embryos crowded in the posterior half of the right peribranchial cavity. Larval trunk measures 0.4 mm to 0.5 mm. Lateral, median dorsal and median ventral ampullae are present.

Remarks : This species can be easily distinguished from *P. constellatum* and *P. madrasensis* two naked species already reported from India by the shape of the colony, common cloacal apertures on small elevations and a narrow branchial sac. The present species though closely resembles *P. nudum* Kott, 1992 in the nature of the colony, naked test, arrangement of zooids, atrial lip from upper border of opening, branchial papillae, nature of gonad, long posterior abdomen etc. a few differences like small size of zooids, lobes in the border of common cloacal aperture, lesser number of stigmata were also observed.

Department of Zoology, A.P.C. Mahalaxmi College for Women, Tuticorin 628 002, Tamil Nadu V.K. MEENAKSHI

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COMPARISON OF THE GROWTH PATTERNS OF INDIAN MACKEREL AND OIL SARDINE

ABSTRACT

The growth parameters of Indian mackerel and oil sardine were estimated from the data collected during the period from April 1996 to March 1998 from fish landing centres in and around Calicut. The L-inf, K and amplitude (C) of mackerel were estimated as 265 mm, 2.4 and 0.7 respectively. The corresponding parameters for oil sardine were 200 mm, 2.1 and 0.6. Both the species showed a drastic reduction of growth rate during December to March, the period of low plankton abundance in the coastal waters. The fishable life span of both the species was estimated as around 16 months.

INDIAN MACKEREL, *Rastrelliger kanagurta* (Cuvier) and oil sardine, *Sardinella longiceps* Valenciennes are the two major species that sustain the pelagic fishery of the southwest coast of India. They inhabit the same area and are in the same trophic level. Both have similar biological periodicities. Hence, environmental variations can be expected to influence their growth and other biological processes similarly.

There are a number of publications on the growth of these two species and the estimated growth parameters differ markedly. Venkataraman (1970) compiled the different views expressed by mackerel workers. Yohannan (1979) while studying the growth pattern of the fish critically reviewed some of the earlier studies. Antony Raja (1969) made a indepth review of the work done on the growth of oil sardine by earlier workers. Annigiri *et al.* (1992) had given the growth parameters of the fish and compared it with some of the earlier studies. Yohannan (1979) observed that the growth of mackerel cannot be explained well with Bertalanffy's growth equation as there were two different patterns of growth, one during the juvenile phase and another one during the mature phase. The L-inf value given by him for the juvenile phase was very high and the t_o value for the mature phase was abnormal. George and Banerji (1968) gave the growth parameters of the fish with L-inf value which was much lower than the size groups normally observed in the commercial catches. Antony Raja (1970) estimated growth parameters of oil sardine with an abnormal t_o value. All these confirm that the growth of these fishes have some peculiarity which is not explained by an ordinary Bertalanffy's growth equation. This paper is an attempt to compare the growth patterns of these species and study the peculiarities and the probable reasons.

Material and Methods

Regular samples of mackerel and oil sardine were collected from the fish landing centres in and around Calicut from April, 1996 to March, 1998. The length frequency distribution, in 5 mm intervals, of each sample was fed to ELEFAN program against the date of the sample so as to get a clear picture of the progression of modal values. The modal progression of the most important brood was clearly seen in the ELEFAN I program. The file was 'cleaned' removing unimportant broods which appear sporadically in the catch. Growth parameters were extracted using the 'automatic search routine'. As the ordinary Bertalanffy's equation was not found to give a satisfactory fit to the data the 'seasonalised von Bertalanffy's growth equation', where the parameters C (amplitude) and WP (winter point) can take care of the amplitude in the growth rate was used. The searching was repeated using different growth parameters with variable starting sample (SS) and starting length (SL) monitoring the Rn values. The best fitting growth lines with maximum Rn values were selected. Later the monthly samples were pooled to get the Fig. 1. Growth parameters thus estimated for mackerel and oil sardine are compared and studied in relation to the well known annual cycle of environmental variations in the coastal waters of the Malabar area.

Results

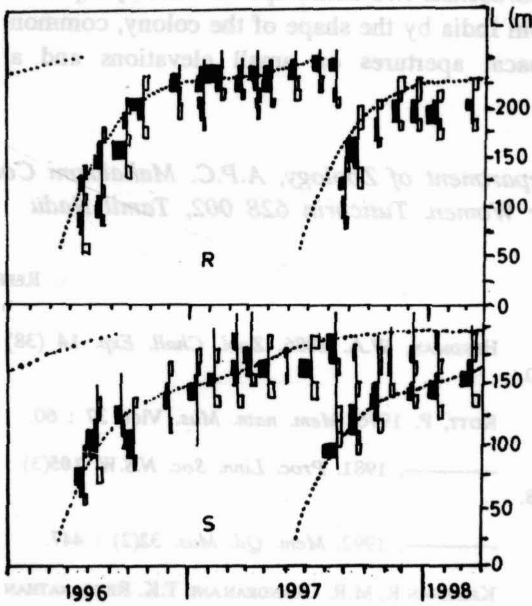

FIG. 1. *Restructured length frequency distribution of Indian mackerel (R) and Oil sardine (S) and the best fitting growth lines.*

Fig. 1 gives the restructured length frequency distribution of monthly pooled samples and the best fitting growth line extracted by the 'automatic search routine' using all available variables. The growth parameters estimated for the two species had the following values:

	Indian mackerel	*Oil sardine*
L-inf	265 mm.	200 mm.
K	2.4	2.1
C	0.7	0.6
WP	0.1	0.0
(Rn)	(0.217)	(0.506)

It may be noted that in 1997 the spawning and recruitment of mackerel was delayed almost by one month, perhaps due to the corresponding delay in the onset of monsoon, and hence the growth line runs slightly above the modal values, resulting in the low Rn value. Both these curves are given in Fig. 2. The similarity between the curves is striking. The major

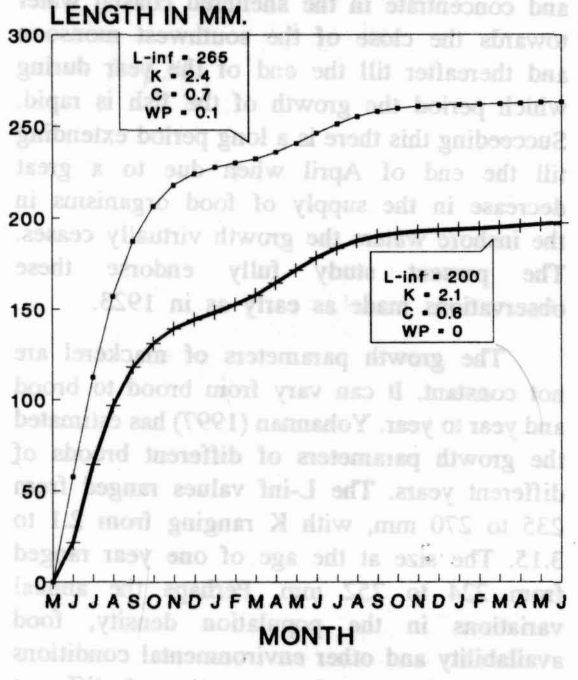

FIG. 2. *The estimated growth curves of Indian mackerel and oil sardine.*

difference between the lines was in the L-inf. values with the Indian mackerel having a higher L-inf. compared to that of the oil sardine. K value of mackerel was also slightly high. The fish grows to 24 cm in one year and is expected to reach 26 cm in two years. About 85% of the potential average size (265 mm) the mackerel can reach is attained in 7 month's period from May to December. Oil sardine grows to 175 mm in one year and can reach 195 mm in two years. About 72% of the potential average size (200 mm) the fish can reach is attained in 7 month's period from May to December. Both the curves indicate a starting point in May/June, a fast growth till around November, a reduction of growth rate subsequently till March and then a further increase till next June/July. The monthly growth rate of mackerel in the first month is 55 mm

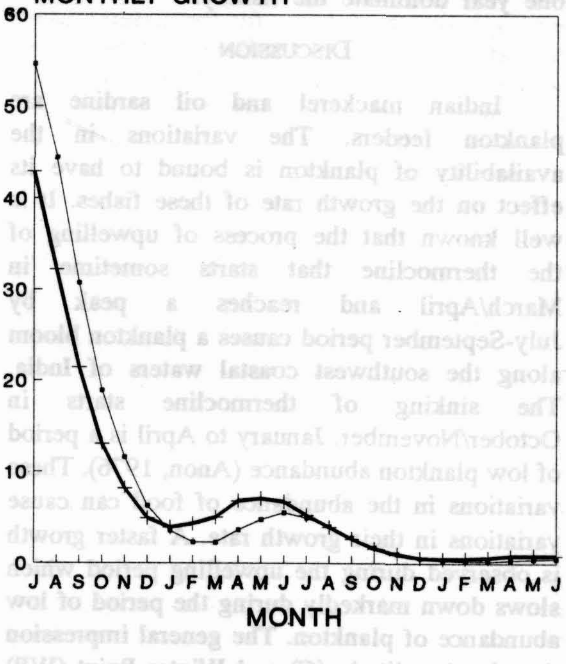

FIG. 3. *The monthly growth rate (in mm) of Indian mackerel and oil sardine.*

which reaches a very low value (2.3 mm) by March and increases again to another smaller peak (5.5 mm) by June. Oil sardine grows at the rate of 43 mm in the first month. The growth rate declines to 3.9 mm by January but, increases again to 7 mm by May. In general December to March is a period of low growth rate for both the species (Fig. 3). It is this peculiarity of growth of these fishes that caused the failure of the ordinary Bertalanffy's equation to explain the process well.

Fig. 1 also indicates that the strong broods of both the species are born sometime around May and start appearing in the fishery in July and stay till August of the succeeding year and then become extremely rare. Hence, they start appearing in the commercial catches at the age of two months and their fishable life span is around 16 months. Fishes of age below one year dominate the fishery.

DISCUSSION

Indian mackerel and oil sardine are plankton feeders. The variations in the availability of plankton is bound to have its effect on the growth rate of these fishes. It is well known that the process of upwelling of the thermocline that starts sometime in March/April and reaches a peak by July-September period causes a plankton bloom along the southwest coastal waters of India. The sinking of thermocline starts in October/November. January to April is a period of low plankton abundance (Anon, 1976). These variations in the abundance of food can cause variations in their growth rate. A faster growth is observed during the upwelling period which slows down markedly during the period of low abundance of plankton. The general impression that the Amplitude (C) and Winter Point (WP) in growth is not applicable to the tropical fishes is not always correct, especially in the case of plankton feeders of the strong upwelling areas. Yohannan (1997) has observed that mackerel shoals move to the deeper waters along with the sinking of the thermocline. The drastic decline in growth rate commence with this process. Hornell and Nayudu (1923) observed that oil sardine attain full adult size at the age of one year when they measure on the average 15 cm. During the second year growth is extremely slow and amounts to only 1 cm. The length measured by them was from snout to the end of the scales. The length measured in the present study was from the snout to the tip of the longest caudal fin. Hence, the size at age estimated in the present study correspond well with their observations. They had also observed that the spawning of the fish takes place from June to August. The reason for the shoreward migration of the fish is to feed upon immense quantities of unicellular plants (protophyta) and animals (protozoa) that develop and concentrate in the sheltered coastal water towards the close of the southwest monsoon and thereafter till the end of the year during which period the growth of the fish is rapid. Succeeding this there is a long period extending till the end of April when due to a great decrease in the supply of food organisms in the inshore waters the growth virtually ceases. The present study fully endorse these observations made as early as in 1923.

The growth parameters of mackerel are not constant. It can vary from brood to brood and year to year. Yohannan (1997) has estimated the growth parameters of different broods of different years. The L-inf values ranged from 235 to 270 mm, with K ranging from 2.1 to 3.15. The size at the age of one year ranged from 224 to 252 mm. Perhaps the annual variations in the population density, food availability and other environmental conditions influence the growth parameters of different year classes.

The peculiar growth pattern of these species has created confusion in the study of their growth. Until the mid seventies these fishes were being exploited with gears of larger mesh or the exploitation used to commence after the monsoon by which time they might have almost completed the period of their early fast growth. Hence, sampling will be mostly during the period of their slow growth, underestimating their growth rate. The L-inf. value of 316 mm and K of 0.6 estimated for mackerel by Rao *et al* (1965) and the estimate of t_0 of 13.42 months and K of 0.6 for oil sardine by Antony Raja (1970) can be the results of this situation. Estimating the growth parameters using ordinary Bertalanffy's equation even with a better picture of the early fast growth can result in an underestimate of L-inf value as happened in the study of growth of mackerel by George and Banerji (1968) as the equation tend to reach the L-inf value with the first strong reduction in growth rate. Yohannan (1979) observed that this first reduction in growth rate may be due to the stress of maturation. Perhaps the stress of maturation during the period of low food availability also might be contributing to it.

While studying the growth of fishes using length frequency distribution it is a normal practice to pool the samples in a month. Even quarterly pooling is common. Thus we loose the continuity of modal progression and identity of different broods. Intensive sampling, especially during the period of early fast growth, and retaining the identity of each sample will clearly reveal the growth pattern of different broods that appear in the catch which will indicate whether the ordinary Bertalanffy's equation or the seasonalised growth equation will have to be used for extraction of growth parameters.

Calicut Research Centre of CMFRI,
West Hill, Calicut-673 005.

T.M. YOHANNAN,
K.K. BALASUBRAMANIAN
V.K. JANAKI

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LENGTH WEIGHT RELATIONSHIP AND RELATIVE CONDITION FACTOR IN *SELAROIDES LEPTOLEPIS* (VALENCIENNES)

ABSTRACT

The length weight relationship and relative condition factor in *Selaroides leptolepis* were studied for a period of one year (1987-'88) along Tuticorin coast. The calculated slope value for males, females and indeterminants, was found to be 2.6682, 2.5518 and 2.7026 respectively. The difference between the regression equation of males, females and indeterminants, was found to be insignificant, and hence, a combined regression equation was calculated. The 'b' value of the pooled fit was found to be significantly different from the cube law. Relative condition of the species was high during spawning season and was found correlated positively with Gonadosomatic Index and negatively with Gastrosomatic index.