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# CARANGID FISHERY AND YIELD PER RECRUIT ANALYSIS OF *CARANX CARANGUS* (BLOCH) AND *CARANX LEPTOLEPIS* CUVIER AND VALENCIENNES FROM TUTICORIN WATERS*

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ABSTRACT

An estimated annual average catch of 205.8 t of carangid were landed during 1981-83 by traditional fishing units. The gearwise catch composition of carangid was observed. Depthwise variation in the abundance of carangid was observed from the catch rates of these traditional gears. During 1984-87, an estimated annual average catch of 1256.3 t of carangid were landed in which the trawl net units landed 1184.8 t and drift gill net units 71.5 t. Though the abundance of carangid varied from year to year, in general, it appears there is one pronounced abundance during July to November and another less pronounced during January to April. The annual average species composition of trawl net landings was also studied. Based on the catch in number, effort and length frequency data, the estimated growth parameters of *Caranx leptolepis* are $L_\infty$ 213 mm, K 1.4283 and $t_o$ -0.0151 and of *C. carangus* are $L_\infty$ 498 mm, K 0.7689 and $t_o$ -0.0455. Estimated growth in weight of these species could be obtained from the length weight relationship given. The natural mortality coefficient M is estimated to be 2.19 for *C. leptolepis* and 1.18 for *C. carangus* from the life span $T_{max}$ of these species. The total mortality coefficient Z varied from 4.33 in 1986-87 to 8.33 in 1984-85 for *C. leptolepis* with an average of 6.10 in trawl net. For *C. carangus*, the Z varied from 4.48 in 1985-86 to 9.69 in 1984-85 with an average of 6.54 in trawl net and in drift gill net it was 2.80 in 1986-87 to 4.77 in 1985-86 with an average of 3.92.

The yield per recruit for 3 different M/K ratios obtained for these two species indicate that *C. leptolepis* is not exposed to higher fishing pressure as in the case of *C. carangus* by trawl net and the effort of trawl net may be increased further to match the $F_{max}$ to realise enhanced production of this species. Whereas, in the case of *C. carangus* further increase in trawl net effort may not be favourable unless the age at first capture is increased by increasing the cod end mesh size which is not practical as the main aim of trawl net is to exploit some other resources like prawns and *C. carangus* is only a bycatch. However, exploitation of this species by drift gill net may be increased by increasing the mesh size further to enhance the age at first capture as the prevailing age at first capture is only 0.28 yr, whereas the optimum age of exploitation is 1.08 yrs.

## INTRODUCTION

CARANGID resource is one of the important pelagic fishery resources as it is constituted by a wide variety of species and being exploited by different gears like trawl net, gill net, hook and line, boat and shore seines along the Indian Coast. Considering the commercial and economic importance, very little information is available on the fishery and biology of the component species of this resource (Tandon, 1961 b, c; 1962 a, b, c, 1964; Sreenivasan,

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1978, 1981; Kagwade, 1965, 1971 a, b, c; James, 1968; Reuben, 1969) from Indian waters and information on the population dynamics of individual species to assess the intensity of exploitation and to provide required details for proper management of the fishery of this resource are totally lacking. With the view to fulfil this lacuna study on the carangid resource was initiated in Tuticorin in 1981 and this account deals on the carangid fishery and population dynamics covering aspects like the growth, mortality rates, yield per recruit, optimum age of exploitation and potential yield per recruit of two species *Caranx carangus* (Bloch) and *Caranx leptolepis* Cuvier and Valenciennes from Tuticorin waters and it is hoped that these information will be useful for better management of the fishery.

The authors are immensely thankful to Dr. P. S. B. R. James, Director, C.M.F.R.I for his encouragements and to Shri. S. Reuben, for his useful suggestions during the course of this study.

## FISHERY

*Catch statistics* : Observations on the fishery were made once in a week to collect basic data on the catch, effort, species composition and length frequency of the dominant species *C. carangus* and *C. leptolepis* by sampling at random a minimum of 10% of the units landed or all the units if the number of units landed were less than ten. The basic data were raised to the sampling day and then to the month with respective raising factors. During 1981-82 an estimated total catch of 174.7 t of carangid were landed by traditional units in which 63.0 t was by 7537 units of *paruvalai* (drift net, mesh size 120-170 mm), 60.6 t by 12325 units of *podivalai* (drift net, mesh size 70-100 mm), 41.0 t by 7529 units of hook and line units, 9.8 t by 1697 units of bottom set gill net (mesh size 200-300 mm) units and 0.2 t by 10 units of shore seines. The percentage composition of the carangid landings by these units are 36.1% by *paruvalai*, 34.7% by *podivalai*, 23.5% by hook and line, 5.6% by bottom set gill net and 0.1% by shore seine in the total carangid landings. An estimated 237.0 t of carangid were landed during 1982-83 in which the gearwise contribution was 50.9 t by 5609 units of *paruvalai*, 43.4 t by 6925 units of *podivalai*, 104.6 t by 10418 units of hook and line, 6.5 t by 2081 units of bottom set gill net and 31.6 t by 76 units of shore seine and the percentage composition was 44.1% by hook and line, 21.5% by *paruvalai*, 18.3% by *podivalai* 13.3% by shore seine and 2.8% by bottom set gill net.

The estimated catch per unit of carangid by different traditional gears operated off Tuticorin during 1981-82 and 1982-83 may be considered as the index of carangid abundance. The variation in the catch rate of individual gear is due to variation in the operation of these gears in different depths, as the *paruvalai* is operated at a depth range of 40 to 50 m, *podivalai* from 20 to 35 m, hook and line from 20 to 50 m, bottom set gill net from 20 to 35 m and shore seine in the near shore waters. The average catch rate of these gears are 8.4 kg/unit by *paruvalai*, 4.9 kg/unit by *podivalai* 5.5. kg/unit by hook and line 5.8 kg/unit by bottom set gill net and 23.8 kg/unit by shore seine during 1981-82 and during 1982-83 it was 9.1 kg/unit by *paruvalai*, 6.3 kg/unit by *podivalai* 10.0 kg/unit by hook and line, 3.1 kg/unit by bottom set gill net and 415.8 kg/unit by shore seine. However, the overall average catch rate of these gears indicate that the abundance of carangid was good during April to August in 1981-82 and during June to August and November to March in 1982-83. From the annual average catch rate of individual gear it appears that abundance of carangid was good in the near shore waters at depth ranges 6 to 10 m.

The estimated annual average catch of carangid was 1256.3 t in which the trawl net units landed 1184.8 t and drift gill net units 71.5 t. The carangid constituted 6 - 6.5% of

the total catch by trawl net and drift gill net catch the composition was 3 - 4.5% during 1984-87. The annual effort of trawl net progressively increased from 29602 units in 1984-85 to 48630 units in 1986-87 whereas the catch declined from 1021.2 t in 1984-85 year and marginally increased to 6.4 kg/unit in 1986-87. There are two peak period of abundance in the occurrence of carangid off Tuticorin, one pronounced abundance during July to November and another less prominent during January to April.

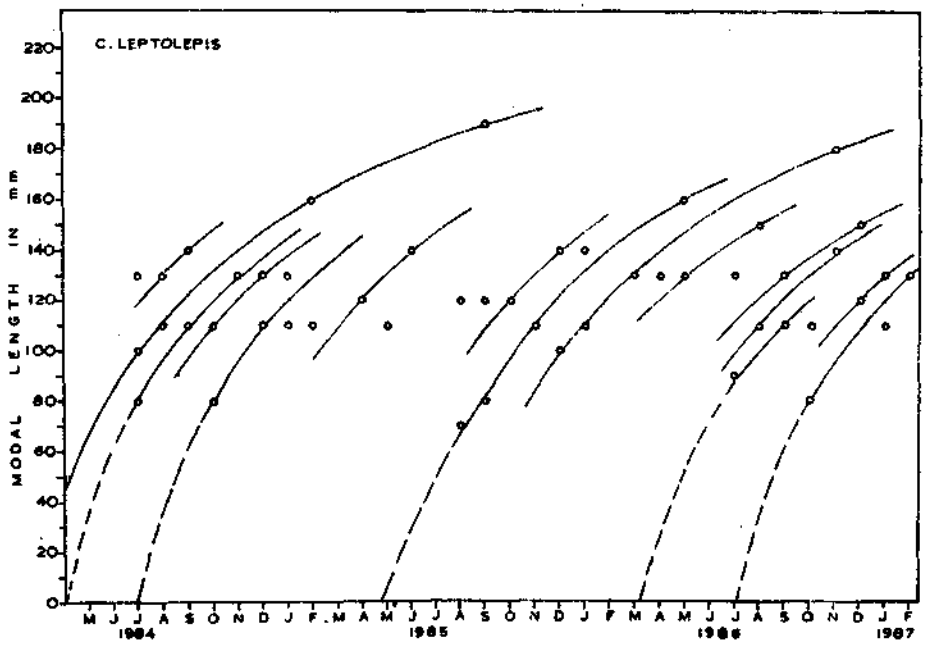


Fig. 1. Analysis of modal progression by scatter diagram of modal lengths - months for *Caranx leptolepis* from Tuticorin waters.

to 927.7 t in 1985-86 and then increased to 1551.6 t in 1986-87 due to variation in the abundance of carangid as indicated by the catch rate which also declined from 34.5 kg/unit in 1984-85 to 24.1 kg/unit in 1985-86 and increased to 31.9 kg/unit in subsequent year. The same trend was reflected in the annual catch and catch rate of drift gill net units with the effort fluctuating from 13871 units in 1984-85 to 8743 units in the following year and increased to 9970 units in 1986-87, the catch declined from 105.2 t in 1984-85 to 45.5 t in 1985-86 and then increased to 64.0 t in the last year and the catch rate was fluctuating from 7.6 kg/unit to 5.2 kg/unit in the following

*Species composition* : Many species belonging to different genera were observed to sustain the carangid fishery off Tuticorin. The carangid landings by trawl net were composed of *Caranx carangus, C. leptolepis, C. malabaricus, C. kalla, Caranx* spp., *Decapterus* spp., *Selar* spp., *Mene maculata, Atropus atropus* and other species. Considering the single species dominance *C. leptolepis* (35.8%) and *C. carangus* (19.0%) were observed to be the major component and other *Caranx* spp., constituted 24.4% in trawl landings. *Decapterus* spp., formed 2.5% and all other less important carangid put together constituted 18.3%. In drift gill net landings *Caranx carangus* (21.1%), *Chorinemus* spp.

(12.9%), *Seriola* spp. (16.3%), other *Caranx* spp. (45.4%) and other carangids (3.2%) were observed to occur. As drift gill nets are being operated for away from the fishing grounds of trawlers, offshore true pelagic carangids like *Seriola* spp., *Chorinemus* spp., *Megalaspis cordyla*, etc. were observed to occur in a limited strength during June to September and the potential of these species for exploitation is not known.

*Age and growth* : The age and growth of *C. leptolepis* and *C. carangus* is studied from the estimated length frequency obtained at size interval of 10 mm from the landings of trawl and gill net during 1984-87. The occurrence of different broods in a year indicates the presence of different broods in the population and the shifting of these modes to higher size ranges in subsequent months indicates the growth roughly. The progress of these modes was traced as per 'integrated

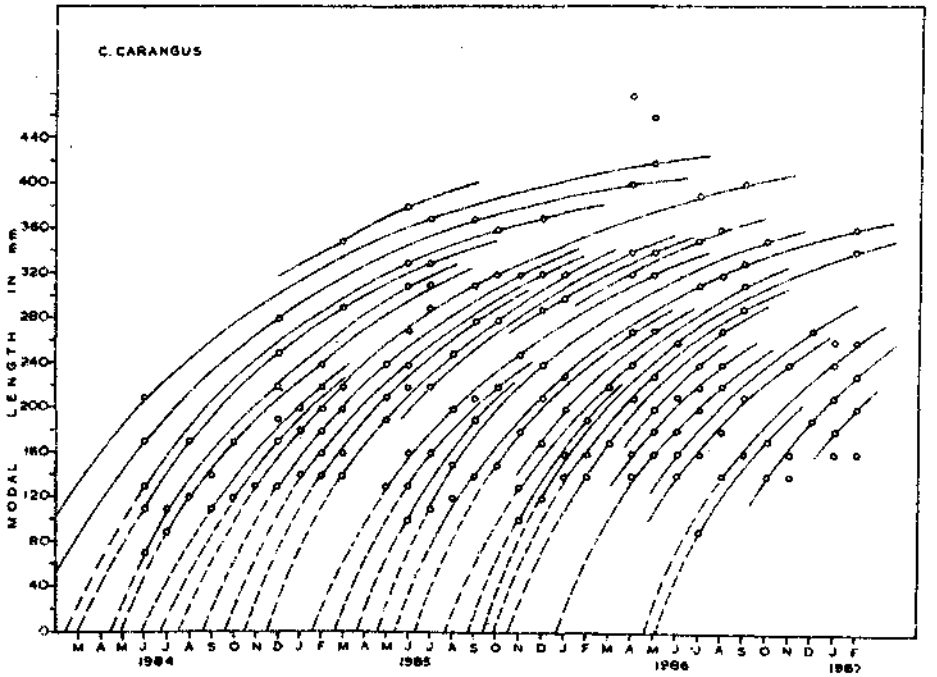


Fig. 2. Analysis of modal progression by scatter diagram of modal lengths - months for *Caranx carangus* from Tuticorin.

## Population Dynamics

Among different species which support the fishery of carangid off Tuticorin, *C. leptolepis* and *C. carangus* were the two dominant species which occurred throughout the year and these two species were selected for detailed study on growth, mortality rates and yield per recruit. *C. leptolepis* was exploited effectively by trawl net and *C. carangus* by both trawl and gill net.

method' of Pauly (1980) from a scatter diagram prepared by plotting the modes available at different size ranges in a month against respective months and fitting a smooth free hand curve through the plots as shown in Fig. 1 and 2 for *C. leptolepis* and *C. carangus* respectively. It is possible to find out the time of origin of some of the modes available at lower size ranges by back tracing the curves to time axis as shown in Fig. 1 and 2 with broken lines which enables to correlate the modes with time. The modes thus traced were arranged in a

tabular form by posting them as per the progression sequence with time and average size attained by these species in subsequent months were obtained. These average sizes are plotted against respective months and a curve is fitted through the plots by naked eye fitting as shown in Fig. 3 and 4 for *C. leptolepis* and *C. carangus* respectively. These curves may be expected to be the empirical growth curve of these species and the size attained by these species at different months could easily be read from these curves. This kind of treatment enables one to obtain the missing values at the intermediate and higher size ranges. *C. leptolepis* attains forkal length of 77, 118, 146, 166, 180 and 190 mm in 0.25, 0.50, 0.75, 1.00, 1.25 and 1.50 yrs respectively and *C. carangus* attains

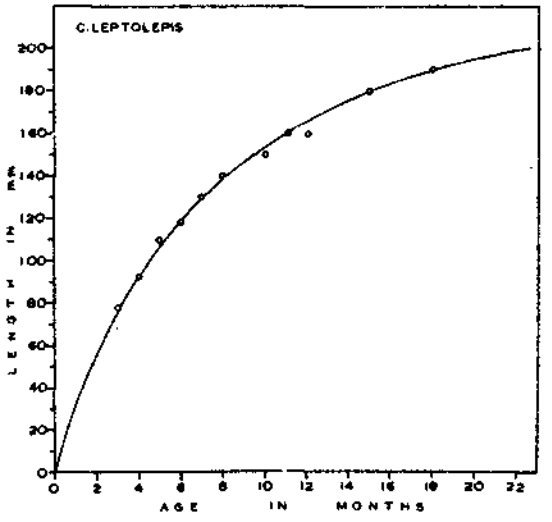


Fig. 3. Empirical growth curve fitted through the plots of mean lengths at age in months based on the scatter diagram for *Caranx leptolepis* from Tuticorin.

fork length of 184, 288, 352, 394, 425, 449, 467 and 479 mm in 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5 and 4.0 yrs respectively. The growth parameters $L_\infty$, K and $t_o$ were estimated from these data as per the method of Bagenal (1955) and the estimates are $L_\infty$ 213 mm, K 1.4283 and $t_o$ -0.0151 for *C. leptolepis* and $L_\infty$ 498 mm, K 0.7689 and $t_o$ -0.0455 for *C. carangus*. The estimates of these parameters as per Alagaraja (1984) method also closely agree with the above estimates. The growth in length of these two species may be expressed according to von Bertalanffy growth equation as follows

*C. leptolepis* : $Lt = 213\left[1 - e^{-1.4283\ (t + 0.0151)}\right]$

*C. carangus* : $Lt = 498\left[1 - e^{-0.7689\ (t + 0.0455)}\right]$.

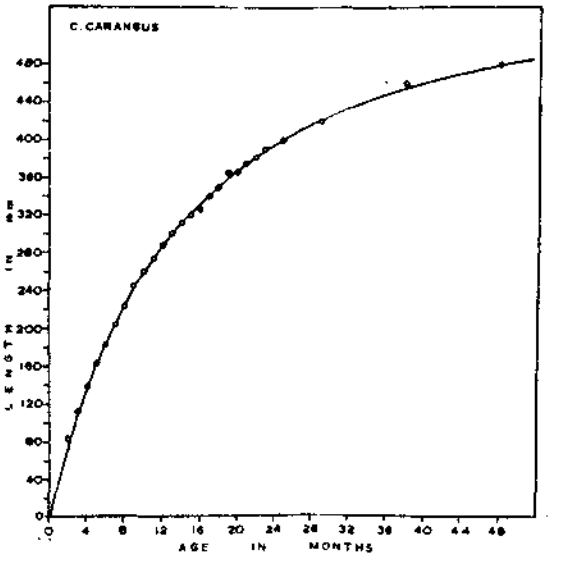


Fig. 4. Empirical growth curve fitted through the plots of mean lengths at age in months based on the scatter diagram for *Caranx carangus* from Tuticorin.

*Length weight relationship* : The length weight relationship of these two species can be described as per the following equations obtained from the regression analysis of fork length in mm and wet weight in g. *C. leptolepis*: Log W = -3.5058 + 2.3732 Log L and *C. carangus*: Log W = -4.3555 + 2.8577 Log L.

*Mortality rates* : The natural mortality coefficient M could be obtained from the life span ($T_{max}$) of the species concerned (Sekharan, 1974). The $T_{max}$ may be obtained from the relation 3/K (Pauly, 1980). The estimates of M obtained from the $T_{max}$ are 2.19 for *C. leptolepis* and 1.18 for *C. carangus*. The total mortality coefficient Z was estimated by the method of Alagaraja (1984). The Z is estimated to be

8.33, 5.63 and 4.33 for *C. leptolepis* by trawl net with an average of 6.10 during 1984-87. The Z estimated for *C. carangus* was 9.69, 4.48 and 5.46 with an average of 6.54 by trawl net and 4.19, 4.77 and 2.80 with an average of 3.92 by gill net during 1984-87.

*Recruitment and gear selection* : The recruitment of these two species into the fishery is indicated by the length frequency modes available at lower size ranges during certain period. The maximum number of broods observed in the fishery of *C. leptolepis* were only three whereas in *C. carangus* a series of broods were observed. Further as indicated by the recruitment there might have been two peak spawning seasons, one highly pronounced preceeding the southwest monsoon and the second, a minor one in the northeast monsoon. Selection of the gear is one of the important factors which affects the fishing mortality of any species. According to Beverton and Holt (1957), the age of entry into the exploited phase is determined by the size at which 50% of the individuals are retained by the fishing gear. The age at recruitment is taken as the size at which the smallest fish which suffers mortality by the gear. The average size at first capture is estimated to be 91.4 mm for *C. leptolepis* and 108.6 mm for *C. carangus* and the corresponding age at first capture are 0.3774 yr and 0.3464 yr for these species respectively. The average size at recruitment are 85.9 and 95.8 mm for *C. leptolepis* and *C. carangus* respectively and the corresponding age at recruitment are 0.2746 and 0.2324 yr for these two species respectively.

*Yield per recruit* : The yield per recruit estimated for three different M/K ratios keeping the age at first capture constant at the prevailing level and at different fishing mortality rates F as per Beverton and Holt (1957) modal simplified by Ricker (1958) are given in Fig. 5 and 6 for *C. leptolepis* and *C. carangus* respectively. The yield per recruit increases with the increase in F to reach the $Y_{max}$ at a particular $F_{max}$ afterwards it tends to decline in higher F. These $Y_{max}$ and $F_{max}$ for the respective M/K ratios are indicated in Fig. 5 and 6. Further, higher the M/K ratio and lower the yield per recruit uniformly in all F. The prevailing average F during 1984-87 is 3.91 for *C. leptolepis* by trawl net and 5.36 and 2.74 for *C. carangus* by trawl net and gill net respectively. Considering the $F_{max}$ for the prevailing M/K

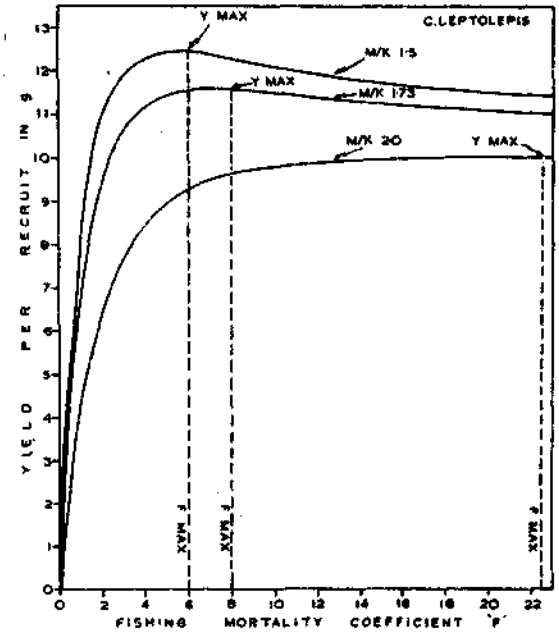


Fig. 5. Yield per recruitment of *Caranx leptolepis* for the prevailing age at first capture at different M/K ratios and various fishing mortality coefficient. The yield $_{max}$ and F $_{max}$ are indicated for each M/K ratio.

ratio and age at first capture of these two species the F generated by the trawl and gill net are higher than the $F_{max}$ indicating higher fishing pressure exerted by this gear on the stock of *C. carangus* in Tuticorin waters. The optimum age of exploitation and potential yield per recruit estimated as per Krishnankutty and Qasim (1968) for *C. leptolepis* are 0.5458 yr and 14.7 g and for *C. carangus* 1.0833 yrs and 122.8 g respectively.

## DISCUSSION

Unlike in temperate waters, study on population dynamics of tropical species is hampered considerably due to constraints in determining the correct age owing to interference of various factors such as more

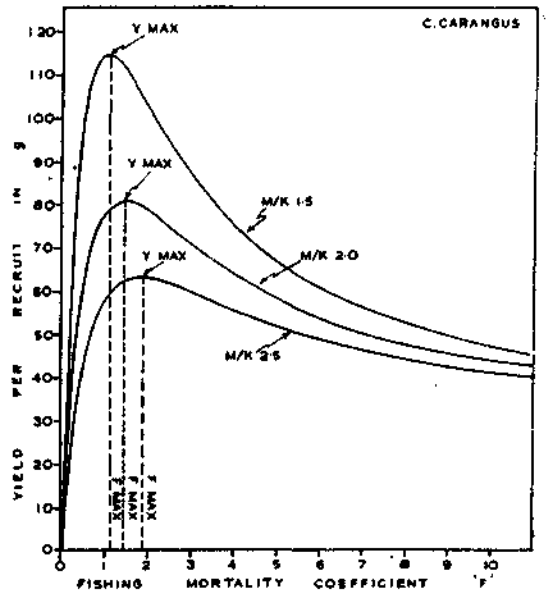


Fig. 6. Yield per recruitment of *Caranx carangus* for the prevailing age at first capture at different M/K ratios and various fishing mortality coefficient. The yield $_{max}$ and F $_{max}$ are indicated for each M/K ratio.

than one breeding season, short life span and seasonal variation in growth within a year. The size distribution of *C. leptolepis* ranged from 70 to 199 mm in the fishery at Tuticorin during 1984-87, whereas it was 80-130 mm in Mandapam waters during 1957-59 (Tandon, 1960). Due to variation in the area inhabited and season, the growth may differ to certain extent (Tandon, 1962) and the growth variation may be due to racial difference which ought to be confirmed by undertaking racial study in Tuticorin waters as done in Mandapam waters for this species (Tandon, 1964). The difference in the length weight relationship proposed by Tandon (1962) and obtained in present study is also attributed to the above said reasons. The maximum size observed for *C. leptolepis* in the fishery at Tuticorin was 199 mm and for *C. carangus* 480 mm. In nature, the oldest fish of a stock grow to attain 95 per cent of their asymptotic length (Taylor, 1962). When the oldest fish observed in the fishery is considered as 95 per cent of $L_\infty$, then the $L_\infty$ may be 210 mm for *C. leptolepis* and 505 mm for *C. carangus*. The estimated $L_\infty$ in this study 213 mm for *C. leptolepis* and 498 mm for *C. carangus* which are very close to the above said estimates obtained form the $L_{max}$.

Obtaining reliable estimates of natural mortality rate for tropical species is difficult due to aforesaid reasons. For mackerel the M ranged from 0.65 to 1.5 according to different workers (Banerji, 1973; Sekharan, 1974; Yohannan, 1982) and in the case of oilsardine the estimate of M ranged from 0.67 to 1.45 (Banerji, 1973; Annigeri, 1972; Sekharan, 1974). As the ghol (*Pseudosciaena diacanthus*) fishery was in an almost virgin state the estimate of Z 0.87 was considered equivalent to M by Rao (1968). Venkataraman *et al.* (1981) have estimated the M as 2.28 for *Leiognathus jonesi* and have attributed the high value of M to the short life span of the species. In the present study the M is estimated to be 2.19 for *C. leptolepis* and 1.18 for *C. carangus*. The life span of *C. leptolepis* and *C. carangus* may be 2.1 and 3.9 yrs respectively as per Pauly (1980).

Yield per recruit indicates that *C. leptolepis* is not exposed to higher fishing pressure as in the case of *C. carangus* by trawl net and the effort of trawl net may be increased further to match the $F_{max}$ to obtain enhanced production of this species. Whereas in the case of *C. carangus* further increase in trawl net effort may not be favourable unless the age at first capture is increased by increasing the cod end mesh size which is not practical as the main aim of the trawl net is to exploit some other resources like prawns and *C. carangus* is only a bycatch. However, exploitation of this species

by drift net is not all that intensive and the effort of this gear may be increased to exploit this species more effectively. The optimum age of exploitation for this species is 1.08 yrs whereas the prevailing age at first capture is only 0.28 yr. Therefore, the mesh size of gill net may be increased to enhance the age at first capture if not close to the optimum age of exploitation at least to a considerable extent which may permit not only further increase in effort of gill net, but also better catches. This limited study on two component species alone may not provide the required information for the proper management of the carangid resource. Such studies on other component species are warrented for the effective management of this resource as many species constitute the carangid resource.

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