PRESENT STATUS OF KNOWLEDGE REGARDING THE BIOLOGY OF INDIAN MACKEREL RASTRELLIGER KANAGURTA (CUVIER)

by

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ABSTRACT

The Indian mackerel (Rastrelliger kanagurta) forms one of the most important commercial pelagic fisheries of the west coast of India. Studies covering the life history, growth rate, reproduction rate, spawning intensity, tagging results, recruitment and abundance are reviewed.

The programme of the Pelagic Fishery Project for the species as well as the inherent problems are presented and recommendations made. The need to have collaborative approach for mackerel research among scientific workers in the Indo-Pacific region is stressed.

1. INTRODUCTION

The Indian mackerel, Rastrelliger kanagurta (Cuvier) forms one of the two (the other is the oil sardine) commercially important pelagic fisheries of the west coast of India. The wide fluctuations in abundance and the related problems that are so characteristic of this important commercial species has engaged the attention of fishery workers since the beginning of this century. The present status of our knowledge regarding the Indian mackerel as well as the gaps in knowledge are presented in the following sections. In order to plan the development of these potential resources, the Government of India through UNDP/FAO started a resources survey programme for the development of pelagic fisheries along the southwest coast of India; the project became operational in February 1971. For detecting fish concentrations and assessing their abundance, an acoustic survey is being conducted by the Pelagic Fishery Project from the 54 foot research vessel "Sardinella", which is equipped with modern fish detecting instruments. A 152 foot stern trawler type vessel is expected to start operation in October, 1972; the vessel will cover the continental shelf and the high seas waters throughout the year. The suggested programmes and those already in operation by the Pelagic Fishery Project are briefly given in this paper.

2. THE FISHERY

The widely fluctuating nature of the fishery is evident from the data (Table 1) covering the past decade (1960-1970).

The mackerel fishery on the west coast extends from Ratnagiri to Quilon; however, the best catches are made in the region between Karwar to Mangalore. The depth of the fishing grounds exploited by the indigenous crafts extends to about 15-18m. The fishing season for mackerel on the west coast extends from August-September to March-April of the following year, with peak landings occurring in October-November. While this describes the general pattern, there are year-to-year variations in the time that the shoals enter the fishing grounds, as well as their exit from the fishing grounds.

3. MATURATION, SPAWNING AND EARLY LIFE HISTORY

It is possible to distinguish the sex of mackerel when they are about 110-120mm in length. A few instances of hermophroditism have been recorded (Prabhu and Antony Raja 1959; Rao, 1962). The size at first maturity for mackerel has been reported to occur when fish are between 190 and 224 mm in length; the majority of the fish maturing at about 220 mm length, or at the end of first year (Devanesan and John, 1940; Pradhan, 1956; Radhakrishnan 1965). The spawning season of mackerel on the west coast appears to be prolonged, extending from about March to October-November. Rao (1964) analysed the maturity stages and distribution of young stages of mackerel as recorded by other workers and concluded that along the west coast intensive spawning takes place during July-August; this is followed by a supplementary spawning in November-December. The studies by Balakrishnan and Rao (1971) on the post-larvae and early juveniles have indicated that the mackerel spawns over several months. It can reasonably be stated that the intensive spawning season of this species seems to coincide with the south-west monsoon period on the west coast. The pelagic trawl surveys carried out by the Pelagic Fishery Project have indicated that the mackerel juveniles occurring off Cochin range in size from 20 to 95 mm. The occurrence of these juveniles and recently spent adults in the commercial catch provided evidence that significant spawning of this species occurs during February-March.

Pradhan (1956), Radhakrishnan (1965), and Sekharan (1958), reported that mackerel eggs are ripened and released in batches over an extended period as indicated by the partial development of eggs in the ovary. A few workers have referred to the possibility of spawning taking place at night (Devanesan and John, 1940). Some workers have referred to the presence of eggs and larvae of Rastrelliger kanagurta in the plankton collections obtained from the Indian waters (Devanesan and John, 1940; Balakrishnan, 1957; Kuthalingam, 1956); however, in the absence of descriptive accounts, the confirmatory evidence must be judged as lacking.

Jones and Kumaran (1964) have provided figures of two juveniles measuring 34 mm and 65 mm in length. Peter (1967) has figured and described some early stages of Rastrelliger; however, Nair and Rao (1970) have questioned this identification and have hinted that these larvae may belong to R. brachysoma. Balakrishnan and Rao (1971) described some of the early stages of the Indian mackerel, the size varying from 8.7 mm to 53.7 mm in body length. Some information is also available on the likely spawning ground of this species. Devanesan and John (1940) mentioned Chaliyam, a place 5 miles off Calicut as a breeding place for mackerel; they collected what they believed to be mackerel eggs from Chaliyam. The region between Vizhinjam and Cape Comorin appears to be a spawning ground for mackerel, since spawners, young mackerel and post-larvae have been obtained from this region (Balakrishnan 1957). Larvae of the Indian mackerel have recently been identified (Anon 1970) from several stations occupied in the area 8°50'N to 10° 40'N and 75°45'E to 76°16'E; chiefly between depth contours of 50 m and 90 m. In some areas, especially around 09°30'N and 76°10'E, night collections made by vertical tows with the Indian Ocean standard net (IOSN) have shown a large abundance of mackerel larvae during the month of May; counts of up to 730/1000 m^3 have been recorded. A comprehensive report of these findings is in progress.

From the above, it is clearly seen that the egg and larval development as well as the spawning area of this species are not clearly understood. Further, the assessment of the spawning season has been made on the basis of observations of the gonadial maturity stages and the occurrence of juveniles in the fishery. Egg and larval surveys contemplated by the Pelagic Fishery Project are aimed primarily at collecting data on the time and duration of spawning, the geographical distribution of spawning, establishing identification keys, and determining the plankton biomass. Sampling is being conducted once a month along six standard hydrographic sections extending from Quilon to Ratnagiri on the west coast of India; stations are located 10 miles apart from the coast to about 60 miles offshore.

4. AGE AND GROWTH

Pradhan (1956) stated that the mackerel attains a length of 10 cm in one year and at the time of entry into the fishery in October the mackerel has completed its 2nd year; the length being 18 cm or greater. Sekharan (1958) concluded that mackerel reach 12-15 cm at the end of 1 year and 21-23 cm at the end of 2 years. Seshappa (1958, 1970) indicated that the size of mackerel at the end of 1, 2, 3, and 4 years were 12-16 cm, 21-24 cm, 25-27 cm, and 28-29 cm, respectively. At the end of 5 years Seshappa assumed that the fish attained a length of 30 cm. Radhakrishnan (1967) gave evidence that the commercial fishery is comprised mainly of mackerel of 18-22 cm length; these fish are in the 0-year or just completing the first year of its life. George and Banerji (1968) stated that the Indian mackerel attains a size of about 22 cm at the end of first year of its life and probably 24 cm at the end of 2nd year. The information on age and growth of mackerel is derived mainly from length frequency studies (Pradhan, 1956; Sekharan, 1958; Radhakrishnan, 1967; George and Banerji, 1968). A few attempts have also been made to deduce the age of this species by examining growth checks on scales (Seshappa 1958). There appears to be no published work describing attempts to age mackerel by

examining opercular bones, centra of vertebrae or other hard parts. Until an accurate ageing method is developed, we will have to depend on the length frequency analysis. This method requires careful scrutiny of the different modal lengths, since there is a possibility of a number of broods entering the fishery (Radhakrishnan 1967, Sekharan 1968). Radhakrishnan (1967) stated that the inshore mackerel fishery is obviously the one that depends upon the movement of mackerel towards the inshore waters during the season. Since there are several broods in the year class involved, a proper assessment of growth for this species will require the identification of each brood and the tracing of the growth of each brood.

5. TAGGING

Confirmation of one or the other view expressed by different workers with regard to age is possible only when we have sufficient data from the recoveries of tagged fish. A tagging programme for mackerel and oil sardine was carried out during the period 1966-1967 to 1968-1969 by the Central Marine Fisheries Research Institute. The results were presented by Prabhu and Venkataraman (1970). In a species supporting a commercial fishery, intensive tagging followed by successful recovery of a fairly reasonable fraction of tagged fish is an indispensible means of elucidating facts about migration, growth, recruitment and mortality rates. The results obtained from tagging experiments conducted earlier showed that the movements of mackerel (as well as sardine) are either local with fish being caught near the vicinity of release, or recapture is within a few kilometres north or south of the place of release and parallel to the coast. It is hoped that with the intensification of the tagging programme, the pattern of migration of this commercially important species will be better understood.

6. POPULATION ASSESSMENT

One of the fundamental problems in fisheries research is to determine the effect of fishing on the fish stock and to determine the level of fishing intensity that will fetch the maximum yield on a sustainable basis. This objective requires the building of mathematical models which link yield to the various population parameters of growth, recruitment and natural and fishing mortalities. Banerji and Krishnan (1968) found no significant differences among the growth equations obtained from the data collected at different centres; thus a pooled growth equation for the west coast has been put forth. The values obtained for K, L_{∞}, and T_o were 0.26, 235 and +0.35, respectively. Based on the relative abundance of various age groups of mackerel in the commercial catches at Karwar for the period 1948-1949 to 1965-1966, Banerji and Krishnan (1968) estimated that the annual instantaneous mortality rate for mackerel varied from 0.86 to 4.55 and averaged 2.06. They estimated the natural mortality rate as 0.65. These estimates appear to be only tentative and they have to be compared with similar estimates for the different centres on the west coast. These comparisons should reveal whether an increase in fishing intensity in the inshore region will result in a further increase in catch. Reference may be made here about the remarks made by Banerji (Quoted by Hayasi, 1971) that "it will be prudent at present to assume that the inshore catch cannot be increased by more than 25 percent". He showed that the maximum sustainable yield for mackerel in Indian inshore waters to be about 73,500 tons. By way of comparison it should be noted that the average landings for 1958-1967 were 58,800 tons. If it is assumed that the mackerel attains a size of about 22 cm in the first year of life, it will be seen that the major contribution to the commercial catch comes from the 0-year class. The 1st and 2nd year classes contribute progressively lesser amounts to the fishery. Hence, the prospect of a fishery in any year will depend mainly on the strength of the 0-year class; this strength in turn depends upon the survival rate of the young and the environmental factors incluencing the immigration of this species into the fishing zones. The conditions during the pre-recruitment phase largely influence the natality and the recruitment in the exploited phase. Detailed studies covering these aspects will have to be made.

7. RELATIONSHIP WITH ENVIRONMENTAL FACTORS

Certain positive correlations with regard to mackerel abundance in relation to environmental factors have been reported by various authors, e.g. Chidambaram and Menon (1945); Panikkar (1949); Bhimachar and George (1950 and 1952); Subramanyan (1959), and Pradhan and Reddy (1964). Murthy (1969) recently observed that the clue for the seasonal and regional variations in our pelagic fisheries is to be found partly in the variations in the pattern of the coastal currents. Murthy found a close correlation between the maximum catches during the winter when the northerly drift currents get established along the west coast and suggested the possibility that the pelagic fisheries of this coast are intimately related to these coastal drift currents. It is difficult to fix any one causative factor determining their abundance, but the atmospheric pressure over the sea surface is known to bring about a series of environmental changes resulting in conditions of the sea responsible for fishery abundance. The necessity to search for fishery-independent factors in order to explain the fluctuations in the yearly recruitment has been brought out by Banerji (1967). In order to study the relation between environmental factors and the distribution and migration of these pelagic fish along the coast, six hydrographic sections located between Quilon and Ratnagiri are regularly occupied by the Pelagic Fishery Project. Stations are 10 miles apart and extend from the shore to about 60 miles off shore; the latter being beyond the edge of the shelf.

The routine hydrographic data collected by the Project from June 1971 until May 1972 have confirmed the previous general finding of the upwelling of cold, oxygen-deficient water onto the coastal shelf during the monsoon season and the subsequent sinking and replenishment. The continuous monthly sampling done by the Project will permit a more detailed study of these processes than it has been possible up to the present.

Although it is generally assumed that the resources potential are much greater than indicated by the present landings, the knowledge of these resources is quite limited because of the extremely inshore nature of the existing fisheries. The short duration of the inshore migration, the almost complete cessation of fishing during the monsoon season, and the marked fluctuations in abundance make it difficult to obtain reliable information on the potentialities of these resources. From the investigations carried out by the Pelagic Fishery Project, a picture of the coastal pelagic resources, their magnitude, behaviour and distribution in time and space is gradually emerging. The fishery season of 1971-1972 appears to have been rather [illegible] throughout the coast, the greatest abundance being approximately between latitude 12°N and 14°N. It was revealed that prior to the fishing season, mackerels are only a few miles off shore and were concentrated near the surface where they are easily located. The surveys conducted along the coastal area from Trivandrum to Karwar during the earlier part of the season (September to November 1971) have shown that fish recordings in the southern area were made in mid-water closer to the bottom than to the surface. The total abundance of pelagic fish during that period in the southern area was evidently smaller than that off Mysore and northern Kerala, but the data available then were insufficient for a proper numerical assessment or comparison between the two areas.

To supplement the vessel surveys, it is planned by the Pelagic Fishery Project to conduct aerial surveys during the months just after the southwest monsoon months. During acoustic surveys, frequent fishing experiments will also be undertaken, for the purpose of identification of echo records, to estimate the size of schools, and to establish catch rates.

Needless to say that most of our investigations on pelagic fish of the Indian seas deal with studies of the mackerel and sardines which come under the neritic-pelagic complex. The exploratory surveys by the Pelagic Fishery Project will certainly throw further light on some aspects of the oceanic-pelagic complex as well. Since the pelagic inshore and high sea resources support fisheries of great importance along the coasts of several South East Asian countries and since the research problems are similar, it is desirable to have a collaborative approach to this problem amongst the scientific workers of these countries.

TABLE I The landings of mackerel as compared with total marine fish production for India during the years from 1960 to 1970.

Year	West coast landings (tons)	East coast landings (tons)	Total catch in tons	All India total marine fish, in tons
1960	129581	4074	133655	879681
1961	27680	6805	34485	683569
1962	25370	3733	29103	644244
1963	72702	4278	76980	655484
1964	18995	4868	23863	859582
1965	40881	2214	43095	832777
1966	27896	4063	31959	890311
1967	23619	5575	29194	862631
1968	16123	4662	20785	902948
1969	43234	48603	91837	913630
1970	95441	47597	147038	1075402

(Source: CMFRI Bull. No. 13, 1969 & CMFRI Annual Report 1970)

8. SUMMARY

Among the pelagic fish of our coast, the Indian mackerel Rastrelliger kanagurta (Cuvier) contributes much to our national economy, ranking next to the prawns and the oil sardine in importance. The existing knowledge on the biology of this species as well as the gaps in knowledge, suggested programmes and those already in hand by the Pelagic Fishery Project are presented. The need to have colloborative approach for mackerel studies amongst the scientific workers of the many countries in the Indo-Pacific region is emphasised.

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