15 cm. or longer in length and grow into the "bigfish" category within a year (Fig. 7) and contribute to the fishery for another two years, of which the major contribution is during the first year. A very small percentage, however, continues for a third year.

It has not been possible to determine directly the age at which it enters the fishing grounds. But the indication by extrapolation of the growth lines is that this species is about six months old when it moves into the fishing grounds. Later it grows steadily for a period of $2\frac{1}{2}$ years during which period the length increases by about 37.5 cm. Subsequently growth slows down.

TABLE III

CHANGES IN AVERAGE LENGTHS OF THE SEA BREAM LANDED DURING THE YEAR 1949 AND FROM 1953–1958

Year	*Northeast monsoon months*		*Southwest monsoon months*		*Annual Average*
	Number measured	*Average lengths*	*Number measured*	*Average lengths*	
		cm.		*cm.*	*cm.*
1949	April-May, No. measured: 299				46·6* (50·8)
1953	316	45·5	—	—	45·6
1954	1,409	44·8	1,198	42·1	43·5
1955	1,134	42·6	1,545	42·0	42·2
1956	730	40·7	1,822	42·6	42·1
1957	863	41·9	1,610	40·5	41·0
1958	—	—	627	45·6	—

*Standard length i.e. snout to base of caudal fin. Its equivalent caudal fork length given in brackets. All others caudal fork length.

AVERAGE SIZES

The average sizes of the specimens of the bigfish category sampled between October, 1953, and October, 1958, are given in Table III. There does not appear to be any striking difference between the average sizes of the specimens caught during the northeast monsoon months and those caught during the southwest monsoon months of the same year. However, a progressive reduction in the sizes of the specimens throughout the period under study is conspicuous.

There is a natural initial reduction in size when a virgin fish population is exploited for the first time. But this does not explain continuous reduction in size over a period of years. Such changes in the average sizes of the population are mainly due to one or both of the following factors : —

(i) fluctuations in recruitment.

(ii) increase in fishing effort.

There is no evidence of the former (page 41) but an increase in fishing effort has been recorded. This explains a gradual reduction in size up to and including 1957. There has been a sudden increase in size for 1958. As discussed earlier this is due to the nature of the samples. They were all obtained from a trawler whose skipper was quite new to the grounds and probably fished in an area not normally visited by others (page 42).

Compared to the sizes obtained in April-May, 1949 (Fig. 5 and Table III), there has been a considerable reduction by 1957.

The increase in fishing effort accompanied by a reduction in (1) size of the most important species of the resident stock, and (2) catch of the resident stock per unit of fishing effort during the off season already reported (Sivalingam 1966) calls for greater vigil and regular analysis of the subsequent catches for proper management of the Wadge Bank resources.

SUMMARY

1. Length frequency distributions of the sea bream collected during the period 1953 to 1958 have been analysed.

2. The increase in average sizes of the sea bream with depth suggests a movement to deeper waters with increase in size.

3. By numbers the sea bream is more abundant between 21 and 30 fathoms than in deeper areas.

4. Recruitment was continuous and regular. There is no sign of entry or progression of a dominant brood throughout the period under study.

5. Length frequency distribution shows three distinct modes. The first mode occurs regularly but does not progress beyond 40cm. recruitment being balanced by natural and fishing mortality. The other two which are not regular are probably the result of fishing outside regular areas.

6. Short sections of " growth lines " which fit into one another when extrapolated, are evident. The larger lines obtained by extrapolation are parallel to one another.

7. These tentative " growth lines " indicate that this species which enters the fishing grounds when 15 cm. or larger in length are exploited by the trawl fishery for a period of three to four years.

8. This species appears to be six months old when it enters the fishing grounds and increases in length by about 37.5 cm. in the next 30 months. Later growth slows down.

9. The average size of the specimens sampled continued to get smaller from 1953 till 1957. It is shown that this reduction in size is due to increased fishing effort.

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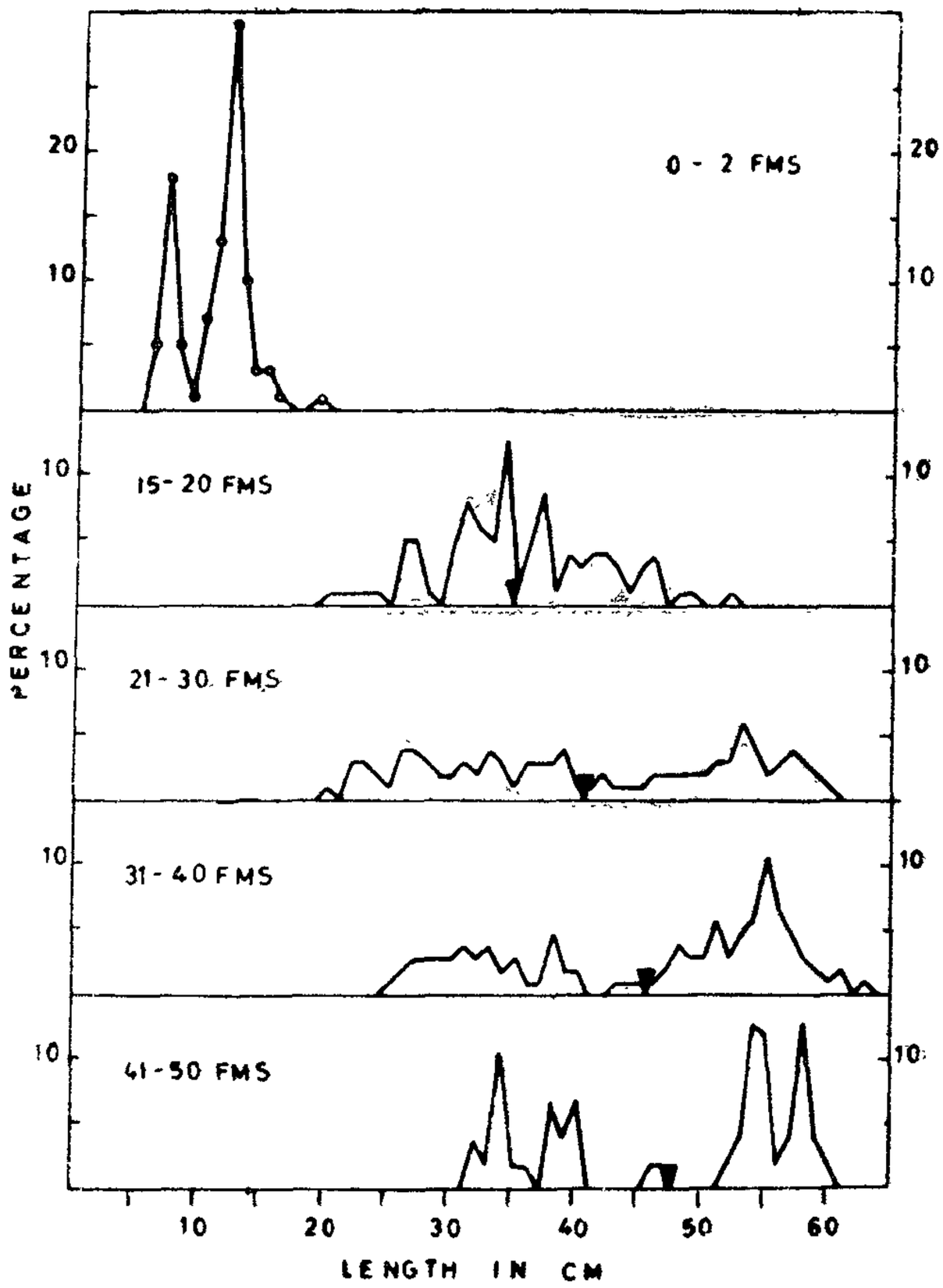

Fig. 1. Length frequency distribution of sea bream by depth. Samples for 0–2 fms caught from Portugal Bay, Gulf of Mannar, by small beach seines. All other samples from Wadge Bank. Average sizes indicated by triangles.

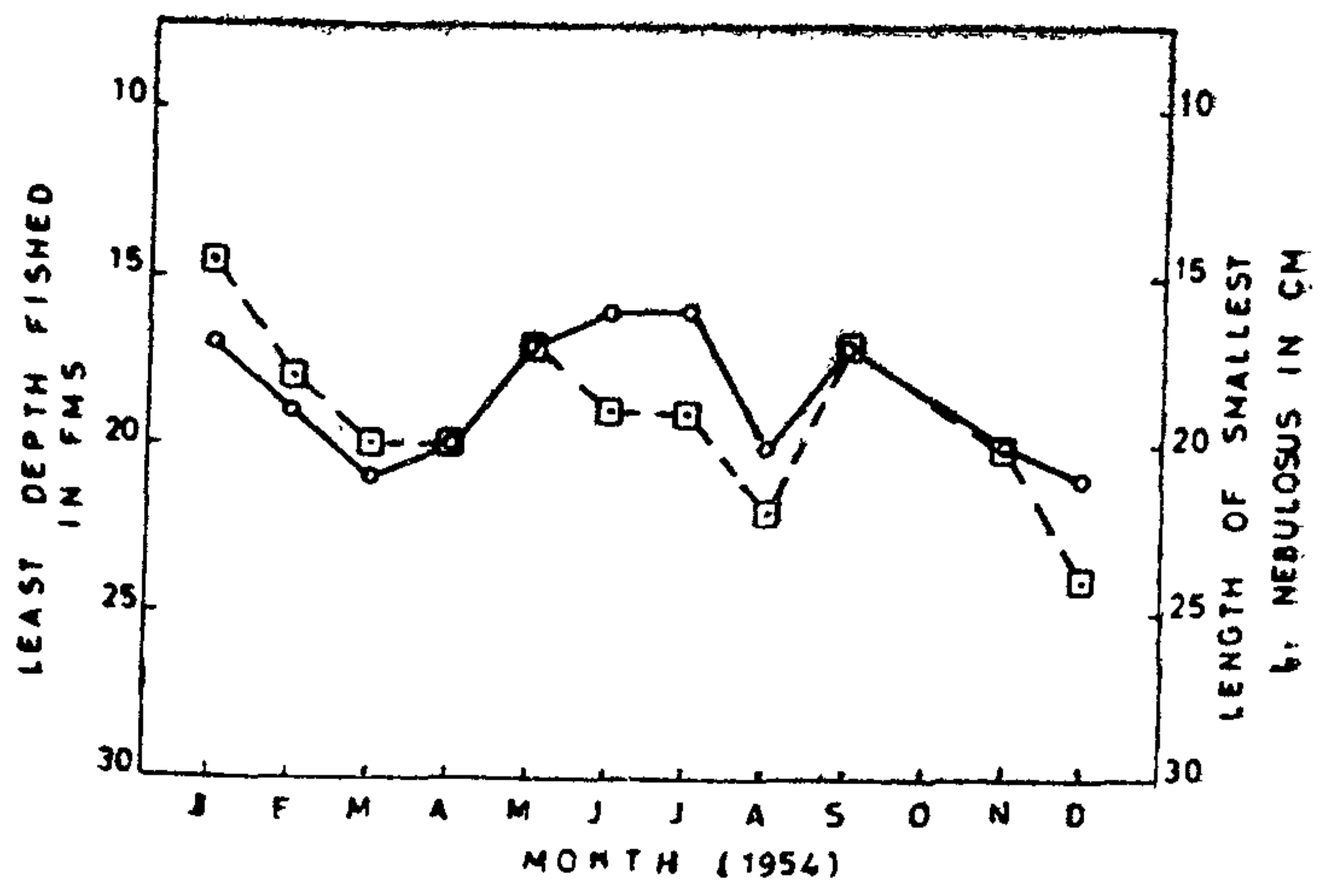

Fig. 2. Relationship between the shallowest depth fished during a trip (squares) and the smallest specimen of sea bream sampled during that trip, in 1954.

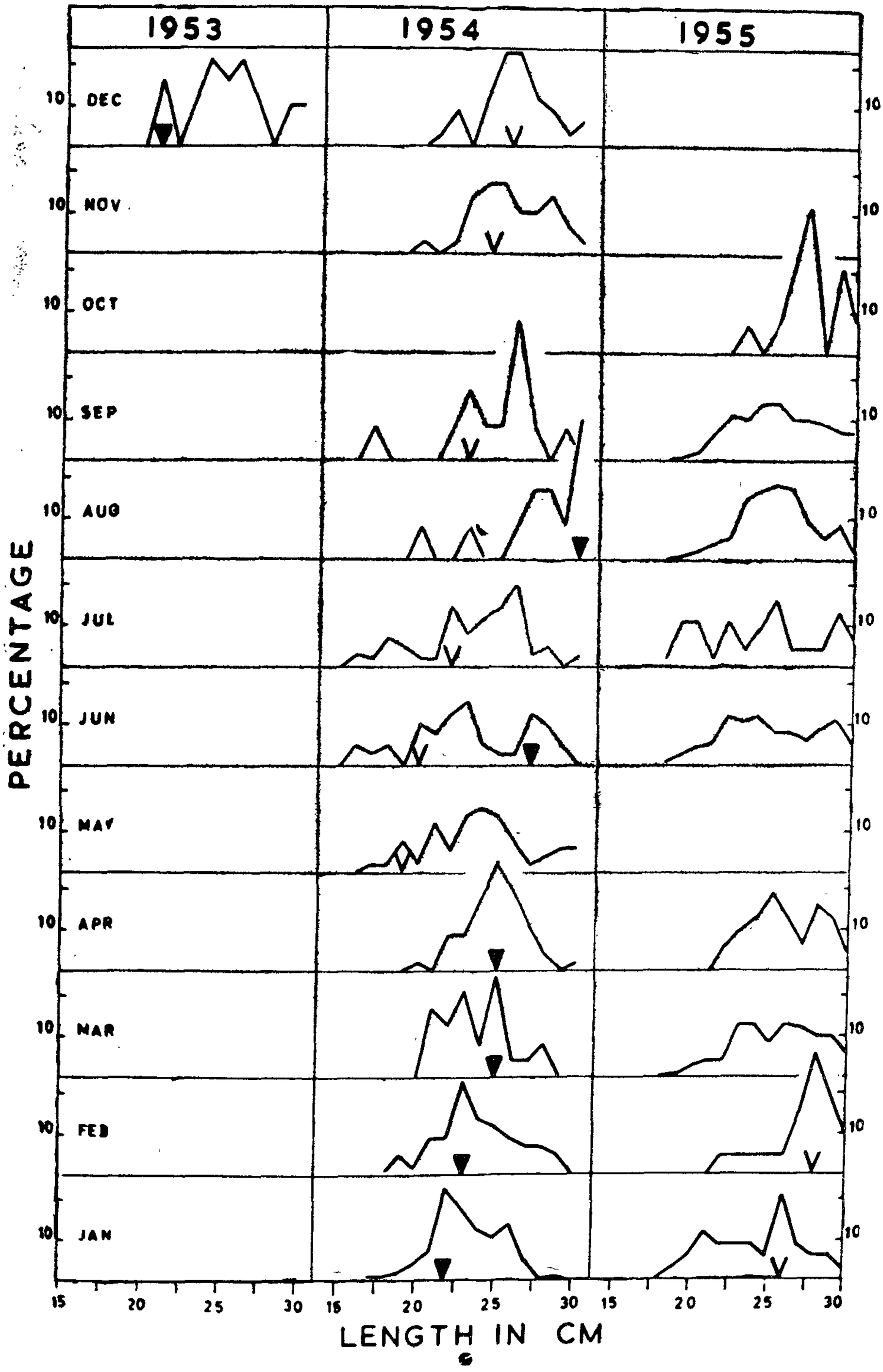

Fig. 3. Monthly length frequency distribution of sea bream ($\leq$30 cm.) for the years 1953–1955. Symbols shown indicate locations of modes used in figure 7.

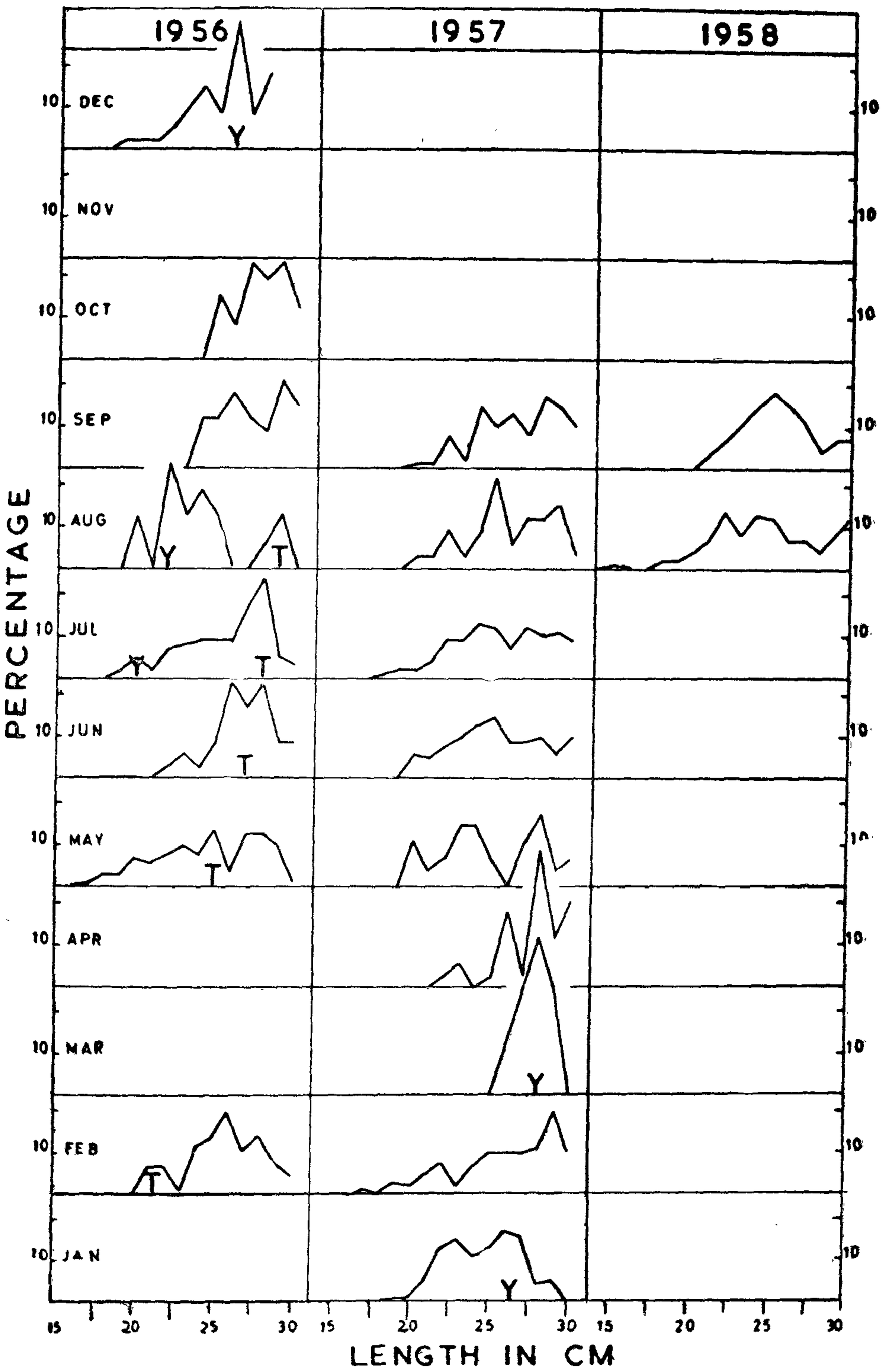

Fig. 4. Monthly length frequency distribution of sea bream ($\leq$30 cm.) for the years 1956–1958. Symbols shown indicate locations of modes used in figure 7.

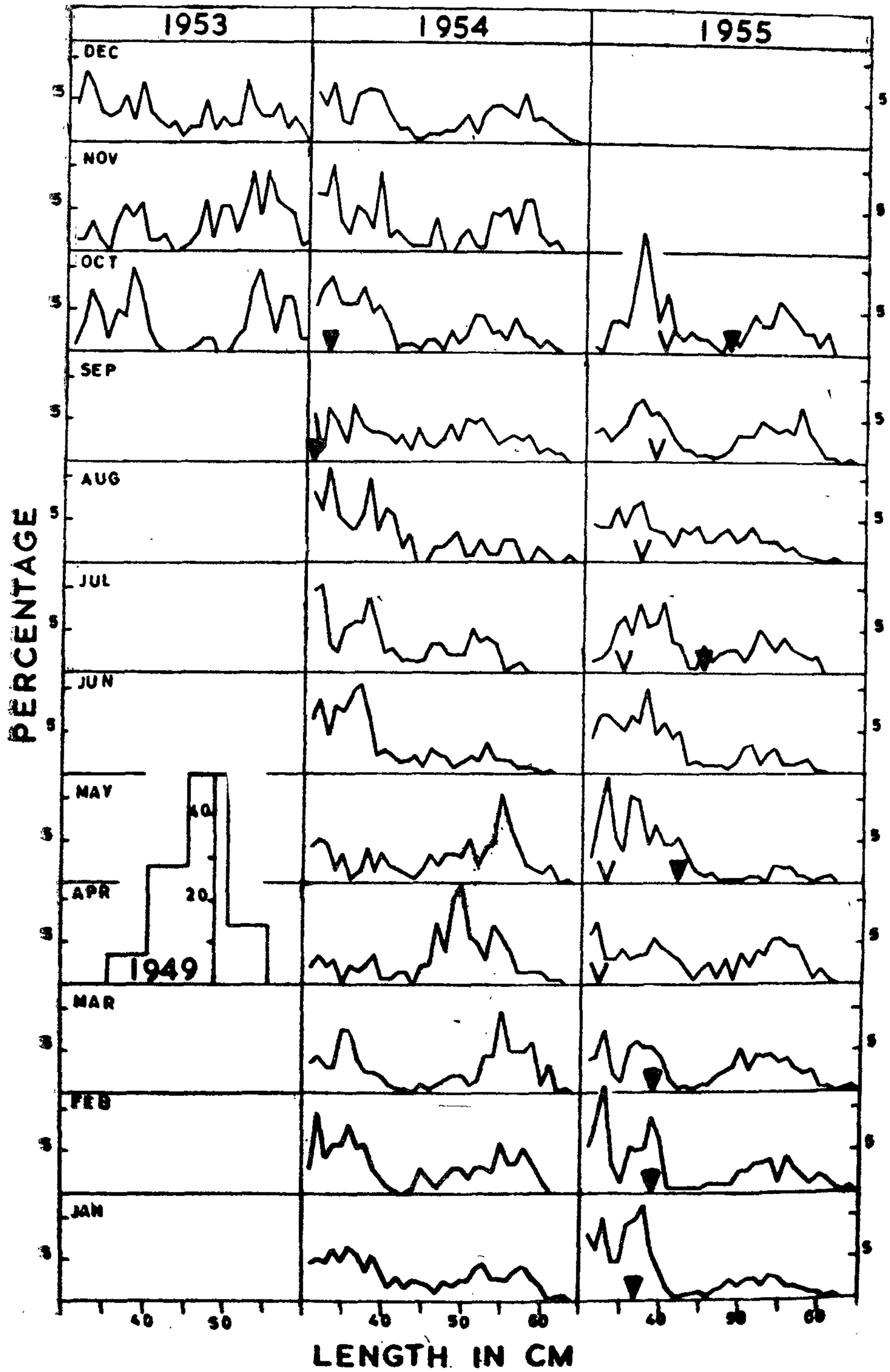

Figure 5. Monthly length frequency distribution of sea bream (>30 cm.) for the years 1953–1955. The histograms for standard lengths (5 cm. groupings) for April-May, 1949, is given for comparison. Symbols indicate locations of modes used in figure 7.

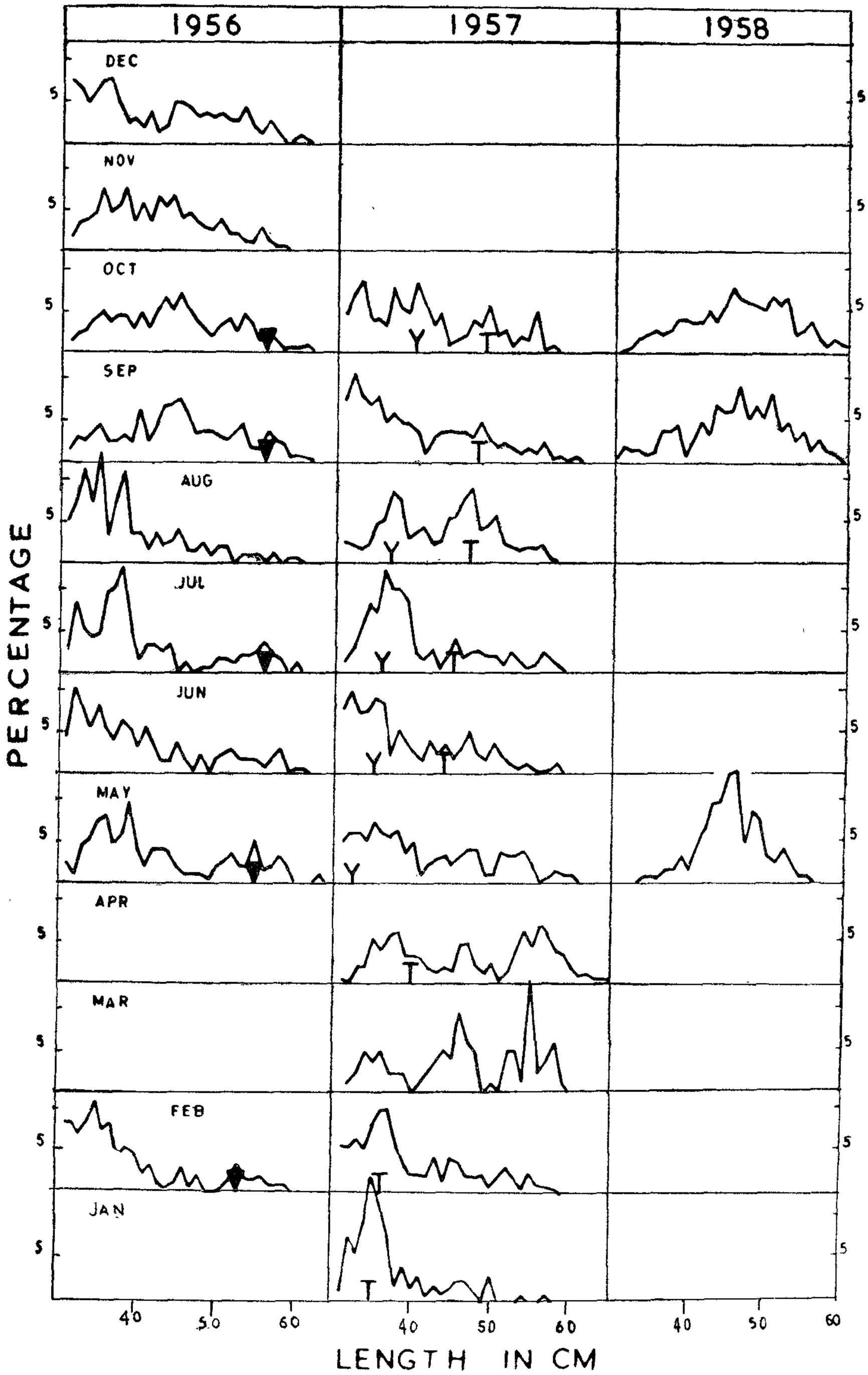

Fig. 6. Monthly length frequency distribution of sea bream (>30 cm.) for the years 1956–1958. Symbols indicate locations of modes in figure 7.

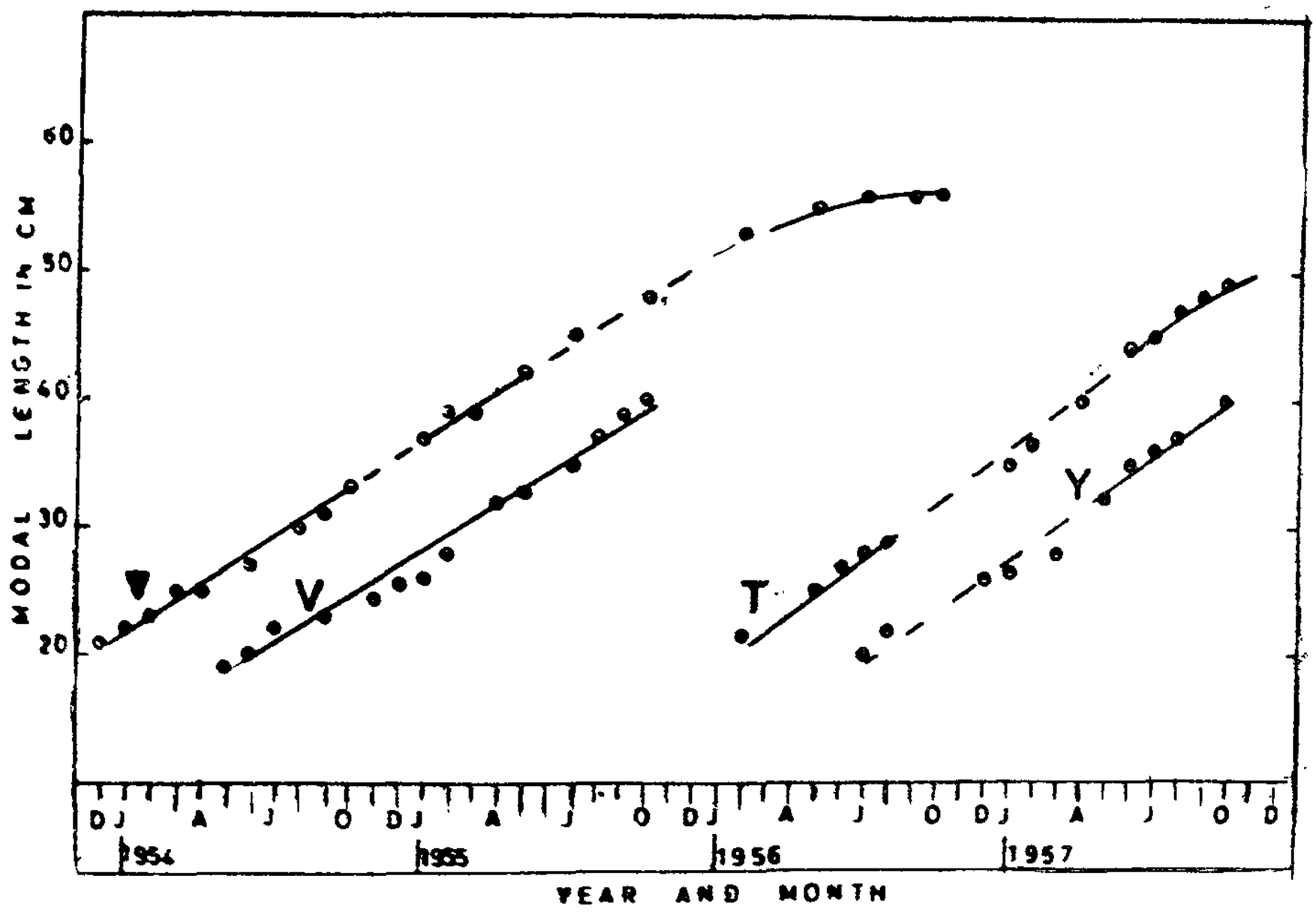

Fig. 7. "Growth lines" of sea bream as determined by modal values based on the locations of modes in figures 3–6.