

AGE AND GROWTH STUDIES ON THE INDIAN MACKEREL *RASTRELLIGER KANAGURTA* (CUVIER) WITH SPECIAL REFERENCE TO LENGTH-FREQUENCY DATA COLLECTED AT COCHIN

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Length-frequency studies on the Indian mackerel *Rastrelliger kanagurta* (Cuvier) have been made by Pradhan (1956), Sekharan (1958) and Balakrishnan (1962-MS), but there has been no agreement with regard to the interpretation of age and growth rate of the fish. Since little work has been done on study of hard parts of the fish, tagging or rearing of the fish under captivity, verification of any of the conclusions arrived at by length-frequency studies has not been possible. Mention may be made in this connection of the work of Seshappa (1958) to interpret the significance of the scale rings of the fish.

After examining the length-frequency data from Karwar from the year 1948-'49 to 1952-'53, Pradhan (1956) came to the conclusion that the size (total length) of mackerel at the completion of 1 year of age is about 10 cm. and it is 18 cm. at the end of its second year of life. Sekharan (1958) examined the length data of mackerel collected by the Madras State Fisheries Department at West Hill from 1934-'35 to 1940-'41 and also the data collected by him at Malpe during the 2 seasons 1954-'55 and 1955-'56 and concluded that mackerel attains the size of 12—15 cm. at the end of the first year of its life and 21—23 cm. at the end of the second year. Based on his observations at Vizhingam during 1955—57, Balakrishnan (-MS.) reported that the rate of growth of the Indian mackerel is slightly more than 1 cm. a month during its first year. Fish measuring about 14 cm. may be one year old. The size groups 19—21 cm. according to him may have completed 2 years of life. By the time they begin to spawn they would have completed 3 years. Spawners are represented by the size groups measuring 23.0 cm. and above and may comprise more than one age group.

In the present paper the length data of mackerel collected at Manassery (Cochin) from 1957-'58 to 1963-'64 have been analysed to obtain the mean size of mackerel at different ages. In this connection the length-frequency data presented by Pradhan (1956) and Sekharan (1958) have also been re-examined.

MATERIAL AND METHODS

Samples of mackerel were obtained 2 to 3 times a week from the country-craft landings at Manassery. Two main types of gear, the boat-seine *Thangu*

vala and the gill-net *Aila vala*, are used at this centre for catching mackerel depending on the size of the fish as well as the shoal, and for completeness these data had necessarily to be pooled. The length data of the fish along with other biological aspects have been regularly recorded. The length-frequency data have been treated monthwise. Figures 1 to 4 show the monthly length-frequency distribution curves for the various fishing seasons from 1957 to '64. A brief description of the size-composition of the catch landed from month to month is given below for each fishing season.

1957-'58 season: A group of mackerel with modal size at 9 cm. was seen in the catch of July 1957. In August two groups with modes at 9 cm. and 13 cm. were seen. In all probability the group with modal size at 9 cm. in July has progressed to 13 cm. in August while the modal group of 9 cm. seen in August is a new group entering the fishery for the first time. The size-group with mode at 17 cm. noticed in September has in all likelihood resulted from growth of modal size 13 cm. seen in August. This group further grows to 19 cm. in November and remains at the same size till January '58. The modal size increases to 20 cm. in February and remains stationary in March. In April and May, the modal size is seen at 21 cm.

In Table I, the growth pattern of the 1957-'58 year class is presented by writing down the position of the modes in successive months from the frequency distribution.

1958-59 season: During this season mackerel was first seen in August '58 with modal size of 15 cm. No sample was available for September. In October, the mode was at 20 cm. and it remained in the same position in November. From December to March the mode was at 21 cm. and it was seen at 22 cm. in April and May '59.

The second row of Table I shows the successive growth pattern of the 1958-'59 year class. The modal size group of 15 cm. seen in August '58 was placed for obvious reasons below the modal group of 13 cm. of July '57. It must be emphasised here that the relative placements of various modal sizes in Table I are made according to possible chronological age and not according to the months of their occurrence. Thus in a season of fast growth a relatively higher modal size will be seen. From a perusal of the alignment in Table I noting down the modal sizes in successive months, it will be seen that it is not done arbitrarily.

1959-60 season: In July '59, modal groups at 10, 17 and also at 19 cm. were found in the length-frequency distribution curve. In August, only one size group with a mode at 12 cm. was seen. In September, only a few specimens of 12-16 cm. length range could be collected and no clear-cut mode was

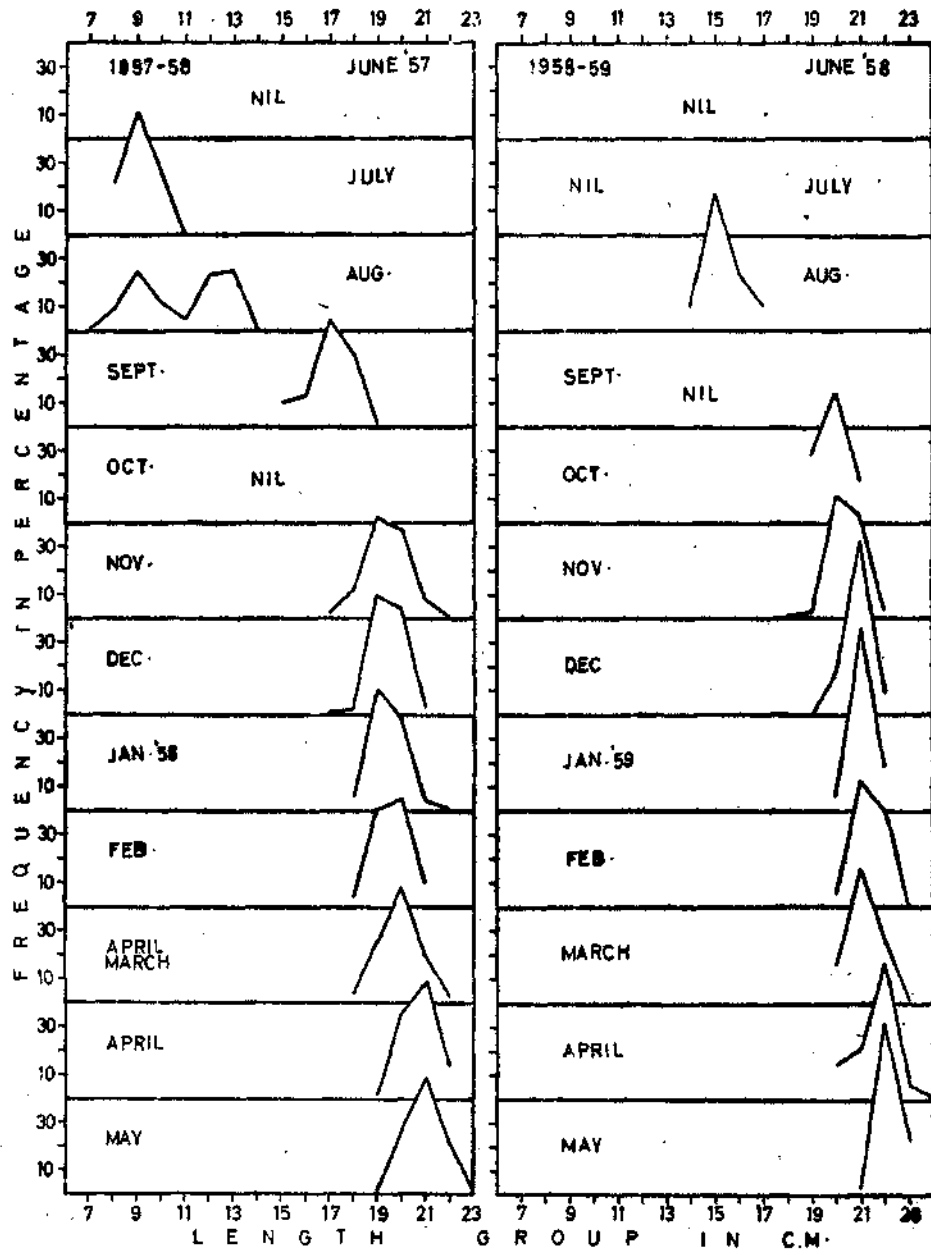


Fig. 1. Monthly length-frequency curves for mackerel caught at Cochin during 1957-58 and 1958-59 seasons.

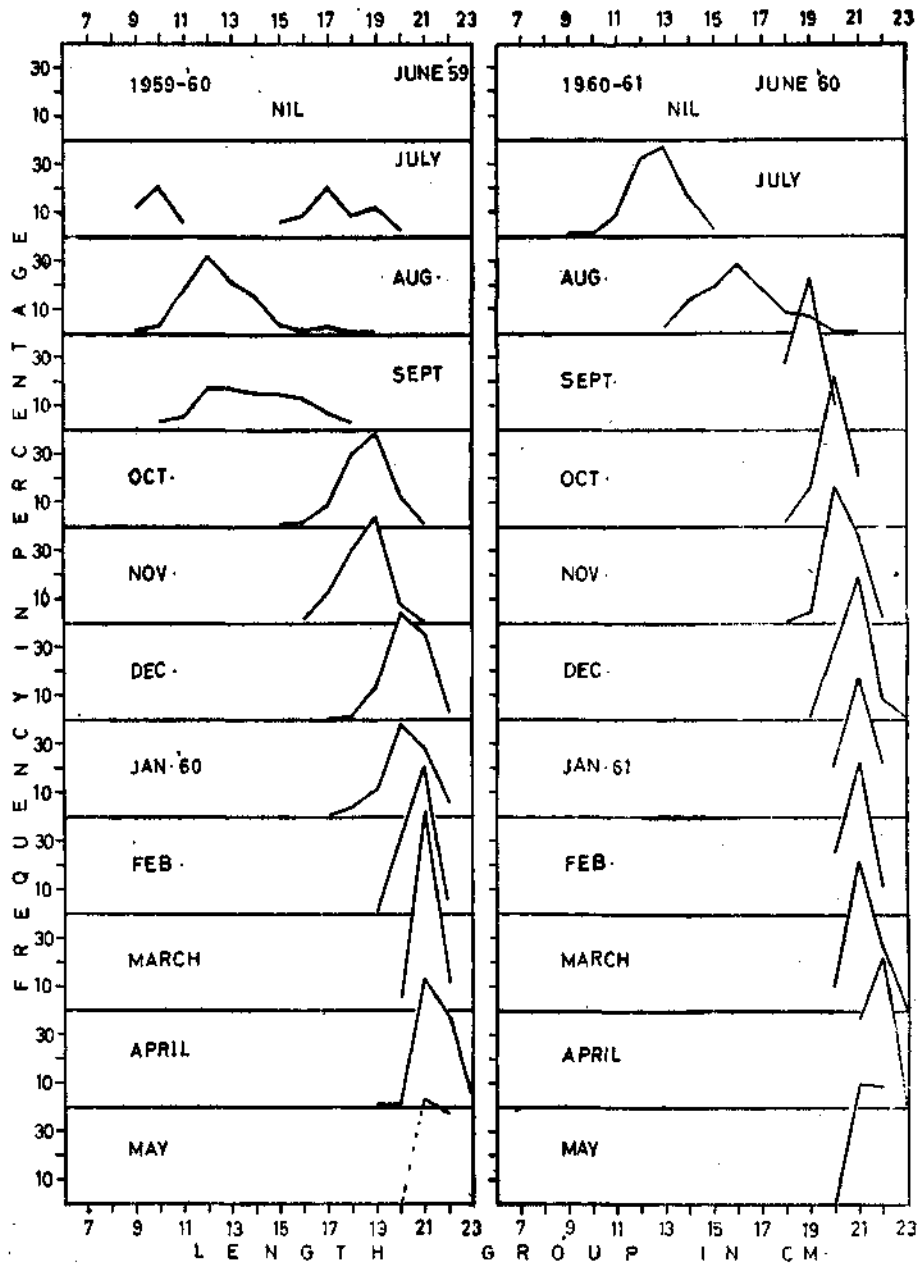


FIG. 2. Monthly length-frequency curves for mackerel caught at Cochin during 1959-60 and 1960-61 seasons.

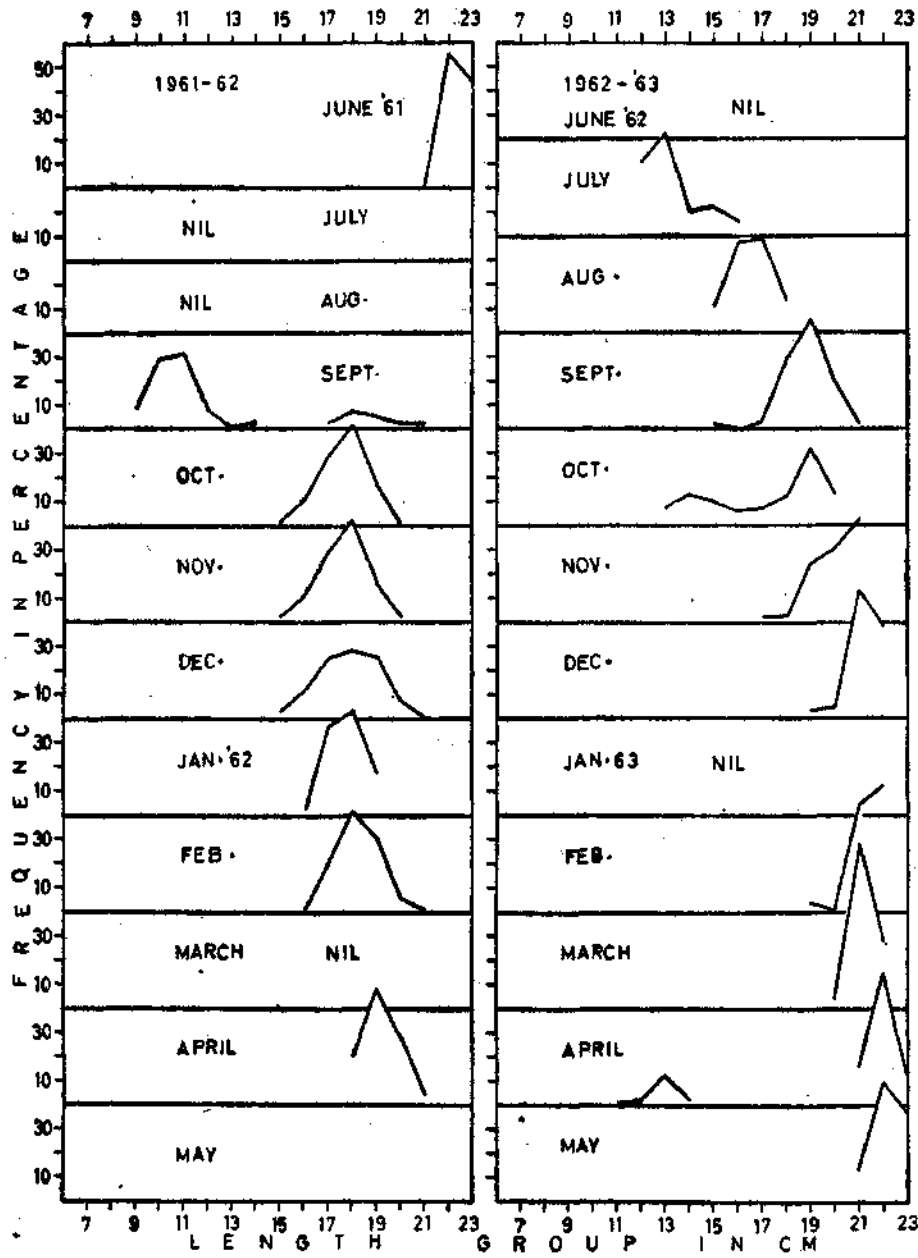


Fig. 3. Monthly length-frequency curves for mackerel caught at Cochin during 1961-62 and 1962-63 seasons.

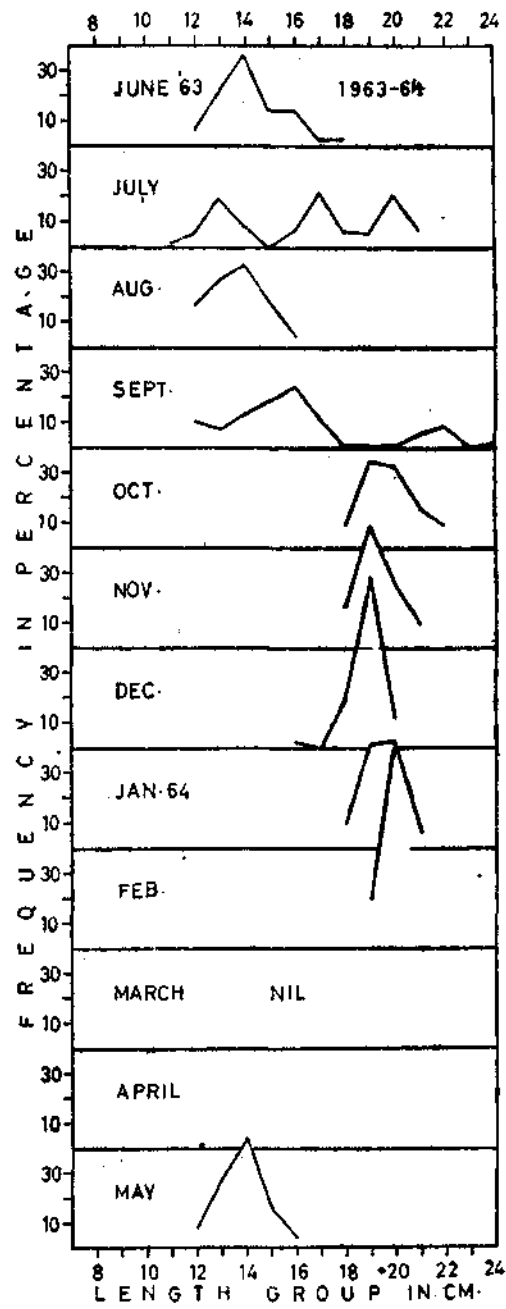


FIG. 4. Monthly length-frequency curves for mackerel caught at Cochin during 1963-64 season.

visible. In October the mode was seen at 19 cm. It remained stationary in November. The mode moved on to 20 cm. in December and remained the same in January. From February to May, the mode stood stationary at 21 cm. From a perusal of the pattern of modal alignments in the earlier months of the season it is seen that there was a comparatively prolonged recruitment of the different broods into the fishery which disturbed a clearer picture of the progressive movement of a modal group. The probable alignment of growth is shown in Table I.

1960-61 season: In June 1960, the average size of mackerel based on only 10 specimens was found to be 16 cm. In July a group with modal size of 13 cm. was seen. In August, this moved up to 16 cm. and it became 19 cm. in September. The mode was seen at 20 cm. in October and November. From December, the mode remained at 21 cm. until in April '61 the mode progressed to 22 cm. Dominant sizes in May were 21 and 22 cm, but not much reliance could be placed on this as only a few measurements were available. The mode in June '61 was at 22 cm. again. The alignment of modal progression can be seen from Table I.

1961-62 season: Samples were available only from September '61. The length-frequency distribution of this month shows two modes at 11 and 18 cm. One sample of 23 cm modal length was available from Kuzhippally, a nearby landing centre. From October to February the mode remained at 18 cm. No sample was available for March. In April, the mode moved up to 19 cm. No samples were available for May and June also. This season the mackerel fishery was a complete failure and only small and erratic catches were recorded.

1962-63 season: A group of modal size 13 cm. was seen in July '62. By August, the mode had moved to 17 cm. In September the mode further progressed to 19 cm. In October, two modes at 14 and 19 cms. were seen. The first mode must represent a new brood and the second represents the same brood seen in September. No clear mode was noticed in November. The mode was seen at 21 cm. in December. No sample was available in January 1963. The data of February do not show a mode. In March the mode is seen at 21 cm. and it moves to 22 cm. April and May. In addition to the mode at 22 cm., a new mode was seen at 13 cm. in the length-frequency distribution curve of April '63.

1963-64 season: In June, the modal size of catch was 14 cm. In July, three modes were seen at 13, 17 and 20 cms. The last mode must be the development of the group seen in April '63 with mode at 13 cm. The mode at 17 cm. must have grown from the group with mode at 14 cm. in June. The group represented by 13 cm. mode must be a new brood entering the fishery for the first time. In August, another new brood with the mode at

TABLE I
 Showing progression of modes in successive months from length-frequency distribution for Cochin
 (Modal values in cm. for successive months)

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---------------|-----|------|------|------|------|------|------|------|------|------|------|------|------|----|----|----|
| 1957-58 | 9 | 13 | 17 | .. | 19 | 19 | 19 | 20 | 20 | 21 | 21 | .. | .. | .. | .. | .. |
| 1958-59 | .. | 15 | .. | 20 | 20 | 21 | 21 | 21 | 21 | 22 | 22 | .. | .. | .. | .. | .. |
| 1959-60 | 10 | 12 | .. | 19 | 19 | 20 | 20 | 21 | 21 | 21 | 21 | .. | .. | .. | .. | .. |
| 1960-61 | .. | 13 | 16 | 19 | 20 | 20 | 21 | 21 | 21 | 21 | 22 | 22 | 22 | .. | .. | 23 |
| 1961-62 | .. | .. | 18 | 18 | 18 | 18 | 18 | 18 | .. | 19 | .. | .. | .. | .. | .. | .. |
| 1962-63 | .. | 13 | 17 | 19 | 19 | 21 | 21 | .. | 21 | 21 | 22 | 22 | .. | .. | .. | .. |
| 1963-64 (1) | .. | 13 | .. | .. | 20 | 20 | 22 | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| (2) | .. | 14 | 17 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| (3) | .. | 14 | 16 | 19 | 19 | 19 | 20 | 20 | .. | .. | .. | .. | .. | .. | .. | .. |
| Average | 9.5 | 13.4 | 16.8 | 19.0 | 19.3 | 19.7 | 20.2 | 20.2 | 20.8 | 20.8 | 21.6 | 22.0 | 22.0 | .. | .. | 23 |
| Age in months | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |

14 cm. enters the fishery. The September frequency curve was characterised by two modes at 16 and 22 cm. respectively. From October to December, the mode was static at 19 cm. In January it progressed to 20 cm. and remained at the same value in February also. There were no samples in March and April, while in May a group of fish with mode at 14 cm. was encountered. It is clear that several successive broods arising from rather prolonged spawning entered the fishery. At least three such broods entering the fishery have been recognised and their growth pattern shown in Table I. According to several authors mackerel has been observed to spawn along the west coast of India from March to September [Devanesan and John (1940); Devanesan and Chidambaram (1948); Chidambaram *et al* (1952); Pradhan (1956); Balakrishnan (1957) and Sekharan (1958)].

The last row of Table I shows the average size of mackerel in successive months from the time of their first occurrence in the fishery for the 7 seasons studied. The minimum size at first appearance is seen to be 9.5 cm. Then it grows to 13.4 cm. in the next month and so on. From the above rate of growth in the initial stages it would seem that the group with an average value of 9.5 cm. will be about 2 months old. [Chirastit (1963) reports a growth increment of 2.93 cm. in tagged *Rastrelliger neglectus*, of the size group of 9.0 to 9.5 cm. recovered within a time range of 16—30 days, in the Gulf of Thailand]. Hence by counting the successive monthly growths as indicated at the bottom of Table I, it is easily seen that mackerel grows to about 21.4 cm. at the end of the first year of its life. From the rate of growth after it has attained the age of one year, it may be inferred that the size at age two will be probably around 24 cm.

In this connection, it is pertinent to examine the findings of Pradhan (1956) and Sekharan (1958). Pradhan (1956) has given the monthly length-frequency distribution tables from 1948-'49 to 1952-'53 of mackerel from the Karwar centre; but an actual estimation of the mean size of the fish at different ages is not available. According to him mackerel ranging from 6 to 11 cm. with an average size of 10 cm. occur in the months July to September and these are presumably the offspring of fish which has spawned in the previous season, the spawning being from June to September. It is also presumed that the mackerel of average size of 10 cm. occurring in July is 1 year old. The suggestion that this group disappears after September and a new group of older fish replaces it in the inshore waters from October onwards in the commercial fishery needs verification by a study of the habits of the fish.

Sekharan (1958) gives the monthly length-frequency curves based on data collected at West Hill from 1934-'35 to 1940-'41 by the Madras State Fisheries Department and tries to trace the progression of the monthly modes in order

to infer about growth rate and average sizes at different ages. The data show in general the appearance of a group having modal sizes between 12 and 15 cm., sometimes in July-September period and it is traced through subsequent months. This group is assumed to be 1 year old, probably on the ground that young mackerel with 6 cm. mode noticed in June '40 must be 0 year class and therefore 12—15 cm. size-group found in July—September period in other years should be 1 year class. The hypothesis put forward by him regarding the rapid growth rate of the mackerel during June to September period is valid only in relation to the juvenile fish and not in relation to the adults. Data show that the juvenile fish grows to about 7 cm. in 3 months between July—September. If therefore the rapid growth rate of 7 cm. in 3 months is recognised for the juvenile mackerel it will be relevant to expect an even faster growth rate before the fish attains this size. Hence it appears to be not correct to assume that mackerel of size 12—15 cm. is about 1 year old.

Tables II and III show the monthly progression of modes as obtained from the data given by Pradhan (1956) and Sekharan (1958) for Karwar and West Hill respectively. The alignment has been drawn up in the same way as explained in the case of Table I. The size at age relationship obtained from the three tables show almost identical results (Fig. 5). Even though the data refer to three widely separated places and that too relating to different periods of time, the similarity of growth pattern is striking.

Thus from a logical method of following the modes through months in case of data obtained from three places collected over different periods of times, we come to the conclusion that the Indian mackerel attains the size of 21.6 cm. at the completion of 1 year of life. Thereafter the growth slows down considerably (Table IV). Such rapid growth in early stages of life is not uncommon in scombroid fishes. Stevens (1952) has shown that the European mackerel *Scomber scombrus* grows to about 24 cm. in the 1st year though the fish has a life span of nearly 20 years during which it grows to about 43 cms. Hatanaka et al (1957) have shown by controlled experiments that the mackerel *Pneumatophorus japonicus* grows from 7 cm. to about 16 cm. in about 2 months time. Fitch (1951) has clearly proved that the Pacific mackerel *Pneumatophorus diego* attains a mean size of about 26 cm. at the completion of the 1st year of life, though the fish is supposed to live up to 9 years when it grows to a mean size of 40 cm. Thus the rapid growth to nearly 22 cm. at the end of the first year of its life for the Indian mackerel is in consonance with the growth pattern of related species in other waters.

From his studies on *Rastrelliger kanagurta* caught in the Lawson's Bay (east coast of India) Rao (1964) stated that the length-frequency data of the juvenile fish indicate very rapid growth in length, probably 2-3 cms. per month.

TABLE II

Showing progression of modes in successive months from length-frequency distribution for Karwar (Pradhan 1958)
(Model values in cm. for successive months)

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---------------|------|------|------|------|------|------|------|------|------|------|----|------|------|------|------|------|------|
| 1948-49 | .. | .. | .. | 20 | 20 | 20 | 20 | 22 | .. | 22 | .. | 23 | .. | .. | .. | .. | .. |
| 1949-50 (1) | 15 | 17 | 19 | .. | 19 | 21 | .. | 22 | 22 | 21 | .. | .. | .. | .. | .. | .. | .. |
| (2) | .. | 18 | 19 | 19 | | | | | | | | | | | | | |
| 1950-51 (1) | .. | 16 | 19 | 20 | 20 | 21 | 22 | 22 | 22 | 22 | .. | 22 | 22 | 22 | .. | .. | .. |
| (2) | .. | 14 | .. | | | | | | | | | | | | | | |
| 1951-52 | .. | .. | 19 | 20 | 20 | 20 | 20 | 20 | 22 | .. | .. | .. | .. | .. | 22 | 23 | 23 |
| 1952-53 | 13 | 17 | 19 | 19 | 19 | 19 | 19 | 19 | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Average | 14.0 | 17.0 | 19.0 | 19.6 | 19.6 | 20.2 | 20.2 | 21.5 | 22.0 | 21.7 | .. | 22.5 | 22.0 | 22.0 | 22.0 | 23.0 | 23.0 |
| Age in months | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |

Age and growth of Indian mackerel

TABLE III
 Showing progression of modes in successive months from length-frequency distribution for West-Hill, Calicut, (Sekharan 1958)
 (Model values in cm. for successive months)

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---------------|-----|----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1934-35 | .. | — | — | .. | — | 19 | 20 | 21 | 21 | 21 | 21 | 22 | .. | .. | .. | .. | .. | 24 |
| 1935-36 | .. | — | 12 | 16 | 17 | 20 | 20 | 20 | 20 | 20 | 21 | 21 | 22 | 22 | 22 | .. | 23 | .. |
| 1936-37 | .. | .. | .. | — | — | 19 | .. | 20 | 21 | 21 | 21 | .. | .. | 22 | 22 | 22 | .. | 23 |
| 1937-38 | .. | .. | 12 | 17 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 24 | .. |
| 1938-39 (1) | .. | .. | 12 | 17 | 19 | 21 | 21 | 22 | 22 | 22 | .. | 23 | 23 | — | — | — | .. | .. |
| (2) | .. | .. | 14 | | | | | | | | | | | | | | | |
| 1939-40 (1) | .. | .. | 12 | 16 | 19 | 20 | .. | 20 | — | .. | .. | .. | .. | — | .. | — | .. | .. |
| (2) | .. | .. | .. | 14 | | | | | | | | | | | | | | |
| 1940-41 (1) | 6 | .. | .. | 17 | 20 | 20 | 20 | 21 | 21 | 22 | 21 | .. | .. | .. | .. | .. | .. | .. |
| (2) | .. | .. | 12 | 17 | 20 | | | | | | | | | | | | | |
| Average | 6.0 | .. | 12.3 | 16.5 | 19.0 | 19.8 | 20.4 | 20.7 | 21.0 | 21.3 | 21.0 | 22.0 | 22.5 | 22.0 | 22.0 | 22.0 | 23.5 | 23.5 |
| Age in months | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |

TABLE IV
Summary of average size attained at different ages
(Length at ages in months in cm.)

| Place | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---------------|-----|-----|------|------|------|------|------|------|------|------|------|------|------|-------|------|------|------|------|------|
| Calicut | 6.0 | .. | 12.3 | 16.5 | 19.0 | 19.8 | 20.4 | 20.7 | 21.0 | 21.3 | 21.0 | 22.0 | 22.5 | 22.0 | 22.0 | 22.0 | 23.5 | 23.5 | .. |
| Karwar | .. | .. | 14.0 | 17.0 | 19.0 | 19.6 | 19.6 | 20.2 | 20.2 | 21.5 | 22.0 | 21.7 | .. | 22.5 | 22.0 | 22.0 | 22.0 | 23.0 | 23.0 |
| Cochin | .. | 9.5 | 13.4 | 16.8 | 19.0 | 19.3 | 19.7 | 20.2 | 20.2 | 20.8 | 20.8 | 21.6 | 22.0 | 22.0 | .. | .. | 23.0 | .. | .. |
| Pooled | | | | | | | | | | | | | | | | | | | |
| Average | 6.0 | 9.5 | 13.1 | 16.6 | 19.0 | 19.7 | 20.1 | 20.5 | 20.7 | 21.3 | 21.4 | 21.7 | 22.2 | 22.25 | 22.0 | 22.0 | 23.0 | 23.3 | 23.0 |

Age and growth of Indian mackerel

Seshappa (1958) observed no rings on scales of the Indian mackerel below 22 cm., while all individuals above 23 cm. showed clear rings. The nature and periodicity of the formation of the scale ring has not been established finally but the suggestion is that it may be a spawning mark.

The very slow progression of the modal length and persistence of the same mode for months together during the fishery season is a feature which requires explanation. After a rapid phase of growth in the juvenile stage there is a significant slowing down of growth noticeable especially in the case of fish above 20 cm. The addition of fast-growing recruits from waves of spawning to a slow-growing population of older recruits in the fishery appears to be the main reason for the above situation. Constant removal of older fish by fishing may also to some degree contribute to this phenomenon. It cannot yet be suggested with any certainty if there is a partial migration of the adult 'would-be spawners' to offshore grounds for spawning.

However the slowing down of growth of older fish after they attain about 20 cm. is a distinct possibility (Table IV—pooled average length at ages—months). If this drastic retardation of growth is maintained in the older fish it is even likely that an overlap of size and age class occurs in them. An intensive study of the hard parts of the fish for identifying periodic growth checks and large scale tagging experiments may help to solve the problem of age determination of the fish more clearly. At present it can only be said from the trend of modal length progression that the Indian mackerel attains a size of about 21.6 cm. at the end of the 1st year of life and probably it is 24 cm. at the end of the 2nd year.

An equation frequently used to describe size at age is that of von Bertalanffy, the derivation of which has been shown in detail by Beverton and Holt (1957). The form of the equation is:

$$l_t = l_{\infty} \left\{ 1 - e^{-k(t-t_0)} \right\}$$

where l_t is the length at age t and l_{∞} is the asymptotic length and k is the growth coefficient and t_0 is an adjustment in the time scale corresponding to the apparent age at length zero. The above equation can be written in the linear form:

$$l_t + 1 = a + bl_t \text{ where}$$

$$k = \log_e b \quad \text{and} \quad l_{\infty} = \frac{a}{1-b}$$

The estimates for the two parameters k and l_{∞} as obtained for the three places from the data given in Tables I to III are as follows:

| Place | k | l_{∞} |
|---------|------|--------------|
| Cochin | 0.43 | 21.77 |
| Calicut | 0.26 | 23.26 |
| Karwar | 0.36 | 22.40 |
| Pooled | 0.30 | 22.84 |

Assuming $t_0 = 0$, and taking $k = 0.30$ and $l_{\infty} = 22.84$, the estimated values from Bertalanffy's equation are given below. Side by side the pooled average sizes obtained from table IV are shown.

TABLE V

| Age (month) | Estimated size Bertalanffy, cm | Observed pooled average size, cm |
|-------------|--------------------------------|----------------------------------|
| 1 | 5.9 | 6.0 |
| 2 | 10.4 | 9.5 |
| 3 | 13.5 | 13.1 |
| 4 | 16.1 | 16.6 |
| 5 | 17.9 | 19.0 |
| 6 | 19.2 | 19.7 |
| 7 | 20.2 | 20.1 |
| 8 | 20.9 | 20.5 |
| 9 | 21.4 | 20.7 |
| 10 | 21.8 | 21.3 |
| 11 | 22.1 | 21.4 |
| 12 | 22.4 | 21.6 |

The agreement seems to be fairly satisfactory. Figure 5 shows the observed growth curves at the three places as well as the pooled growth curve and the fitted growth curve.

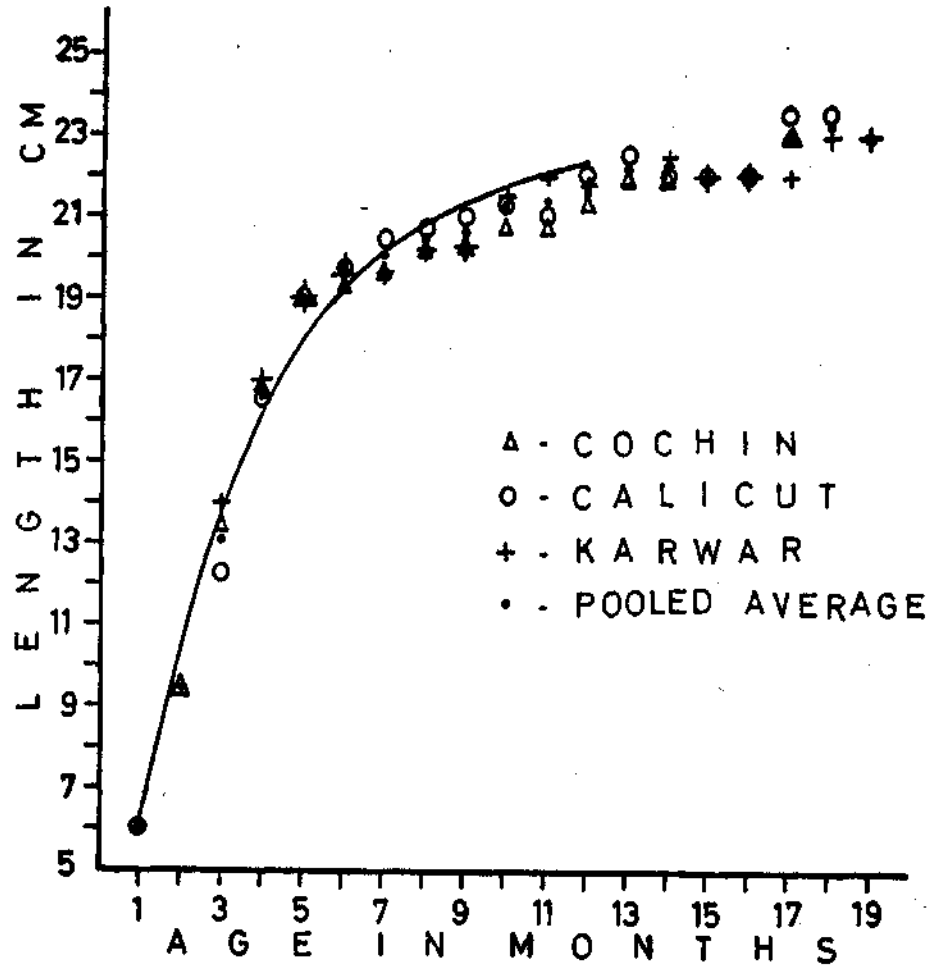


FIG 5.— The observed growth in length of mackerel at Cochin, Calicut and Karwar and the pooled average value for these places, with the fitted growth curve.

The conclusion that the Indian mackerel attains a size of nearly 22 cm. at the completion of age 1 has an important bearing with regard to the commercial fishery. It is known that the commercial fishing mainly depends on fish of the size range of 18 to 22 cm., *i.e.*, on fish which are either in the zero year or just completing their 1st year of life. Hence the success of the fishery in any season will depend on the strength of the incoming 0-year class. Any fishery which depends on the strength of a single incoming class of fish with a short span of life may show wide fluctuations in catch from year to year. This in turn will depend on the survival rate of young as well as immigration of these into the inshore fishing region which is dependent on the environmental conditions there. We feel that this is the situation encountered in the case of the Indian mackerel fishery.

SUMMARY

The length-frequency data on the Indian mackerel *Rastrelliger kanagurta* (Cuvier) collected at Cochin for 7 seasons from 1957 to 1964 are analysed for determination of the age and growth of the fish. In this connection length-frequency data published by Pradhan (1956) and Sekharan (1958) are also reanalysed.

By following the modal progression through months in the case of data obtained from the three centres, namely, Karwar, Calicut and Cochin, it is concluded that the fish attains the size of nearly 22 cm. at the completion of 1 year of life. The growth trend indicates that probably it attains about 24 cm. at the end of the 2nd year. ●

It is suggested that after a rapid phase of growth in the juvenile stage there is significant decrease in the growth of the fish.

Based on the observed values, a growth estimation is made by applying the well-known Bertalanffy equation which shows satisfactory agreement.

Since the commercial fishery mainly depends on fish ranging in size from 18 to 22 cm., *i.e.*, on fish which are in the 0-year completing its 1st year of life through the fishery, success of the fishery in any season will depend on the strength of the incoming 0-year class. Such a fishery may show wide fluctuations dependant on the year to year survival rate of the young and also the environmental conditions influencing immigration of the fish to the fishing zones.

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