# STUDIES ON THE AGE AND GROWTH OF TRENCHED SARDINE, *SARDINELLA SIRM* (WALBAUM), FROM VIZHINJAM, SOUTHWEST COAST OF INDIA

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## INTRODUCTION

The age and growth of *Sardinella sirm* has been studied based on the length-frequency data collected from Vizhinjam during the period 1975-78. Calculated size of *S. sirm* at the end of one year was 196 mm and the maximum attainable theoretical size was 210 mm. Growth rate was observed to differ highly during the different quarters. Calculated sizes indicated that, with aging, growth rate steadily decreased.

## INTRODUCTION

*Sardinella sirm*, locally known as *'keerimeen chalai'*, support a fishery of some importance along the southwest coast of India between Cape Comorin and Quilon. However, only very little information is available on its age and growth, the only literature being Gnanamekalai (1963), based on materials above 125 mm total length drawn from drift gill nets locally called *'kola vala'* and *'chalu vala'* operated off Tuticorin and Radhakrishnan (1973), reporting the length-frequency distribution from Vizhinjam.

## MATERIAL AND METHODS

The age was studied employing Peterson's method on materials collected from the commercial catches at Vizhinjam between October 1975 and April 1978; the gear used for capture had been gill net (*Chala vala*), boat seine (*thattu madi*) and shore seine (*kara madi* or *kamba vala*) which operated within the inshore region. Juveniles used in the study were caught by small-meshed shore seine called *'nonna vala'*, which was used exclusively for the capture of small fish (Nonnavu). However, for age and growth studies only samples from non-selective gears were considered.

Random samples each consisting of 30 to 50 fish were drawn twice a week from the fishlanding centre at Vizhinjam. Samples of post-larvae and juveniles were collected daily. The samples thus collected were 180 in total, consisting of 4741 specimens. They were measured in the laboratory in fresh condition. Total length was from the tip of snout to the end of longest caudal ray in the lower lobe. The size of the fish ranged from 10 mm to 230 mm, which was divided into 5-mm groups and referred to as 10 mm, 15 mm, etc., the starting point of each range. As the number of fish measured each month was not constant, the length distribution was made comparable by converting the frequencies into percentages of total for the month. The year reckoned was from October to September.

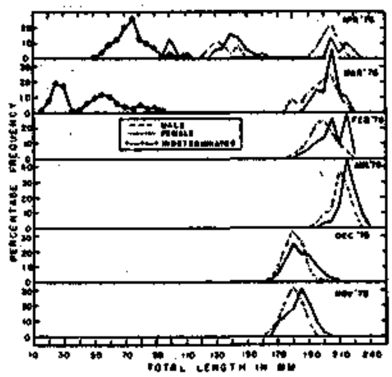
As there was a slight difference in the size at first maturity between sexes (Lazarus MS), the data were analysed separately for indeterminates, males and females (Fig. 1, A). Normally only 5-mm difference was found between the modal values of the sexes, the modes for males being mostly 5 mm less than the modes for females. Therefore, for age and rate of growth, they were pooled together (Fig. 2).

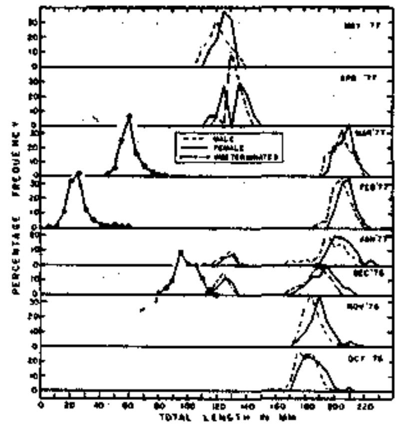
## Observations

The length-frequency data show some conspicuous modes together with a few smaller modes. As the identity of the smaller modes is doubtful, the growth rate has been calculated by tracing a few of the conspicuous modes.

In November 1975 only one mode was observed at 180 mm. Similarly, in December 1975 and January 1976 only one mode was observed, respectively at 185 mm and 215 mm. In rest of the season, February to April 1976, the prominent mode was found at 205 mm. This could be traced back to 180 mm mode of November 1975, indicating a progress of 25 mm in five months. In March 1976 three new modes were observed, at 25 mm, 55 mm and 80 mm. In April 1976 also four new modes could be observed. In this the modes at 75 mm and 110 mm could be traced back respectively to 55 mm and 80 mm modes of the previous month, showing a growth increment respectively of 20 mm and 30 mm in one month.

In October 1976 two modes were seen one at 175 mm and another at 185 mm. The 175 mm mode of this month could be traced back to 75 mm mode of April 1976, showing an average growth of 16.6 mm per month. The 185 mm mode could be traced back to 110 mm mode of April, that is an addition of 12.5 mm per month. The two modes of October were found merged together to form a single mode in the coming months. This was 190 mm in November, 195 mm in December, 200 mm in January and 205 mm in February and March. An average of 5 mm growth per month was observed for this group from November to February. In December 1976 two more modes were seen, one at 95 mm and the other at 125 mm. In January 1977 also two more modes were seen, one at 130 mm and the other at 170 mm. In February 1977 a new mode, may be a new recruit, was seen at 25 mm. This was shifted to 60 mm in March and 120 mm in May. Thus in the first three months a monthly growth



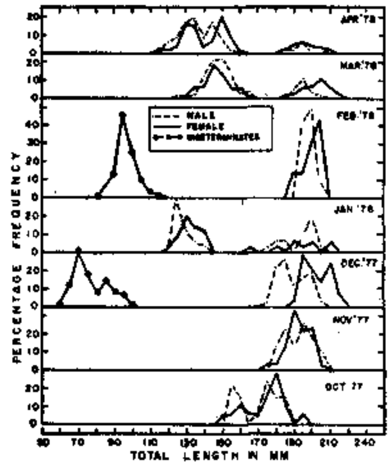




FIG. 1. Sexwise size distribution of *S. sirm* during Nov. 1975 to April 1978.

increment of 31.7 mm was apparent. In April a mode appeared at 135 mm. In October 1977 two modes were seen at 155 mm and 180 mm. In November also two modes were seen at 185 mm and 195 mm. In December two modes were seen of the larger size groups, 185 mm and 200 mm, and two fresh modes were seen of the smaller size group at 70 mm and 85 mm. The mode of 200 mm was found to persist in January and February also. In January one more mode was observed at 125 mm and in February at 95 mm. In March three modes were observed, at 140 mm, 195 mm and 205 mm. Similarly in April also three modes were observed, at 130 mm, 150 mm and 195 mm. The 200 mm mode of February 1978 could be traced back to 120 mm mode of May 1977 and 200 mm mode of January 1978 could be traced back to 135 mm mode of April 1977, thus giving a monthly growth of 8.7 mm for the former and 7.2 mm for the latter. The 150 mm mode of April 1978 could be traced back to 85 mm mode of December 1977, thus giving a monthly growth of 16.3 mm.

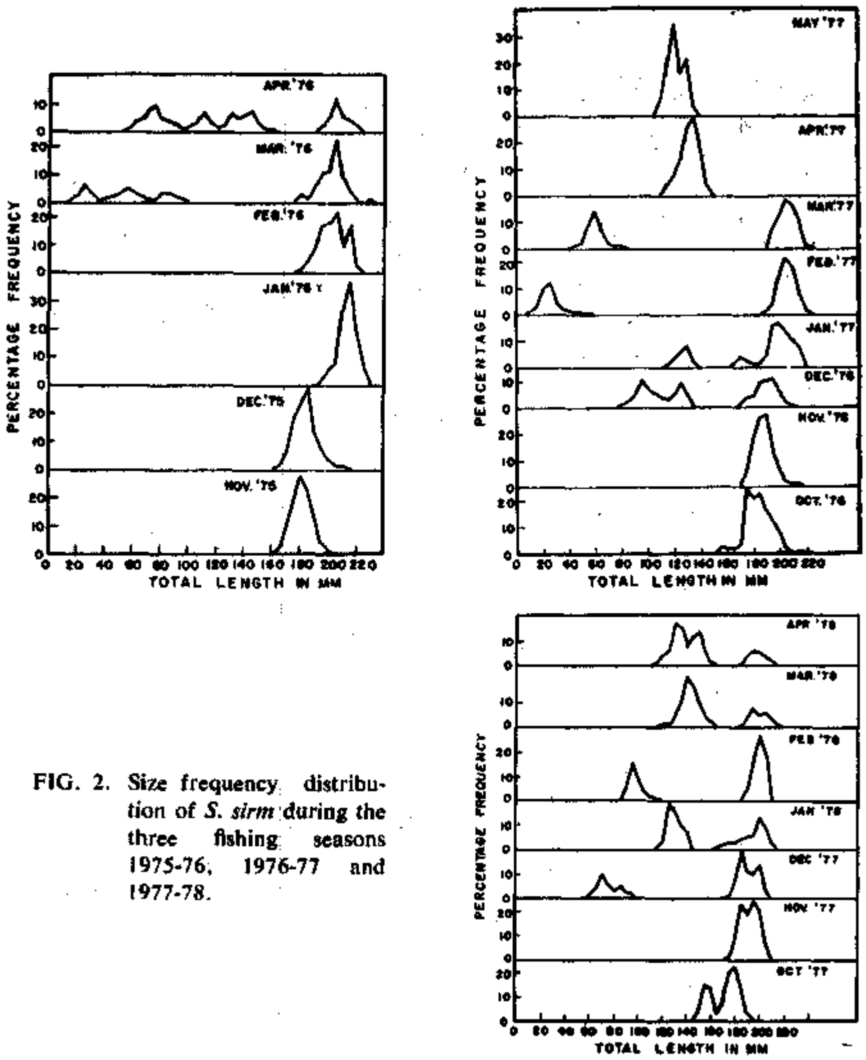


FIG. 2. Size frequency distribution of *S. sirm* during the three fishing seasons 1975-76, 1976-77 and 1977-78.

*Number of broods*: The modal values from the length-frequency polygons were represented in the form of a scatter diagram (Fig. 3) of month-mode, i.e., the modal values on the 'Y' axis and the time at monthly intervals on the 'X' axis; the origin of the 'Y' axis was kept at 0 (Devaraj 1977). The modal progression in the scatter diagram was traced by fitting a trendline representing the growth of the brood. It appeared that a given year class was comprised of two broods, a first major brood released during the peak spawning season between December and February, and a second weak brood which appeared to have been released around September-October.

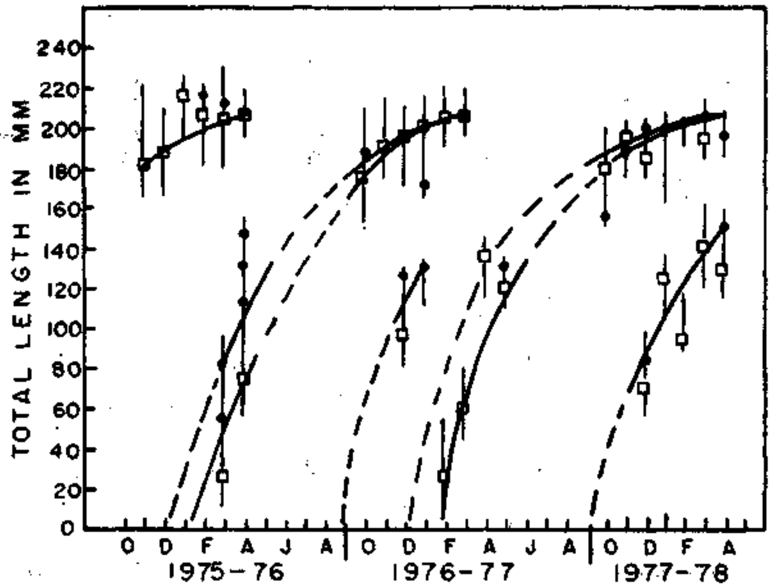



FIG. 3. Monthly length-frequency of *S. sirm*.

Ova-diameter-frequency polygons of ripe ovaries indicated two distinct batches of ova, one fully ripe, ready for spawning, and the other, maturing opaque ova (Lazarus, MS). The spawning of the advanced batches of eggs began to contribute to the first major brood. This brood seemed to have been further strengthened by the spawning of the preceding batch. The presence of multiple modes among the younger size groups (indeterminate class) as clearly seen in the scatter diagram also indicated the consolidation of the first major brood by the spawning of these two batches of ova. The extrapolated diagram indicated a maximum time gap of about one and a half months between the spawning of the two batches. The presence of minor modes between the two growth lines representing the growth of the product of the two batches of ova was an indication that spawning took place in spurts nonsynchronically, meaning to say that within the overall spawning season lasting from December to February the fish might spawn at any time. If the two batches of ova are assumed to have spawned in succession, then the time gap of one and a half months would actually be the time taken by the preceding batch of ova to be spawned.

There seems to be no justification to treat the products of the two batches of ova as two different broods for the following reasons;

1. Between the products of the two batches it is only the products of the second batch which are clearly represented as distinct modes in the scatter diagram.

2. The product of the first batch is represented by scanty and insignificant number of modes only among the smaller size groups.

3. From inferences 1 and 2 drawn above it may tentatively concluded that the product of the first batch may slow down in growth beyond a size of about 120 or 130 mm so that the length of the fish belonging to the first batch would merge with that of the second batch.

It is inferered that the September brood was the product of the spawning of freshly maturing ova and probably also the ova which were part of the preceding batch (of the last spawning season) which lagged behind in growth, but subsequently triggered into growth after the spawning of the second batch of ova. The time gap between the two broods thus seems to be approximately 7 months (from January to August, both inclusive).

*Age*: From Fig. 3 the dominant modes of the different batches as well as the average of all the mods are given in Table 1. From the averages it could be seen that *S. sirm* reached a size of 200 mm by the end of the first year. Further growth could not be traced owing to the non-availability of samples. As suggested by Gulland (1969), an attempt was made to express growth mathematically, following von Bertalanffy equation (Beverton 1954, Beverton and Holt 1957).

$$l_t = L_\infty \left[ 1 - e^{-K(t-t_0)} \right]$$

The resultant growth equation for *S. sirm* is

$$l_t = 218.5642 \; 1 - e^{-0.6188 \, (t - 0.3203)}$$

on a quarterly basis. The theoretical length of *S. sirm* by the end of consecutive quarters are estimated as.

| *Quarter* | *Size (mm)* |
|---|---|
| 1 | 75.03 |
| 2 | 141.26 |
| 3 | 176.93 |
| 4 | 196.14 |
| 5 | 206.48 |

These correspond well with the observed values as given in Fig. 4. The equation gave a size of 196 mm at the end of first year and the size at the end of second year could be estimated as 217 mm.

*Rate of growth*: From the observed values of length during different quarters it could be estimated that *S. sirm* had an average monthly growth rate of 25 mm

TABLE 1. *Modal values of different batches of* Trenched Sardine *in various months during the seasons* 1975-76 *to* 1977-78.

| Seasons | Batches | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1975-76 | I | — | 55 | 75 | — | — | — | — | — | 175 | — | 195 | 200 | 205 | 205 | — |
| | II | — | — | 80 | 110 | — | — | — | — | — | 185 | 190 | — | — | — | — |
| 1976-77 | I | 25 | 60 | — | 120 | — | — | — | — | 180 | 185 | 185 | — | — | 195 | — |
| | II | — | — | — | 135 | — | — | — | — | — | — | 195 | 200 | 200 | — | 205 |
| 1977-78 | I | — | — | 70 | — | 130 | 140 | — | — | — | — | — | — | — | — | — |
| Average | | 25 | 57.5 | 75.0 | 121.7 | 130 | 140 | — | — | 177.5 | 185.0 | 188.8 | 200.0 | 202.5 | 200.0 | 205.0 |

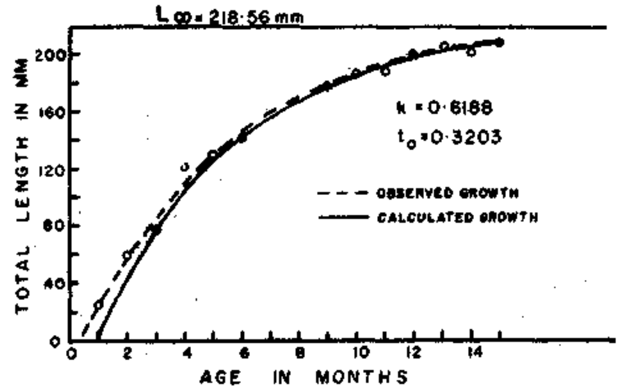



FIG. 4. Fitted growth-curve plot against the average monthly.

during the first quarter, 22 mm during the second quarter, 13 mm during the third quarter, 8 mm during the fourth quarter and 2 mm during the fifth quarter.

## Discussion

The present study does not agree with the inference drawn by Gnanamekalai (1963) on the various aspects of the biology of *S. sirm*. According to her, the maximum size found in the normal commercial catches of Tuticorin was 250 mm. She had even observed bigger specimens, up to 300 mm, during the off-season. According to Chacko (1956) the catches of Tuticorin comprised mainly of individuals measuring from 145 mm to 215 mm only. Ronquillo (1960) gave 100 mm to 180 mm TL as the commercial size at Philippines. In the present study at Vizhinjam also a common maximum size of 214 mm and a rare case of 230 mm only were noticed. There is no record of a size more than 230 mm seen in the literature for this species. So there is every likelihood of Gnanamekalai (1963) having included in her studies the closely related species like *S. clupeoides* and *S. leiogaster*, which grow to a bigger size than *S. sirm*. Moreover, the inferences she has given regarding spawning frequencies and periods have no supporting evidence.

The scatter of lengths at age and the calculated growth curve given in Fig. 4 indicate that the observed values were generally greater than the theoretical values during the first six months. This was due to the fact that the growth rate varied slightly from batch to batch and from season to season and during all the seasons the length data for all months for all the batches were not available, thus causing bias in the averages. Moreover, the length data for individuals older than one year were wanting. The data between the third month and the eighth month were scarce. However, the estimated parameters seems sufficient to explain the growth pattern during the exploited phase.

The estimated $L_\infty$ may be an under estimate considering the occurrence of individuals of sizes more than 218 mm in the fishery. But this seems to be characteristic of tropical pelagic fishes, in which there is a sudden reduction in the growth rate as the process of maturation sets in as was observed by Yohannan (1981) in Indian mackerel, and a secondary growth period immediately after spawning. Sekharan (1971) also observed a secondary acceleration in the growth rates of *S. albella* and *S. gibbosa*. Since the present data relate to fishes before the secondary growth period, it was not reflected in the estimation of growth parametesrs, thereby giving an $L_\infty$ value smaller than the sizes observed in the fishery. Consequently, the estimated size at the end of second year should be taken as only theoretical. Such $L_\infty$ values were given by Howard and Landa (1958) and Bayliff (1967) for the Peruvian anchovy, *Cetengraulis mysticetus*, Sekharan (1971) for *Sardinella albella* and *S. gibbosa* and Banerji (1973) for the Indian mackerel *Rastrelliger kanagurta*. Though Raja (1972) got an acceptable value of $L_\infty$ for the oil sardine, *Sardinella longiceps*, the to value given by him was —13.42 (though he has given it as 13.42 from his figure 4-B it can be understood that is a minus value). This is because the period of fast growth of oil sardine (first three months) is not reflected in his estimation since he had used the size values after three months for estimating the growth parameters. Consequently his K value can be an underestimate.

From Fig. 4 it can be seen that the growth during the early part of its life was rapid reaching a size of about 178 mm by the end of first nine months. The fish seemed to add only 27 mm to its length during the succeeding six months. Thus it could be assumed that as the process of maturation set in there was a drastic reduction in growth. Qasim and Bhatt (1966) observed that in the case of *Ophiocephalus punctatus* as the maturation started the food resources were utilised more for the maturation of gonad than on linear growth. Thus, there may be two different growth patterns in *S. sirm* as observed in the Indian mackerel by Yohannan (1981). So under these conditions a better fit on the von Bertalanffy's equation than the present one may not be possible.

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