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26 The Indian mackerel

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ABSTRACT

The Indian mackerel forms the major pelagic resources along the Indian coast. Its trend of production fluctuates in space and time. Several scientists have conducted considerable research works on its biology, fishery and population structure from various parts of its distributional range at different periods of time. Its fishing pattern witnessed large changes in response to mechanisation, motorisation, innovative gear and synthetic nets, together with extension of fishing to deeper grounds. The paper reviews the status of mackerel fisheries research that were carried out in CMFRI since 1950 through regular monitoring programme for its sustainable harvest

Introduction

The Indian mackerel *Rastrelliger kanagurta* was the major contributor to the pelagic fishery of the SW coast in weight and value. In view of its importance in the economy of the country, the Central Marine Fisheries Research Institute started investigations on its biology and fisheries in the Indian waters. Pradhan(1956) made a detailed study of the fishery and biology of Indian mackerel at Karwar. Subsequent research by the Institute yielded comprehensive data on its fishery, biology and population dynamics. Venkatraman (1970) summarised the information collected by various workers on the bionomics and life history of the fish. Studies made on the population and exploitation were reviewed by Banerji (1970) and Rao (1970). Noble and Geetha (1992) gave an annotated bibliography of the publications on mackerel and its fishery.

The pattern of fishing underwent many changes consequent on the change of cotton and hemp fibres to nylon fibre net making; from the traditional *rampani* nets (Karnataka) to purse seines; from indegenons crafts to outboard engine driven motorised crafts capable to fish beyond the traditional limits; wide

application of innovative gear like ring nets; demand for target groups such as prawns and cephalopods; deep water fishing by bigger trawlers; all of which have augmented the yield of Indian mackerel, but with annual fluctuations. In the above context it is imperative to monitor the resource for sustainable production.

Biology

Size at first maturity: Devanesan and John(1940), Chidambaram and Venkatraman (1946) and Pradhan (1956) were the early workers to study the size at first maturity of mackerel. Subsequently many publications (Radhakrishnan, 1965, Gopakumar *et al*,1991) have touched on this subject. The sizes observed by them fall between 190 mm and 225 mm(in total length) which can be well within the reasonable variations from year to year and area to area, and it can be said that the mackerel mature at a size of around 200 mm.

Spawning period: There is general agreement among the workers that the spawning period of mackerel is a protracted one, but, regarding the peak spawning period there are differences of opinion. Chidambaram *et al*(1952), Bhimachar and George(1952), Pradhan(1956), Gopakumar *et al*(1991), etc. put the spawning period of mackerel during different periods, but within April to September at different localities along the west coast. Along the east cost the spawning season commences by about October or November and lasts till April or May according to the observations of Rao(1964) at Waltair. These observations were made from the maturity conditon of mackerel caught in different areas.

Basheeruddin and Nayar (1961) observed spawning of mackerel during or after north east monsoon off Madras, based on the study of the juveniles. Bennet (1967) observed two important spawning periods for mackerel at Vizhingam, one in March-May and another in August-September, again based on the study of juveniles appearing in the fishery. Yohannan and Balasubramanian(1991) while presenting the length frequency distribution of the two major broods of mackerel in the commercial catches in Calicut traced these broods back to their time of birth to around June and August. Yohannan(1993) observed spawning concentration of mackerel off Quilon in May.

Fig. 1 shows the length frequency data presented by different authors from different areas during the different seasons transformed to a uniform pattern. Though the pattern of growth described by different authors vary considerably the pattern seen in the figure is strikingly similar. It clearly shows that those broods were born probably one or two months before and after June. Thus, there is ample evidence that intensive and most successful spawning of mackerel takes place during April-August period. The Pelagic Fisheries Project surveys(Anon, 1976) also have found that mackerel larvae were more abundant during the March-August period.

Spawning area: Larvae and young ones of the fish were collected by many workers from different localities. Kuthalingam (1956) collected postlarvae and juveniles from coastal waters of Madras and Balakrishnan (1957) and Balakrishnan and Rao (1967) from Vizhingam. Silas (1979) collected mackerel larvae from the continental shelf area of the west coast of India from latitude 7° N to 13° N. The larvae and young ones measuring 6 cm were

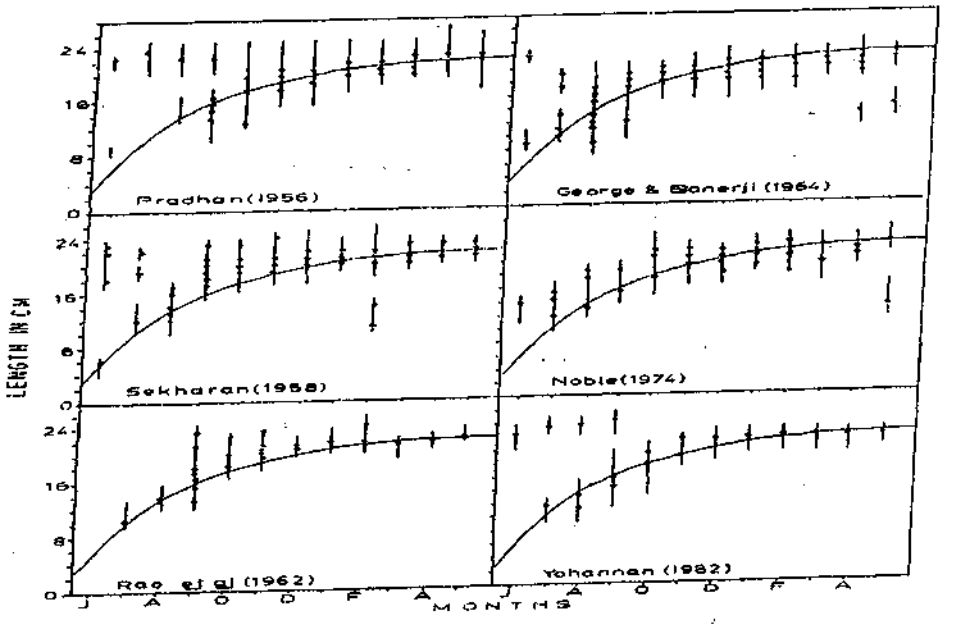

Fig. 1 Length frequency distribution of mackerel in different months taken from data presented by various authors from different localities with a common growth curve drawn through the data sets

reported from Vizhingam to Ratnagiri (Rao, 1974) along the west coast and Visakhapatnam to Madras along the east coast indicating that spawning takes place all along the coastal area. The PFP reports (Anon, 1976a) also state that spawning takes place all along the coast and definite spawning area cannot be delineated.

Spawning frequency: Observations made by Pradhan(1956) indicated that mackerel spawns in succession and eggs are released in batches. Sekharan (1958), Radhakrishnan (1965), Vijayaraghavan (1965), Rao (1962) and Rao (1967) also supported this observation.

Spawning time: Devanesan and John(1940) and Vijayaraghavan(1965) observed that the spawning of mackerel takes place mostly in the night.

Fecundity: Devanesan and John(1940) estimated an average of 94000 eggs in mackerel. Ramamohana Rao(1967)estimated an average of 110000 eggs in 3 size groups in mackerel ranging from 228-232 mm. Gopakumar *et al.* (1991) estimated 198 to 515 eggs per gram of body weight of a mature mackerel.

Young ones: Juveniles were collected from Bombay (Pillai and Jayaprakash, 1978), Ratnagiri (George and Annigiri, 1960), Mangalore and Kannur (Rao, 1962), Goa (Dhawan, 1973), Calicut (Bhimachar and George, 1952; Chidambaram *et al.* 1952), Cochin (Noble, 1972a), Waltair (Rao 1962a) and Andamans (Rao, 1962).

Feeding: Mackerel is primarily a plankton feeder as revealed from the studies made by different workers (Chacko, 1949; Pradhan, 1956; Venkatraman, 1961; Noble, 1965)

Growth: Different views have been expressed by different workers, on the growth of mackerel but the differences can be broadly grouped into two. According to one school of thought the mackerel reaches a size of around 22 cm by the end of second year of their life. The other view is that 22 cm size is reached by the end of first year itself. The first view is mainly based on the idea put forward by Pradhan(1956) that mackerel spawns during June to September and the juvenile mackerel ranging in length between 6 and 11 mm recorded occassionally during this period are the off-springs of the spawning of the previous year and the mackerel of size around 22 cm found during this period

are two year olds. Subsequent workers, based on the size groups they got during the observed spawning seasons, suggested the size at the end of the first year as upto 18 cm. A dissenting view was put forward first by Radhakrishnan(1964) when he observed that the growth in the initial stages of life of mackerel was very fast and broods encountered in the fishery between 115-155 mm are obviously the products of current year's spawning. It was later confirmed by George and Banerji(1968) who first observed that mackerel reaches a size of around 21 cm by the end of first year. This was further elaborated by Yohannan(1979). Fig. 1 shows the monthly size groups and the progression of the modal values over time observed by different authors during different years at different places with a growth curve superimposed on it. The similarity is striking. Though the authors have attributed different sizes at different ages the figure shows a size of around 22 cm by the end of first year, indicating the age at first spawning as one year.

Relation with environment

An inverse relation with mackerel and sardine fishery had been observed by many workers (Hornell, 1910; Nair and Chidambaram, 1951; Antony Raja, 1969). Though this is not very evident in the year to year catches of these two species, five- yearly average catch showed a clear relation as shown in Fig.2. Many studies on mackerel fishery in relation to rainfall are available. Pradhan and Reddy (1962) and Noble (1972) found an inverse relation between rainfall and mackerel catch, whereas Murthy and Edelman (1966) and Yohannan (1977) found the relation direct. The importance of upwelling and sinking and other oceanographic features to the fishery was studied by Rao *et al*(1973), Pillai (1991) and Madhuprathap (1994).

The fishery

The effort and yield in the mackerel fishery in India was under constant study by the Institute which revealed the availability of the fish in space and time. Fig. 3 shows the total mackerel catch along the east and west coast of India and the total figures from 1956 to 1994. Annual catch figures from west coast fluctuated from 9820 tonnes in 1968 to 272610 tonnes in 1989. The fishery was good in the late fifties and early seventies. Catches improved considerably after 1988. As the catches from the west coast formed the bulk (83.5%) of the total mackerel catch in India, the total annual catch in the

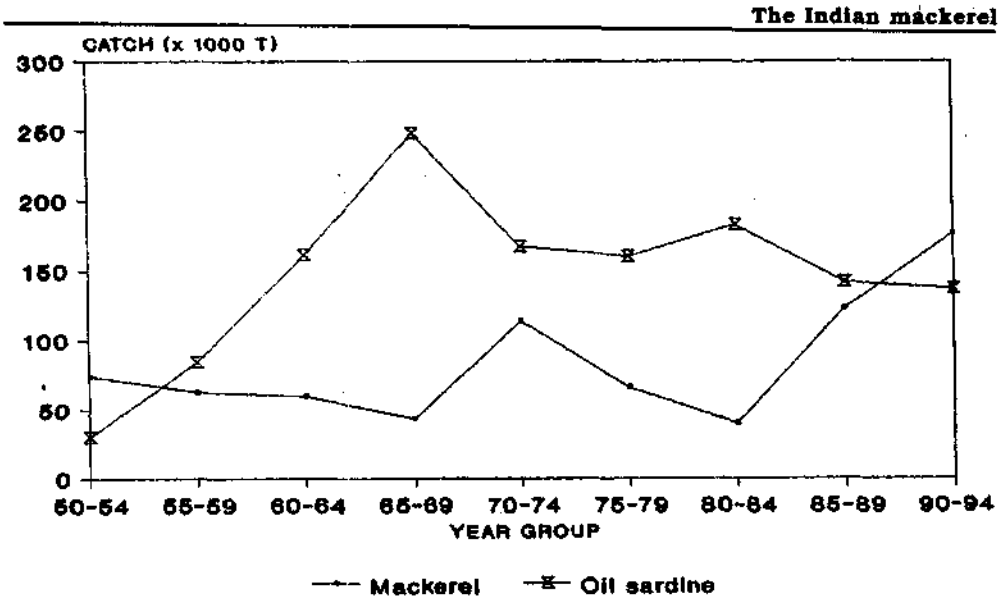

Fig. 2 Five-yearly average catch of mackerel and oil sardine in India

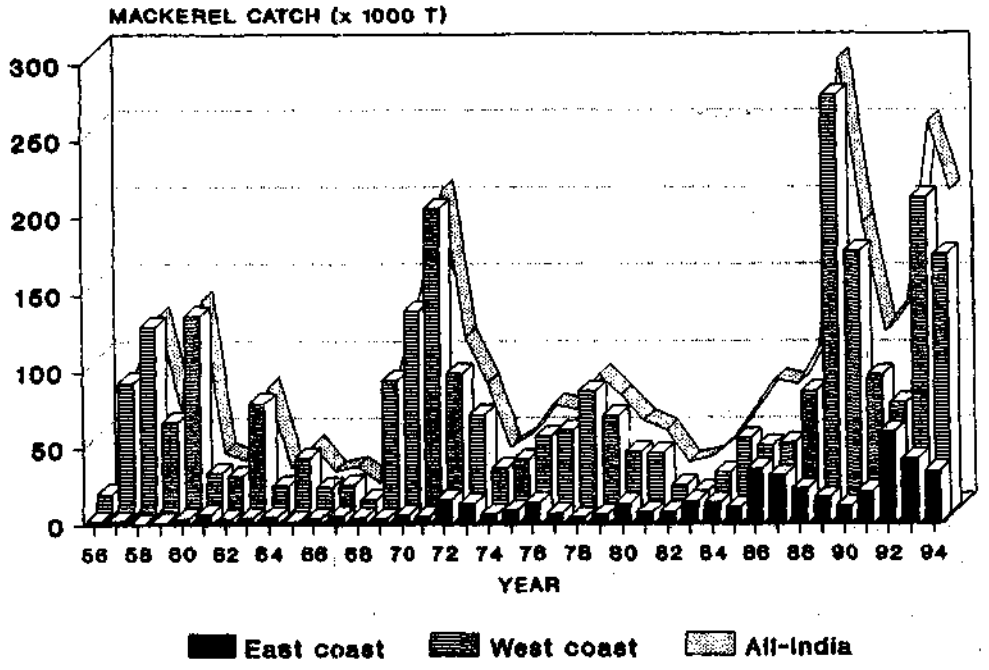

Fig. 3 Total annual catch of mackerel in India and along the east and west coast (1956-'94)

country followed a similar pattern with minimum yield (14480 t) in 1968 and peak production (290160 t) in 1989. The yield from the east coast was insignificant. But, there was a tremendous increase in the catches after 1986. The average mackerel catch from the east and west coasts during different periods is given in Table 1.

TABLE 1. The average mackerel catch in tonnes from east and west coasts during different periods.

Period	1956 -'94	1956 -'84	1985 - '94
East coast	12750	7050	29280
(%)	(14.70)	(10.85)	(19.55)
West coast	73980	57930	120500
(%)	(85.30)	(89.15)	(80.45)
All India	86730	64980	149780
(%)	(100)	(100)	(100)

A general increase in mackerel catch after 1985 as well as an upward trend in the percentage contribution from the east coast is evident from Table 1. An inverse relation between the catches from the east and the west coasts is apparent in fig. 3. especially from 1976 onwards. In general the catch fluctuations are more pronounced along the west coast than the east coast.

Fig. 4 shows the situation in the different States along the west coast. The catches of Maharashtra and Gujarat as well as of Karnataka & Goa are given together. Karnataka & Goa along with Kerala contribute on an average 92.28 % of the west coast catch and 78.49 % of the all-India catch and set the trend of the mackerel fishery in the country.

TABLE. 2. The average mackerel catch in tonnes from different states along

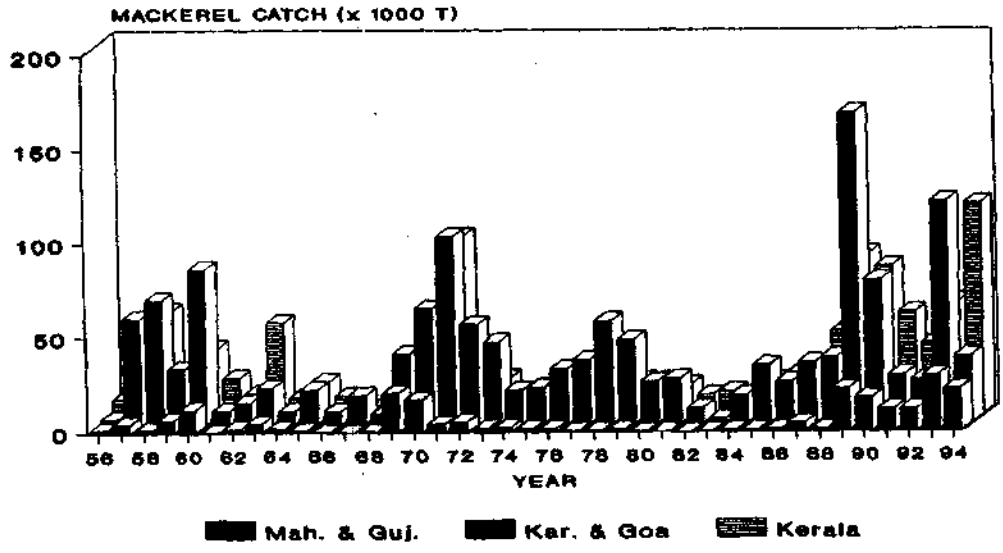

Fig. 4 Statewise total annual catch of mackerel along the west coast (1956-'94)

the west coast during different periods.

Period	1956-'94	1956-'84	1985-'94
Kerala	31090	23860	52050
(%)	(42.02)	(41.19)	(43.20)
Karnataka & Goa	37180	30640	56120
(%)	(50.26)	(52.89)	(46.57)
Maharashtra & Gujarat	5710	3430	12340
(%)	(7.72)	(5.92)	(10.24)
West Coast	73980	57930	120500
(%)	(100)	(100)	(100)

Table 2 shows that the percentage contribution by Kerala has slightly increased, whereas that of Karnataka & Goa shows a decline. The contribution by Maharashtra & Gujarat, though insignificant, has improved.

Fig. 5 shows the corresponding situation along the east coast. Here most of the catches are from Tamil Nadu & Pondicherry and Andhra Pradesh. Tamil Nadu & Pondicherry contributes the maximum catch. But, after 1985 the catches in Andhra Pradesh increased substantially as given in Table 3.

TABLE 3. The average mackerel catch in tonnes from different States along the east coast during different periods.

Period	1956-'94	1956-'84	1985-'94
West Bengal & Orissa	420	310	730
(%)	(3.29)	(4.40)	(2.49)
Andhra Pradesh	5290	2350	13810
(%)	(41.49)	(33.33)	(47.17)
Tamil Nadu & Pondicherry	7050	4390	14740
(%)	(55.29)	(62.27)	(50.34)
East Coast	12750	7050	29280
(%)	(100)	(100)	(100)

With the general improvement in catches, the mackerel fishery in Kerala and Karnataka & Goa is undergoing a very important change since the mid-seventies. Prior to this period the bulk of the catch was being made in the fourth quarter (October to December). Subsequently there was a steep increase in the catches during the third quarter (July to September). Fig. 6 shows the increase in the percentage of catch during the third quarter in Kerala and Karnataka & Goa. In 1975 only 1.3 % of the total annual catch in Kerala was made in this quarter. By 1994 the percentage increased to 60.7. Similarly in Karnataka & Goa the increase was from 2.1 in 1975 to 50.12 in 1994.

Fig. 1 shows the pattern of appearance of the different length groups along the west coast and, unlike in the fourth quarter early juveniles dominate the catches during third quarter. Hence, it is evident that with the increasing exploitation during the third quarter the fishery depends more on

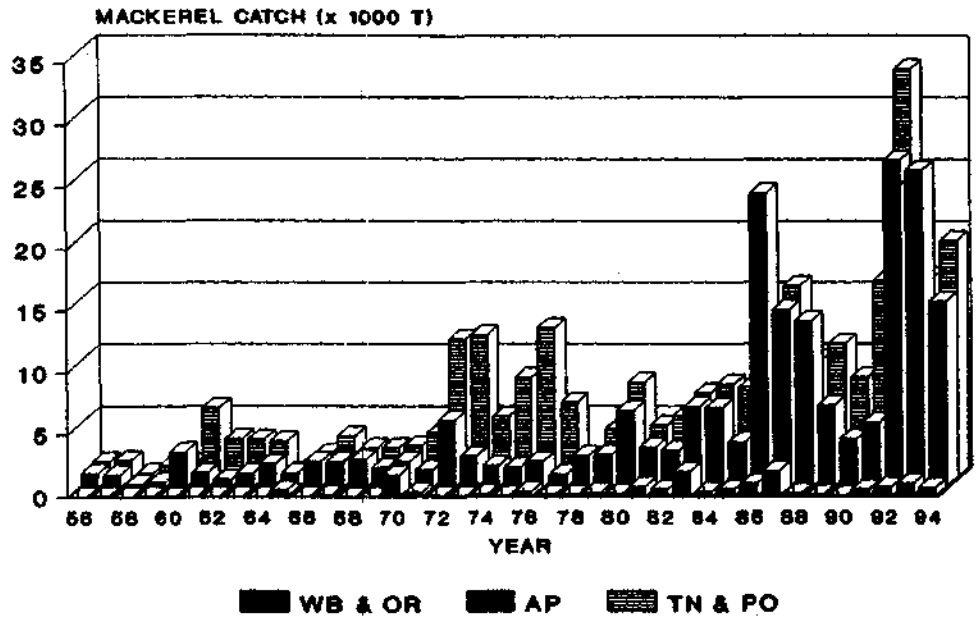

Fig. 5 Statewise total annual catch of mackerel along the east coast (1956-'94)

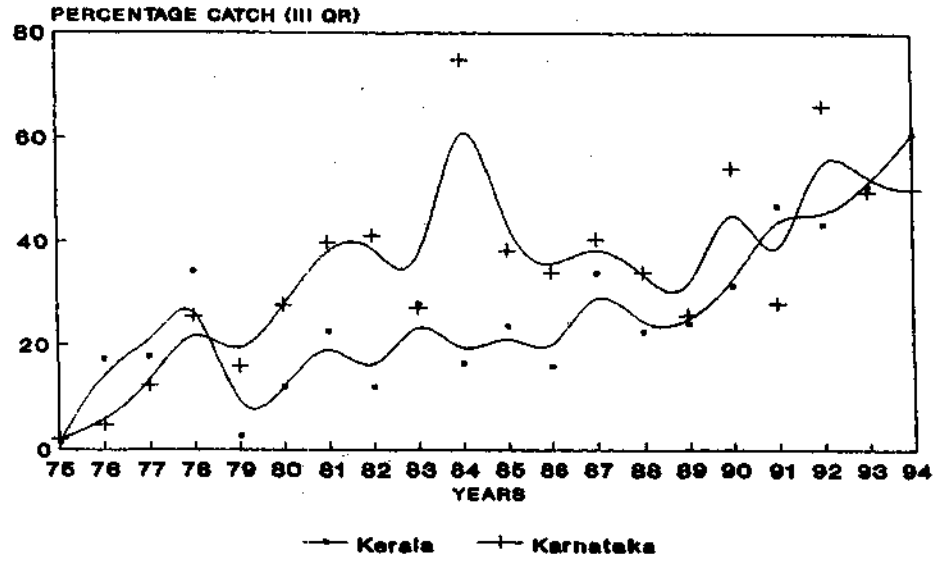

Fig. 6 The percentage catch of mackerel in the third quarterin Kerala and Karnataka (the pattern indicate the percentage catch and the lines give the trend of increase)

these early juveniles which is the situation in the southwest coast of India.

This situation was caused by the recent developments in the crafts and gears employed in the mackerel fishery. Towards the end of seventies the large beach-seines *Rampani* in Karnataka were replaced by Purse-seines operated from mechanised vessels. By the middle of eighties outboard engines were introduced into the indegenous fishery. Soon, most of the country crafts employed in the mackerel fishery were motorised. Subsequently, the old boat seines (*Kollivala*), the major gear used in the mackerel fishery in Kerala, became obsolete and was replaced by large ring nets with small mesh. Improving the engine power constantly, the fishing units acquired the necessary speed of operation. With the development of infrastructural facilities like fishing harbours and jetties the indegenous units dared to defy the bad weather during the south west monsoon(July-September) and made huge catches of early juveniles of mackerel. The recent increase in the catch of mackerel is largely due to these developments. How this very important change in the fishery will affect the natural resilience of the stock and on its judicial exploitation is the most serious enquiry which demands urgent attention.

Population

Studies on the population dynamics and stocks of Indian mackerel were made by Banerji (1973), Sekharan (1974), George *et al.* (1977), Yohannan (1982), Devaraj (1983), Devaraj *et al*(1994) and Noble *et al.* (1992).

Growth parameters: As there are differences of opinion on the growth pattern of the fish the growth parameters given by various workers ranged from an $L\infty$ value of 316 mm and a K value of 0.6 given by Rao *et al*(1962) to an $L\infty$ value of 228 mm and a K value of 3.6 given by George and Banerji (1964).

Natural mortality (M): The wide range of growth parameters estimated resulted in a wide range of natural mortality estimates. Banerji (1973) estimated an M value of 0.65. Sekharan (1974) estimated the M value as 0.9 and Yohannan (1982) as 1.5. According to Devaraj (1983) M value between 2.21 and 2.61 for mackerel will be in right order. Devaraj *et al.* (1994) rejected the very basic theory that M is a constant and estimated independent values for different years from 1985 to 1993 ranging from 0.03 to 7.35.

In spite of all these variations in the basic input data made by different authors during the different periods there is a surprising uniformity in the conclusions made on the mackerel fishery - that the fishing is closely around the maximum sustainable yield (MSY) level and further increase in effort will either fetch only marginal increase in yield or cause decline.

Studies made on the mackerel fishery as early as in 1958 - '67 (Banerji, 1973) indicated that the fishery was near the optimum yield and increase in effort will only make marginal increase. Noble *et al.* (1992) also found a similar situation continuing. Devaraj *et al.* (1994) while analysing the mackerel fishery of Kerala - Karnataka during the years 1934 - '73 observed that the average catch is only 16.58 % less than the MSY level with slight annual variations to left or right limb of the yield curve. Fishing at F_{msy} values have to be taken up with caution. Theoretically, exceeding F_{msy} will result in severe fluctuations of stock and their return time to equilibrium will increase markedly (Beddington and May, 1977). The seriousness of the increase in the efficiency of mackerel fishery enabling it to exploit the early juveniles abundantly during the monsoon season has to be viewed against this background.

The recent change in the pattern of the mackerel fishery has brought out some very important information on the behaviour of the mackerel. The tremendous increase in the catch of early juveniles during the monsoon season and increased availability from deeper areas during the post-monsoon and summer seasons indicate that the area of availability of the fish change with changing environment. The studies on the population dynamics and stock of mackerel hitherto made were based mainly on the commercial fishery existed, which was limited to the surface waters during the post monsoon season. It is important to verify whether the wide annual fluctuations observed in the mackerel catch in India are really due to similar fluctuations in the stock abundance or simply due to the changing availability of the fish to the existing types of gears and fishing methods due to certain environmental changes.

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