SYMPOSIUM ON
THE PELAGIC FISHERIES RESOURCES OF THE SEAS AROUND INDIA
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ABSTRACTS

ICAR

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THE PELAGIC FISHERIES RESOURCES OF THE SEAS AROUND INDIA

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ABSTRACTS

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I. GENERAL CONSIDERATIONS

1. STUDIES ON POPULATIONS OF INDIAN FISHES

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Populations of tropical fishes like oil sardine, mackerel and Bombay duck present some unique features. The data published to date cannot be quite fitted into the known models and their characteristics. Satisfactory population models cannot be formulated without physiological and behaviour studies.

The best estimate of a population can be obtained by devising experimental gear to collect unbiased samples of all the size (and hence age) groups in the population under investigation. It is evident that such a study has to be a long-term project and should take into account such seasonal, annual and short - or long-term fluctuations as may occur. A pre-requisite to such a study is knowledge of the geographic limits of the population, knowledge which is often difficult to obtain because of migrations or sporadic movements beyond normal limits.

In India, problems pertaining to different aspects of fish populations have been tackled more at the level of individual worker, rather than as problems to be tackled by groups of workers or institutions. A study of the work to date on fishes like *Sardinella longiceps* Val., *Rastrelliger kanagurta* (Cuv.) etc. exposes lacunae in our knowledge of important aspects of population structure and behaviour. For example, we do not know the limits of distribution of the above two fishes along the west coast of India, nor do we know with any degree of certainty the spawning seasons and grounds of these species. We have no knowledge of the direction and distance of movement of these and other fishes, at the end of the fishing season in the coastal waters.

Indian fishery scientists work under the following limitations: (1) in any given area many fisheries at present are seasonal, so that valid data are available only for part of the year, (2) studies have to be based almost entirely on samples from commercial gear which are selective and are operated only seasonally, because of climatic or oceanographic conditions, and (3) even if a species is restricted in a well defined area throughout the year, there is no suitable gear to obtain samples of all the size (and age) groups in the population throughout the year.

The absence in commercial catches of particular sections of the population during certain months or seasons should not *per se* be assumed to mean the absence of such sections in the area of investigation, or in the population.

There is a definite case for fresh thinking on design of experiment and for more critical methods for studies on Indian fishes. There is an urgent need to move away from hasty empirical methods and to tackle first principles. Piecemeal investigations have no doubt served some purpose in the past. The time has come to tackle the exploited populations as units in future programmes of research.

2. DISTRIBUTION PATTERN OF THE EXPLOITED PELAGIC FISHERY RESOURCES OF INDIA

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The total marine fish production in India has reached about 1.2 million tonnes of which about 63% come from the exploited pelagic fisheries. While the most important pelagic fisheries in the west coast of India are oil sardine, mackerel and Bombay duck, the same on the east coast are lesser sardines, *Stolephorus* spp, *Thrissocles* spp, other clupeids and ribbon fish. The state-wise distribution of pelagic fishes during the 20 year period, 1952 to 1971, has been studied in detail. The study reveals that the percentages of all-India

pelagic catches to the total catches fluctuated between 45 and 71 during the 20 year period. Kerala and Mysore contributed the highest pelagic fish production, the minimum, the maximum and the average percentages of the pelagic catch for the 20 year period being respectively 56, 86 and 77 for Kerala and 53, 95 and 82 for Mysore. The same for Maharashtra and Gujarat are 23, 49 and 41 and 34, 80 and 64 respectively. The corresponding figures for the east coast are 44, 64 and 54 for Tamil Nadu (including Pondicherry), 47, 72 and 57 for Andhra and 35, 94 and 58 for West Bengal and Orissa.

As increasing effort is being put in to produce higher yields, a study of these figures assumes greater importance for a proper understanding of the resources of the pelagic fisheries. The common types of gear used for the exploitation of pelagic fisheries on both the coasts are boat-seine, shore-seine, gill net, drift net and cast net. In Maharashtra and Gujarat fixed bag net locally, known as "Dol", are used for Bombay duck fishery. On the east coast of India, lesser sardines contribute about 12% of the total catch. The percentage contribution of other important pelagic fishes along this coast are anchovies and white baits (9%), ribbon fish (9%) and other clupeids (4%). An increasing trend is seen in the catches of lesser sardines, anchovies and white baits on the east coast of India.

3. SOME GAPS IN OUR KNOWLEDGE OF THE PELAGIC FISHERY RESOURCES OF THE SEAS AROUND INDIA

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Although during the past twenty five years considerable knowledge has been gained on pelagic stocks of the Indian Seas, the magnitude of each type of resource has not been fully assessed. For example, we still do not know what the potential yields of oil sardine, mackerel or Bombay duck would be and whether their populations would continue to sustain increased exploitation. Our understanding

about the wide fluctuations in the annual yields of oil sardine and mackerel being as a result of fishery-dependent or fishery-independent factors is totally incomplete. The causes of slight decline in the yield of Bombay duck in recent years, associated with a decrease in the size of exploited fishes, have not been properly enumerated.

Similarly, several gaps exist in our knowledge of the biology of oil sardine and mackerel. The controversy whether the 0 group or the 1 year old fishes largely constitute the fishery of the oil sardine has not been resolved. In the mackerel also the rate of growth has been a debated issue and in the oil sardine the question of phyto-plankton organisms acting as indicator for fishery has not been properly investigated. In addition to these, some of the more fundamental questions, such as where the oil sardine and mackerel breed and what happens to the shoals after the fishing season is over, have remained unanswered. Moreover, what the underlying mechanisms of shoaling in pelagic stocks in nearshore or offshore waters are and whether the congregation is for feeding or because of some other environmental factors, have remained unexplained.

The gaps in our knowledge regarding the tunas of the Indian seas are even wider. We know very little about the magnitude of various tuna resources and how best these could be exploited. Our knowledge of some of the important problems of the biology of tunas is still incomplete and several aspects need immediate attention.

Pelagic resources are distributed very widely in the Indian Ocean. The types of resources exploited along the west coast of India are very different from those of the east coast. There is no pelagic fishery of the size of oil sardine or mackerel along the east coast, but the other pelagic resources such as the lesser sardines and anchovies are no less important for the east coast. Similarly, the pelagic resources of the Laccadive and Andaman Seas are so very different from those of the coastal waters. Much work seems necessary to fill in the gaps in our knowledge and to find ways for exploiting these resources to an optimum level. The fishery wealth of our country would largely depend on our greater understanding of these resources.

II. OIL SARDINE AND OTHER CLUPEOID RESOURCES

4. AN ESTIMATE OF THE OIL SARDINE STOCK IN THE PRESENT FISHING GROUNDS OFF THE WEST COAST OF INDIA

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If M is the annual instantaneous natural mortality coefficient and F the annual instantaneous fishing mortality coefficient, the annual exploitation rate, U (the fraction of the population fished per year), can be estimated by the well-known expression $\frac{F}{F+M}(1-e^{-(F+M)})$. Let Y be the annual catch; then Y/U gives an estimate of the total stock in the fishing grounds, and Y/F an estimate of the average standing crop.

In the oil sardine, the total annual instantaneous mortality ($Z=F+M$) has been estimated as 1.66. Like most tropical fishes the oil sardine is a short-lived species. Fish greater than 19 cm in length are rare in the catches. Studies already made show that the natural life-span of the species is about 4 years. Assuming that 99% of the individuals in the population do not live beyond this age in the unexploited state, the value of annual M is estimated as 1.12. The value of F then becomes 0.54 and $U=0.26$.

In 1960-71, the annual average catch of the oil sardine on the west coast was about 2.1 lakh tonnes. From this and the value of U, it would follow that in the fishing grounds the average annual stock of oil sardine was about 8.1 lakh tonnes during that period. The average standing crop in the fishing grounds for a year can be estimated as about 4 lakh tonnes.

5. SOME RECENT DATA ON GROWTH AND AGE OF OIL SARDINE : A CASE STUDY

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Our concepts of a fish population and its important characteristics have been derived mostly from and influenced by publications based on the intensive work over many decades, on coldwater and temperate species, mainly from the north Atlantic and connected seas. Indian fishery scientists have yet to assess to what extent these basic concepts and the population models need modification when applied to tropical fishes. Tropical seas are in some ways very different from those at higher latitudes and the biology and behaviour of the fishes inhabiting them show characteristic features, apart from having relatively faster growth rate and shorter life-span.

Taking the oil sardine as a case, is there only one population or are there two or more populations which may form a population continuum along the southern half of the west coast of India? Unless this problem is solved using modern techniques, and unless we have a clear picture of the spatial limits of the population(s), analyses of landings at any one centre for length frequency distribution, growth rate and estimation of age have limited value because the exploited area cannot be equated with the area over which the population is distributed. Moreover, the samples from commercial catches do not give a faithful picture of all the length groups in the population, because the gear is selective to particular length groups or is operated in areas where only particular length groups aggregate.

The published data do not give a true picture of the growth rate of the oil sardine for the following reasons: (1) the samples do not include all the size groups in the population, (2) it is not possible to isolate and trace the growth history of each of the two or more broods of each spawning season, over successive months, and (3) the persistence of particular length groups over many months indicates either the movement into the restricted exploited area of successive broods in that length range in successive months or, it is due to the selectivity of the gear and/or to the fact that the growing sardines

(of sizes larger than those represented by the persistent mode) are beyond the range of the gear operated. There are no convincing reasons to believe that the oil sardine attains an age of more than 3 years. In such a short-lived fish, the need for estimating growth rate and relationship between length and age with greater accuracy is all the more important.

The oil sardine spawns in waters beyond the limits of the narrow exploited belt. The appearance of small juveniles over a long stretch of the coast indicates a wide-spread (albeit unknown) spawning area. The two or more broods during the extended spawning seasons are represented by distinct modes in the multi-modal length frequency distribution.

Recent publications of data on growth and age collected at Karwar, Mangalore, Cannanore, Calicut and Cochin are discussed. The empirical methods adopted and the inferences are not always satisfactory; the data could fit models other than those taken for granted.

6. A COMPARISON OF SEASONAL ABUNDANCE OF OIL SARDINE AT KARWAR WITH MANGALORE AND MYSORE COASTS

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A comparison is made of the oil sardine catch trends at Karwar for the seasons 1958-59 to 1970-71 with those for Mangalore and Mysore coasts. Between Karwar and Mangalore centres it is seen that the data for 1958-59, 1961-62, 1962-63, 1966-67 and 1970-71 show an inverse trend. While a comparison of the total catch of the entire Mysore coast with Karwar shows such a feature for 1958-59, 1964-65, 1965-66, 1966-67 and 1967-68, it was not the case between Mysore and Mangalore for any season except one or two. Perhaps these trends may be due to differences in the percentage variation between years which is found to be the highest at Karwar, (143%) followed by Mysore (102%) and Mangalore (78%).

7. SOME POSSIBLE EXPLANATION OF THE PRE-MONSOON DECLINE OF OIL SARDINE FISHERY IN KERALA

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In 1972, a sudden decrease in the oil sardine fishery was observed in February in the southern zones in Kerala. The decline in sardine fishery gradually shifted towards north and by April Cochin area was found to be affected. A hydrographic survey was made in April 1972 covering 26 stations in the shelf region between Cochin and Trivandrum. The survey showed the presence of a tongue of cold dense water nearshore which extended from south to north. At the surface, the major portion of the shelf region was covered by water of temperature more than 29.5°C extending from north to south. The denser water near the shore had a temperature of 28.5°C. At greater depth the extent of the area covered by the tongue of cold water increased. Distribution of salinity and density also showed a similar pattern; denser water was limited to the southern region nearer the shore. Vertical sections of density off Trivandrum, Quilon and Kayamkulam showed a general upward tilt of the isopycnal towards the coast, indicating upwelling in these regions. Probably upwelling started much earlier in the south and the northern regions were gradually affected. Eddy flow might have carried the upwelled water further north of the region. The south to north decline in the fishery was probably due to upwelling.

8. THE SYMPTOMS TO FORECAST THE OIL SARDINE FISHERY

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Relating the oil sardine landings data on the Kerala-Mysore coast for the last 16 seasons to the rainfall amount as obtained at Calicut during the peak spawning periods of June to

August, it is seen that there is a general correspondence in the oscillations between the two. It appears that a mean daily rainfall range of 25 to 35 mm for June-July or 20 to 30 mm for June-August periods may indicate the likelihood of obtaining favourable ecological conditions that would contribute towards successful spawning and, therefrom, recruitment of juveniles to the commercial fishery, whereas an amount outside the above range appears to have a role in the catch declension. While the periods of feeble rainfall coincide with extensive atresia in the ovaries both during the pre-ovulation and post-ovulation phases thus reducing the spawning potential of the population, it is suggested that very intense monsoon condition, as indicated by high rainfall amount, may, in addition to affecting ova-production, interfere with the survival rate of the eggs and larvae, causing a reduction in the recruitment. The incursion of large number of early juveniles into the nearshore waters during July-September of certain seasons that were also characterised by poor rainfall may also indicate the prevalence of unfavourable conditions in the spawning/nursery ground. Hence the rainfall amount, extent of atresia and relative abundance of early juveniles during the spawning months are considered as symptoms with which it would be possible to forecast in a qualitative way whether the ensuing fishery for the juveniles would record a reduction or not.

9. THE FOOD OF OIL SARDINE OFF THE COCHIN AND CALICUT COASTS

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Studies on the food of the oil sardine were undertaken from 1959 to 1962 at Calicut and from 1964 to 1969 at Cochin. In the Cochin area, copepods, larval bivalves, tintinnids, dinoflagellates, crustacean remains, nauplii and diatoms constituted the major portion of the diet of oil sardine. Though, among these, there was often dominance of the zooplankton items, no clear indication of selective or discriminative feeding was observed. The predominance may largely be attributed to the spatial and temporal abundance of zooplankton in the same environment. An "availability dependent" feeding proclivity in the sardine is, thus indicated.

At Calicut it was found that the fish is mainly a phytoplankton feeder with diatoms, dinoflagellates and zooplankton appearing in the order of importance in its food all through the year. Myxophyceae was represented by one species of *Trichodesmium*. The bulk of the stomach contents, very often, contained unidentifiable detritus which may possibly have some food value.

Among the numerous diatoms and dinoflagellates occurring off the west coast of India, members of 24 genera were noticed in the stomach contents.

Fragilaria oceanica constituted an important item of food, like any other "very common" items such as the several species of *Coscinodiscus*, *Biddulphia*, *Peridinium* and *Prorocentrum micans*, all of which occurred through the year, generally in greater intensity from May to November.

Intensity of feeding was not found to vary with any particular item or group of items among the various age-classes of the sardine.

A comparative study of nutrition of the sardine off the Cochin and Calicut coasts revealed that though the zooplankton items dominated in the food in the former area, the principal food in the latter area consisted of phytoplankton. Though *Fragilaria oceanica* constituted a very important item in the food at Calicut, it appeared only in lesser quantities in the sardine diet at Cochin. Copepods, though being the most important element in the food at Cochin, had only a secondary importance in the diet of the sardine at Calicut. Though there is no evidence in support of selective feeding at Cochin, some amount of selectivity was noticed by the investigators from Calicut area. Increased dominance of copepods was often found synchronous with the rich sardine fishery season at Cochin.

10. SEX-RATIO IN OIL SARDINE

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During a study of the biology of oil sardine, *Sardinella longiceps* Valenciennes, from 1960-61 to 1970-71, the sex-ratios of fish caught in the Mangalore area by the non-selective gear, *viz.*, cast

net, shore-seines *(kairampani* and *rampani)* and boat-seines, were determined. It was seen that the maximum total length attained by the males and females in general was more or less the same (212 mm); however, in most of the years the size attained by the females was larger than the males. The average length attained by the males and females for the eleven-year period works out to be 190.6 and 195.6 mm respectively. However, what is of interest is the significant variations in the sex-ratios of various length groups. From 1960-61 to 1964-65 the proportion of males and females in most of the size-groups was of even order. In subsequent years, females outnumbered the males practically in most of the size-groups.

The size of oil sardine at first maturity is about 150 mm. The fish were grouped under pre-and post-spawning categories to determine the pattern of distribution of sex-ratios. The data revealed that the proportion of females is higher in the majority of the years in both the groups. This may be one of the reasons for the stabilisation of the oil sardine fishery in the sixties.

There is some striking similarity between the stock of oil sardine and Peruvian anchoveta. The appearance of small fish in fishery late in the season (January and February) suggests that they belong to the current year's brood. This also supports the view that the growth during the first year is very fast, and the fish reaches the length of about 150-160 mm at the end of the first year.

11. MIGRATION OF THE JUVENILE OIL SARDINE, *SARDINELLA LONGICEPS* (VAL) INTO THE BACKWATERS OF COCHIN

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The juveniles of oil sardine of the size range 35 to 60 mm were caught in the stake nets and in the chinese dip nets operated at Thoppumpady and Thevara region of the Cochin Backwater during the last week of August and the first week of September, 1972. Apart from these, juveniles of oil sardine in very large numbers have also been caught in the chinese dip nets operated at the Fort Cochin area

of the backwater during these weeks. These fish were not actively feeding and their stomachs were found empty or only up to one-fourth full. But the samples of the same size groups examined from the inshore catches of the same periods showed that their feeding activity was very high and their stomachs were full or three-fourth full. However, there was similarity in the main items of the stomach contents. The average salinity of the backwater area from where the samples were collected was only 2.96 $^{o}/_{oo}$ with a surface temperature of 28.8°C. Though the causative factor which influences this unusual migrations of oil sardine into the less saline waters of the backwaters is a matter of conjecture, it is interesting to note here that the appearance of these juveniles in the backwater and their sudden disappearance coincided with the full-moon and new-moon.

12. FISHERY RESOURCES OF CLUPEIFORMES IN THE GULF OF MANNAR

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An estimated annual catch of 6,000 to 10,000 tonnes of clupeiform fishes (*Sardinella, Thrissocles, Anchoviella, Dussumieria* etc.) is landed along the Gulf of Mannar coast. Some of the important fishing centres are Kanyakumari, Manapad, Thiruchendur, Pinnakayal, Tuticorin, Vembar, Mandapam etc. The important nets are gillnets, shore-seines and boat-seines. At Tuticorin alone the annual catch amounted to 550 and 700 tonnes during 1968 and 1969 respectively, contributing to more than 40% of the total landings.

Published literature shows that except for one or two groups, no detailed information is available on the catch statistics of the others. Though the fishery for some of the individual species may not be of much importance in some centres, collectively they form one of the important resources in the Gulf of Mannar. But, at present, due to the increasing demand of prawns, lobsters *etc.*, most of the fishermen have changed over from the less profitable operations for clupeiform fishes. This has resulted in a decrease of fishing effort and higher prices for this group, which till recently was the cheap protein for the common man.

13. 'KATI' RESOURCES OF BOMBAY-SAURASHTRA ZONE

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Among the Clupeoid fishes of Bombay, Indian herrings (locally called 'Kati') rank next to Golden Anchovies *(Coilia dussumieri)* in the commercial catches. *Ilisha filigera* is an important commercial fish of Bombay and Saurashtra coasts and it forms more than 3.6% of the total catch of the trawlers in these regions. The chief types of gear employed in the fishery are bag nets and trawl nets. The paper is based on the data collected during 1959-1961. The Bombay-Saurashtra waters have been divided into six regions, namely, Bombay, Cambay, Veraval, Porbander, Dwaraka and Kutch. The best yield of *I. filigera* was 187.07 kg. per trawling hour from kutch region in November 1959. The average catch per trawling hour was fairly high in all the regions except in Bombay region. The seasonal trend noticed from catches suggests that the 'Kati' fishery starts from the northern region in November-April and progresses southwards gradually.

14. THE RESOURCES OF CLUPEOID FISHES OF THE ANDAMAN SEA

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Clupeoid fishes play a significant role among the pelagic fishery resources of the Andaman sea. In Andaman Isles, fishing is of a diffused nature and landings are by indigenous crafts using a few types of gears, confined mostly to the narrow, rocky coastal belt of the east coast. The important fish landing centres are located in and around Port Blair (South Andamans) and a few scattered centres in North Andamans. As many as 19 species of clupeoid fishes are now known to occur in the seas around Andamans. About 8 species contribute to the commercial catches, of which the bulk is composed lesser sardines and short-jaw anchovies almost throughout the year. The biology of a few commercially important species in relation to their fisheries and environmental biota is dealt with. There is considerable scope for the development of the fishery with increased effort in sheltered areas with muddy and sandy coasts.

15. THE SARDINE FISHERY ALONG THE SOUTH-EAST COAST OF INDIA

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The paper is a review of the available information on the fishery and biology of sardines (*Sardinella* spp.) along the south-east coast of India. Prevailing water movements and changes in environmental conditions connected with south-west and north-east monsoons are given. Appearance of some species of sardines in the inshore waters in relation to water currents is discussed. Brief descriptions are given on the fishing implements used in the sardine fishery and methods of fishing. Relative importance of the different species of sardines in the fishery is also given. The species of sardines that occur along the south-east coast of India in accordance with their commercial importance are: *Sardinella albella, Sardinella gibbosa, Sardinella fimbriata, Sardinella sirm, Sardinella clupeoides* and *Sardinella longiceps.* A species of unsettled taxonomic status is also found in this region.

Brief information on biological aspects like size range in the commercial fishery, fishing seasons, feeding habits, spawning seasons, parasites and predators are given. Use of the body parasite *Peroderma cylindricum* Heller in determining the origin and mixing of *Sardinella albella* populations is discussed. Observations are made on the food value and commercial uses of sardines.

16. THE LESSER SARDINES (*SARDINELLA* SPP.) OF INDIA - A REVIEW

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The paper presents the current status of our knowledge on the lesser sardines (*Sardinella* spp.) of India, oriented subject-wise on identity, distribution, bionomics, life history, population and exploitation.

The close similarity between sets of species and difficulties in identification justify undertaking a modern systematic review of this group based on biometrics.

Only a broad pattern of distribution is available indicating the local importance of *S. fimbriata* and *S. gibbosa* on the Andhra seaboard, *S. gibbosa*, *S. albella* and *S. sirm* on both the coasts of southernmost peninsular region and again *S. fimbriata* on the Konkan coast.

On the bionomics and life history, it is generally seen that *S. fimbriata*, *S. gibbosa* and *S. albella* have a roughly similar growth reaching about 120 to 130 mm at the end of one year when they attain maturity. In spawning also these three species appear to have a seasonal similarity, confined mainly to the first half of the year, as well as in the frequency, limited to once in the season. *S. stet sirm* appears to have a rapid growth, attaining about 170-180 mm during the first year. The food habits of all the species exhibit the same tendency of preference for zooplankters, mostly copepods. The identity of the eggs and larvae reported in some works is of doubtful nature. Practically little is known about *S. melanura*, *S. clupeoides* and *S. dayi*.

Regarding population, some information is available on the sex-ratio and the dependence of the fishery on the O-year class.

Although exploitation of the fishery is carried out mostly during October to March, there seems to be a progressive shift in the seasonal abundance within this period as we proceed from West Bengal-Orissa to Gujarat zones along the coast. In the average annual harvest of about 40,000 tonnes that form about 5% of total marine fish production in India, the east coast takes a greater share of about 62% of the total with Andhra and Tamil Nadu each contributing roughly an equal amount of 11,000 tonnes. On the west coast the lesser sardines appear to be of fishery importance in south Kerala and Goa coasts only. Perhaps *S. fimbriata* is the most important species but the relative importance of the others in recent years will have to be assessed.

In view of the possibility of developing the fisheries of the lesser sardines, it is necessary to have a co-ordinated research programme on their resources to be executed from at least 5 centres on the east coast and 2 on the west.

17. WHITE-BAIT FISHERY RESOURCES OF THE SOUTH WEST COAST OF INDIA

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The major portion of the white-bait landings on the west coast of India comes from the south west coast extending from south of Quilon to Cape Comorin. At Vizhinjam, which is situated at about the middle of this zone, the white-baits constitute about 7% of the total fish catch. Here the season extends from April to November with two peak periods, one from May to July and another during September - October. In the order of their returns the three types of nets in which this fish is caught are the boat seines (62%), gill nets *(Netholi vala)* (26%) and shore seines (12%). The seasons of their operations have been given. More than half the catch is used for consumption in fresh state. The rest is either sun-dried or salted and dried, depending on the weather; the former quality has more demand in the markets inland as well as abroad.

Although seven species of white-baits occur in the area, only two, *viz.*, *Stolephorus bataviensis* Hardenberg and *S. devisi* (Whitley) are commercially important; they together form about 85% of the annual white-bait catch. Both species occur in the fishery in the size range 25-109 mm with common sizes varying from 30 to 95 mm. Recruitment takes place during March, May-July and September in the first species and during March-June and November-December in the other. *S. bataviensis* has two spawning periods in a year: May-July and September–December. *S. devisi* spawns in the inshore waters almost throughout the year, the peak being in November-June. Minimum size at first maturity is 65 mm in the first species and 55 mm in the other. The food of both species consists mainly of copepods, other small crustaceans and larval bivalves. The life-span of both species is about one year. In view of the short life-span, the extended spawning period and the continuous recruitment to the fishery together with their vulnerability to 'torch fishing' or 'light fishing' there is reason to believe that the white-bait catch of the area could be further stepped up.

III. MACKEREL, TUNA AND OTHER SCOMBROID RESOURCES

18. NEED FOR A CRITICAL REVIEW OF THE BASIC FEATURES OF MACKEREL BIOLOGY

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Although researches on the biology of the Indian mackerel, *Rastrelliger kanagurta* have been carried out for several years past, opinions on even the basic biological features such as reproduction and growth still remain largely controversial. The paper presents the divergent views and urges the desirability to have an objective evaluation of the existing data which might lead to concrete and logical conclusions.

19. ON THE NATURE OF VARIABILITY OF MACKEREL ABUNDANCE IN THE INSHORE AREA OFF KARWAR AND ITS PROBABLE IMPLICATION AS A MEASURE OF TOTAL MORTALITY OF MACKEREL

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It is a general feature over years that mackerel fishery in Karwar area starts during the month of October, reaches its peak sometime in the season and disappears in the month of April-May. When more or less the same pattern is repeated every year it is of interest to see how within a season abundance is related to fishing effort and how its variation over different months behaves. With this view, the data relating to mackerel fishery of the seasons 1959-'60 to 1966-'67 have been analysed. The concentration index which is given by the correlation coefficient between the index of abundance and the effort has been interpreted and the rate of decline of abundance over time has been studied for every year. On the assumption that the fish

present in the population belongs to the same age group the rate of decline has been taken as equivalent to an estimate of instantaneous rate of total mortality.

20. AN ESTIMATE OF THE STOCK OF THE MACKEREL IN THE PRESENT FISHING GROUNDS OFF THE WEST COAST OF INDIA

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If in a stock the annual instantaneous natural mortality coefficient be M and the annual instantaneous fishing mortality F, the well-known expression $\frac{F}{F+M}(1-e^{-(F+M)})$ will give the estimate of U, which will be the annual exploitation rate (the fraction of the stock dying due to fishing). If Y is the annual catch, then Y/U gives an estimate of the total stock in the grounds, and Y/F the average standing crop; these relations have been used to estimate the total and standing stock of mackerel in the existing fishing grounds.

The total annual instantaneous mortality ($Z=F+M$) of mackerel of the west coast has been estimated to be 2·05. The studies previously made have shown that the maximum life-span of the species is about 5 years, and that mackerel larger than 28 cm in length are rarely observed in the catches. Assuming that 99% of the population in the virgin state do not live beyond 5 years, the value of annual M may be obtained as 0·9. Then $F=1·15$ and $U=0·49$.

In 1960-'71, the annual average mackerel catch on the west coast was about 65,000 tonnes. The stock of mackerel in the fishing grounds during that period may then be estimated on an average as 133,000 tonnes a year. It also follows that the average annual standing crop would be 57,000 tonnes.

The values of both total mortality and fishing mortality are higher in the mackerel stock than in the oil sardine stock. The two stocks, normally yield 35-40% of the total annual marine fish production of the country. The difference in mortality is clearly

reflected in the age-composition of the catches. In the oil sardine fishery, a year-class may contribute to the catches in two seasons. Such a situation is rarely, if ever, witnessed in the mackerel fishery, where the catches have to come almost exclusively from a new year-class every year. In the oil sardine fishery, during the periods of peak abundance of the fish, the fishermen restrict fishing owing to glut in the market. Mackerel on the other hand, fetches a better price and hence no restraint is exercised in it sfishery. The higher fishing mortality in the mackerel stock is therefore only to be expected.

21. THE FISHERY OF SMALL-SIZED INDIAN MACKEREL, *RASTRELLIGER KANAGURTA* (CUVIER) OFF THE SOUTH-WEST COAST OF INDIA DURING THE RAINY SEASON OF 1972

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Widespread occurrence of small-sized Indian mackerel was noticed along the west coast during the south-west monsoon period, and the observations made on them in the south zone (from Ponnani to Quilon in Kerala State) are presented.

A total of about 902 tonnes of the small-sized mackerel was estimated to have been landed here in June-August of which 60% were caught in the *Chakara* fishery at Ambalapuzha lasting just for a few days in the first week of July. The length of the mackerel caught ranged between 45 and 165 mm. The size groups, 75 to 95 mm., were more common and the mode was at 90 mm. The smaller fish seemed to follow comparatively big ones in their occurrence. These fish in general showed only moderate feeding. The food was phytoplanktonic with diatoms dominating.

The mackerel during this fishery, being very small, secured only a low price estimated at about Rs. 82,000/-. An equal number of fish in the commercial size range of 170-220 mm. could have weighed 9·5 times more and fetched a sixtyeight-fold increase in the financial return. The indiscriminate exploitation of the under-sized mackerel, therefore appears to be an uneconomical drain on our resource potential, which could rationally be avoided for better.

22. THE MACKEREL FISHERY RESOURCES OF THE MANGALORE ZONE DURING 1963-1967

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The studies have shown that the mackerel fishery has been declining from the season 1963-'64 to 1965-'66. The duration of fishery is observed to be from August to March with peak landing during October to December. The standard fishing effort in terms of *Pattabala* (Gill net) is estimated to be 611, 459 and 461 for the respective years 1963-'64, '64-'65 and '65-'66 and the percentage of mackerel in the total landings is 22·61%, 7% and 3·1% for the respective seasons.

Studies on the size composition reveals that more than one brood of different years spawning appear during the season and the fishery is mainly supported by the size groups 180-220 mm. and the maximum landing is by surface gill nets and shore seines.

The ratio of male and female individuals is seen to be more or less equal at the earlier stages of maturity (stages I, II, III and IV). But in bottom-set gill nets the percentage of females is observed to be more towards the beginning of the spawning season. Spawners are rarely recorded in the inshore catches.

It is observed that high percentage of advanced stages of maturity occurs in bottom-set gill nets. The high percentage of spent individuals and stage VI B, in these nets compared to the surface gill nets show that during spawning the fishes prefer deeper waters and the spawning takes place not far from shore.

23. *RASTRELLIGER FAUGHNI*, MATSUI, A NEW MACKEREL RESOURCE ON THE EAST COAST OF INDIA

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The paper presents an account of the fishery of *Rastrelliger faughni* on the east coast of India with special reference to Madras

coast. The gears used and the methods of fishing are briefly described. Unlike the Indian mackerel, *R. kanagurta*, this species appears to move about in loose concentration covering a wider area. This species supports a minor fishery during January - March, when fish measuring above 22·0 cm. form the bulk of the catches. Very young juveniles of this species measuring below 10·0 cm. form a good percentage of juvenile mackerel in April and May. The size-groups available in different months are presented.

Macroscopic examination of gonads and intra-ovarian egg diameter studies indicate that spawning period may be from January to April. This conclusion is supported by the occurrence of young juveniles in April and May. The spawning stimulus seems to be an important factor for the maintenance of the loose concentration of *R. faughni* in the coastal waters and they may retire to deeper waters offshore after spawning.

24. SEER FISH FISHERY ALONG THE INDIAN COAST WITH SPECIAL REFERENCE TO LAWSON'S BAY AREA, BAY OF BENGAL

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The catch statistics published by the Central Marine Fisheries Research Institute and the detailed catch and effort statistics collected by the author during the period April 1955 to March 1961 from the Lawson's Bay are made use of for comparing the seer fish potentialities on the east and west coasts of India. The available data show that Rameswaram in the Gulf of Mannar region (south-east) and Lawson's Bay in the North Andhra Coast (north-east) are rich grounds for these fishes and of the two, the North Andhra coast appears more promising, particularly for *Scomberomorus guttatus*. The peak periods of the catches of *S. guttatus* and *S. commerson* at Lawson's Bay show a regularity from year to year - the period from May to July for the former and February to April for the latter.

The seasonal variation in the catch at Lawson's Bay is related to the effort of the hook and line gear. From the relation between catch

and catch per unit of effort, it is seen that catch itself may be taken as indicative of the stock abundance (apparent) of the fish off Visakhapatnam.

The catch per man-hour figures of *S. guttatus* at Lawson's Bay when compared with the catch per man-hour figures of the total marine fish landings along the Indian coast further substantiate the richness of the North Andhra coast (as represented by Lawson's Bay) in seer fish content.

Of the several factors that influence the seasonal variation in the stock abundance of *S. guttatus* along the east coast, the current patterns and their seasonal changes seem to play an important role.

25. TUNA RESOURCES OF THE SOUTH-WEST COAST OF INDIA

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An assessment of the tuna resources of the south-west coast of India has been made from the data collected on catch, effort and biological aspects of different species of tunas such as, *Euthynnus affinis, Auxis thazard, A. rochei, Sarda orientalis, Thunnus (Neothunnus) albacares* and *Katsuwonus pelamis* occurring from Neendakara to Cape Comorin. A large share of the country's tuna landings comes from this zone. Kerala state alone contributes to about 50% of the total tuna catches. The percentage composition of each species in the catch varies in relation to gears and seasons. The little tunny, *E. affinis* is the most abundant species in this zone and forms about 60% of the tuna landings. The truly oceanic species such as, *T(N). albacares* and *K. pelamis* occur only at two centres north of Vizhinjam, although Vizhinjam is the most important tuna landing centre of this zone.

The most common species, *E. affinis*, has been studied in greater detail. It grows to about 40 cm. in length during the first year of its life. In the 2nd and 3rd year its growth slows down considerably. The von Bertallanfy's equation was fitted to the growth data. The sexes seem to be equally distributed in the population. The spawning season lasts from March to September. All species

of tunas have been found to be carnivorous, feeding largely on fish, molluscs and crustaceans.

The landed tuna is largely utilized in a fresh condition. Little effort has so far been made towards processing and canning tunas in this region. From the existing figures it seems that we are at present utilizing only a small portion of the potential tuna resources. The future of tuna fishery seem to be bright provided a well-balanced and rational management policy is adopted.

26. PRESENT STATUS OF INVESTIGATIONS ON THE TUNA AND BILLFISH RESOURCES OF THE INDIAN OCEAN

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In the future marine fisheries development programme in the country greater emphasis is to be given for the development of tuna fisheries. At present, the annual landings of tunas in the country amounts to less than 10,000 tonnes and is mostly composed of the coastal species, *Euthynnus affinis*, *Auxis thazard*, *A. rochei*, *Sarda orientalis* and *Thunnus tonggol*. The skipjack *Katsuwonus pelamis* supports a surface fishery in the Laccadives and in 1971 about 1,200 tonnes of this species was landed there in the pole and line fishery. Here again there has been considerable fluctuations in the catch depending also on the availability of live bait. A detailed analysis of zone-wise landings of tunas along the Indian coast and in the Laccadives is presented, for the period 1966 to 1971.

Information on the coastal fisheries for tunas by the countries bordering the Indian Ocean is given indicating the present trends in development. Catches of tunas in the different areas of the Indian Ocean based on surface as well as longline fisheries is presented with basic information on the state of the stocks of yellowfin, bigeye, albacore and the southern bluefin. Possible management measures are also discussed.

Available information on the billfish resources of the Indian Ocean is also presented.

27. STUDIES ON THE OCCURRENCE OF THE LARVAE AND JUVENILES OF THE OCEANIC SKIPJACK *(KATSUWONUS PELAMIS)* AND *ORIENTAL BONITO (SARDA ORIENTALIS)* FROM THE INSHORE WATERS OF THE SOUTH-WEST COAST OF INDIA

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The oceanic skipjack *Katsuwonus pelamis* forms the main resource of the tuna fishery of the Maldive Islands and the Laccadive Islands in the Indian Ocean. Knowledge on the seasonal occurrence and distribution of the larvae and juveniles of this species is highly essential for taking conservation measures for the rational exploitation of this fishery apart from its scientific significance. The larvae and juveniles of *K. pelamis* is known only from the Laccadive area and the present report on their occurrence in the inshore waters extends its spawning grounds to the coastal waters of the mainland also. *K. pelamis* forms a fishery during certain months at Valiaveli (Trivandrum) and the occurence of the larvae in the neighbouring centres is also of interest on the biological point of view. Larvae and juveniles measuring from 4 mm. to 25 mm. (S. L.) are described and figured in this paper.

Juveniles of *Sarda orientalis* measuring from 63 mm. to 286 mm. are also figured and described in this paper. The change in the colour pattern from vertical stripes to horizontal bars are described. Based on the occurrence of the larvae the probable spawning seasons are also discussed. Apart from this the food and feeding habits of the larvae and juveniles of these two species are also included in the present account.

IV. OTHER PELAGIC RESOURCES

28. HOOK AND LINE PELAGIC FISHERY RESOURCES OF TIRUNELVELI COAST

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The hook and line fishery for large-sized pelagic fishes has been in existence along the Tirunelveli coast (Gulf of Mannar) for a long time. Long-lining for fishes such as sharks, carangids *etc.* which takes "stationary baits" is conducted during June-August while trolling for fishes such as seer, tuna, barracuda *etc.* which take only "mobile baits", is conducted during July-March. The grounds for these pelagic fishes are located about 20 to 40 km. off the Pinnakayal-Manapad sector with bases at Tuticorin, Virapandiapatnam and Manapad. Trolling is also conducted by fishermen of a few other centres while returning from sardine fishing in comparatively nearshore areas. From the data published as well as observations made in the past few years, it appears that there is considerable scope for increasing the present level of exploitation by mechanising the crafts and gear for venturing to further offshore areas.

29. PRESENT STATUS OF THE RIBBON-FISH FISHERY IN INDIA, WITH SPECIAL REFERENCE TO THE BIOLOGY OF *TRICHIURUS LEPTURUS* LINNAEUS

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The trend of ribbon-fish catches during the period 1968 to 1971 at a few important centres along the east and west coasts of India has been presented. Though *Trichiurus lepturus* forms the bulk of the catches of ribbon-fishes on an all-India basis, three other species, *viz.*,

Lepturacanthus savala, *Eupleurogrammus intermedius* and *E. muticus* also occur and contribute to the catches at several places. Biological data on age, growth, food and spawning habits available till date for *T. lepturus* are summarised incorporating the recent observations of the authors on this species off Mangalore, to highlight the pattern of occurrence and distribution of the species in the seas around India.

The total size range of *T. lepturus* in the commercial catches at important centres varies from 83 to 1115 mm. S. L. The modes at high sizes are usually associated with the occurrence of large shoals, the shoals normally composed of spent fish of limited size range. Fish about 500 mm. are mature. In most months almost all maturity stages occur indicating that the species has a prolonged spawning period. The food of the species mainly consists of clupeoid fishes, prawns and shrimps. The rate of growth is rapid, with a life span of about six years.

Unlike in certain other pelagic fishes, violent fluctuations in the catch of ribbon-fishes have not been noticed, the annual average yield being about 29,000 tonnes (1958-'67). The catch was of the same order in 1968 and 1970 but was higher in 1969 and 1971. For the fishery, along both sides of the sub-continent the second half of the year when larger fish are captured is more important than the first half. While shore seines and boat seines are the most important gear for the capture of ribbon-fishes, the catches by trawl nets operated from mechanised boats, especially off the west coast, are also important, since they consist of larger fish from deeper waters upto about 24 metres.

30. ON THE PELAGIC FISHERIES RESOURCES OF KANYAKUMARI DISTRICT, TAMIL NADU

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The 44 fishing villages of Kanyakumari district, spread along its 67·2 km. coast line, extending from Neroodi on the west coast to Kootapuly on the east coast of India have been considered in this paper. The fishermen population of the district is more than one lakh of whom 37,000 are actively engaged in fishing. The socio-economic conditions of the community is given.

The important pelagic fishes of the area are anchovies, sardines, round herrings, wolf herrings, spotted herrings, ribbon fishes, tunas, bill fishes, seer fishes, mackerel and carangids. This paper discusses their fishery resources in the area and the present state of exploitation. The present exploitation of the fishery resources in the district is mostly on traditional lines.

Dug-out canoes and plank-built canoes are used for operating shore-seines and catamarans for other gears like drift net, hooks and lines, boat seines and gill nets with different mesh sizes with separate names like '*Ral vala*', '*Netholi vala*', '*Chala vala*' and '*Vala vala*'. The indigenous crafts and gears used in the district have their own limitations. The advantage of fitting the out-board engines on '*catamarans*' which number about 15,000 in this district appears to be considerable. Other developmental activities needed for improving the lot of the fishermen community and the local fisheries are outlined.

There is vast potential for increasing the marine fish catch of the area.

31. PELAGIC FISHERY RESOURCES OF LAWSON'S BAY, WALTAIR

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The average annual landings of pelagic fish at Lawson's Bay, Waltair, are of the order of 600 tonnes. The bulk of the landings are by gill nets and hooks and lines. Boat-seines and shore seines rank next in importance. Sardines, seer fishes, anchovies, other clupeoids, mackerel, silver bellies and ribbon fishes are the important groups contributing to the pelagic fishery. The seasonal variations of the above important fish are discussed. There are large untapped resources of sardines, anchovies, ribbon fishes and seer fishes in the area.

32. ON THE INSHORE PELAGIC FISH STOCKS AT MADRAS

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The trend of fisheries as obtained from the catch rates of the boat seine and the hooks and lines at San Thome and Harbour, Madras, have been studied. For the boat seines while it ranged between 0·18 to 1·86 kg. per man-hour at San Thome, it was between 0·23 to 1·67 kg. per man-hour at Harbour; and it ranged from 0·27 to 1.50 kg. per man-hour when both the centres were considered together. Generally in all the years, the months of April to December witnessed peak catch rates.

The operation of hooks and lines was confined to San Thome only. The highest and the lowest values recorded during the entire period of investigation respectively were 1·18 and 0·32 kg. per man-hour. The most productive months for this unit were during May to December in any year.

Although 63 species were recorded, those that were characteristic of boat seines and hooks and lines were very few and those of economic or fishery importance much less. They have been listed. Majority of the species were pelagic fishes subsisting on planktonic items of food.

The observed fluctuations in the catch rates closely followed the fluctuations in the total volume of plankton which in turn reflected the fluctuations in the phosphate content of the inshore coastal waters.

33. THE INFLUENCE OF SOME ENVIRONMENTAL FACTORS ON THE FISHERY RESOURCES OF THE ANDHRA COAST

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The pelagic fishery resources of the Andhra coast seem to be influenced by the oceanographic conditions in the Bay of Bengal.

There is a reversal of current in the sea from the south-west monsoon to the north-east monsoon. Concurrently with the current reversal, other changes such as the dilution of water in the Bay of Bengal brought about by the large rivers and the occurrence of upwelling and sinking along the east coast seem to be of much importance. These environmental changes seem to have an impact on the seasonal fishery of the east coast as well as on the general abundance of plankton.

Besides some species that occur throught the year, the fishery of the rest can be generalised into three main types along the Andhra coast. Type 'A' are primarily associated with the waters of low salinity in the northern region of the Bay of Bengal. Type 'B' is primarily associated with the waters of southern part of Bay of Bengal which is characterised by the equatorial and upwelled waters of relatively high salinity. Type 'C' include crustaceans which are confined to the estuarine areas of Godavari and Krishna.

34. THE BOMBAY DUCK FISHERY OF MAHARASHTRA WITH SPECIAL REFERENCE TO VERSOVA

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AND

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The Bombay duck fishery, confined mainly to Maharashtra and Gujarat is supported mainly by a single species, *Harpodon nehereus*. The annual landings averaged about 14,000 tonnes in early fifties, and rose to over 100,000 tonnes in late fifties, but stabilised around 80,000 tonnes (forming about 10% of the annual marine fish catch of the country) from 1964 onwards. The Maharashtra catch stabilised around 30,000 tonnes in late fifties and the

Gujarat catch around 50,000 tonnes in early sixties. With mechanisation of craft there has been considerable increase in effort, but no rise in catches; and a marginal decrease in catch per unit of effort is observed.

The Bombay duck breeds throughout the year with peak in December-March. The precentage of mature fish in the catches at Versova has declined from 24 in 1959-'60 to 7 in 1970-'71. The average length varied from 168 to 223 mm. in 1957-'58 to 1960-'61, but from 169 to 179 mm. during 1967-'68 to 1970-'71. The bag net, the main gear used, fishes indiscriminately. The present situation indicates that overfishing, if not already set in, is around the corner.

35. ON THE CAPTURE FISHERY FOR DECAPOD CRUSTACEANS IN THE PELAGIC ZONE

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The most important crustaceans fished from the upper layers of the water belong to the family Sergestidae, Penaeidae and Portunidae. The species of *Acetes* which are found gregariously swimming near the surface waters, support a commercial fishery of substantial magnitude along Maharashtra, Kerala, Tamil nadu, Andhra and Bengal coasts. In Maharashtra alone, the species contributes to an annual average catch of 13,000 tonnes, forming about 19% of the prawn landings. Among penaeids, *Penaeus indicus* is known to swim at the surface during night, and to occur sporadically in shoals in the pelagic zone. The littoral portunids, *Portunus (Portunus) pelagicus* and *P.(Portunus) sanguinolentus* as well as some of the species of *Charybdis*, are also fished from the pelagic province. They form only a subsistence fishery at present, but the resources are abundant enough to give much larger catches. Recent surveys have also shown the existence of rich potential resources of the oceanic swarming crab, *Charybdis (Goniohellenus) edwardsi* off the west coast of India between Lat. 8° and 14° N, and from the western part of the Indian Ocean.

36. THE PELAGIC CEPHALOPOD RESOURCES OF INDIAN SEAS

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Squids, cuttlefishes and octopuses, collectively known as cephalopods, form one of the important molluscan sea food recources. Among them, the pelagic squids are heavily exploited in certain parts of the world. In the Mediterranean region, China, Japan, the Philippines, Far East and Oceania these are widely eaten as a delicacy. Reports indicate that in the recent years there has been growing awareness for cephalopods as a fishery resource. In fact, the world-wide production of cephalopods has increased from 630 thousand tonnes in 1964 to 1,180 thousand tonnes in 1968. The demand for cephalopods has also increased in the countries mentioned above which in 1970 alone imported more than 30,300 tonnes of cephalopod products worth 22·77 million US dollars. The cephalopod resources of Indian Seas are abundant, but remain to a large extent unexploited. The average annual production in India for the period from 1962 to 1971 is estimated to be only of the order of 780 tonnes. But the substantial increase in the production and demand for cephalopods in the world markets offer considerable scope for developing this latent resource.

37. PHYTOPLANKTON STUDIES IN THE WATERS OFF THE INDIAN COAST

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The phytoplankton research in India dates back to as early as 1903. However, studies with some continuity started only in 1923 on the west coast and in 1931 on the east coast. Most of these dealt with seasonal cycles and the distribution pattern of phytoplankton in general. Recently studies were also made to measure the organic

production in the Sea by Carbon isotope (C^{14}). Based on intensive investigations at Calicut, the magnitude of phytoplankton production on the west coast in relation to the fish landed has been assessed. It was found that the fish landed represents only a fraction of the total production that could be sustained by the phytoplankton and that increased fishing effort would result in higher production. The primary productivity studies have also indicated that the Gulf of Mannar and the Palk Bay are among the highly productive regions in the world. The inshore waters of the west coast have an average production rate which is slightly less than the above regions with the maximum production during the season of upwelling. This too indicates the possibility of a higher fish yield than at present. The potential annual harvest, as assessed from organic production, would be 2·0 to 2·5 million tonnes of fish for both the coasts.

38. THE CYCLONIC STORMS AND DEPRESSIONS FROM THE SEAS AROUND INDIA AND THEIR IMPACT ON THE PELAGIC FISHERIES RESOURCES OF THE COUNTRY

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The atmospheric phenomena play an important role at the interphase of the air-sea boundary. Among them, the storms and depressions are important and they exert great influence on the fishery resources of a maritime country.

The activities of the cyclonic storms and depressions of the east and west coast waters of India and their relationship with the pelagic fisheries resources of the country are discussed.

V. TECHNOLOGY OF EXPLOITATION AND UTILISATION

39. HYPOCHOLESTEROLEMIC EFFECT OF SARDINE OIL AND OIL SARDINE *(SARDINELLA LONGICEPS)*

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AND

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Much of the recent work on the possible cause of atherosclerosis and coronary thrombosis in humans has been concerned between these afflictions and raised cholesterol content of serum. During the last two decades, investigations have been carried out on the efficiency of fish-oils in reducing serum-cholesterol level. Investigation has established the effectiveness of marine oils in treatment of hypercholesterolemia in man, chicken, mice and rats.

Quantitatively oil sardine *(Sardinella longiceps)* is the most important marine fishery in India, constituting 20-30% of total marine fish landings. It is a fatty fish with a fat content of 11-16% during season. About 4,000 tonnes of sardine oil are produced in our country with a potentiality of 10,000 tonnes at the present level of landings. In view of the importance of oil sardine and sardine oil, Central Food Technological Reseach Institute, Mysore, in collaboration with Kasturba Medical College, Mangalore, initiated a research programme to test oil sardine fish and sardine oil including its fractions for their possible hypocholesterolemic effect.

Experiments were conducted with cholesterol-bile salt stressed rats. Rats were given diet containing 15% or 10% fat in the form of hydrogenated vegetable fat. During the test period of 6-8 weeks, 66·6% in the former case and 50% in the latter case was replaced by fish-oil either as such or in the form of fish. Sardine oil used was

prepared in the Pilot Plant of CFTRI Experiment Station, Mangalore, and had an FFA less than 0·5% and conformed to ISI specification.

With oil sardine fish, serum total cholesterol level was found to be 120 mg/100 cc (15% fat) and 121 mg/100 cc (10% fat) at the end of test period, while corresponding figure for control group given hydrogenated vegetable oil only was 322 (15% fat in diet) and 326 (10% fat). With sardine oil, serum total cholesterol was found to be 134 mg/100 cc (15% fat) and 168 mg/100 cc (10% fat). When winterised sardine oil with an I. V. of 168 was tried, serum total cholesterol level came down to 112 mg/100 cc (10% fat). With solvent winterised sardine oil (I. V. = 215), serum cholesterol level came down to 90 when only 25% of 10% fat in diet was replaced with it. There was also substantial decrease in free cholesterol level, ester cholesterol level and total cholesterol-phospholipid ratio in all the cases where hydrogenated vegetable oil was replaced with sardine oil, winterised sardine oil, solvent winterised sardine oil or oil sardine fish. Results clearly indicate the beneficial effect of sardine oil and oil sardine fish in controlling hyper-cholesterolemia in cholesterol-bile salt stressed rats.

Further investigation with human volunteers is in progress. However, on the basis of data obtained so far, it can be concluded that the present study opens a new possibility to utilise properly extracted sardine oil. The study further indicates the possibility of controlling hyper-cholesterolemia through the use of oil sardine.

40. USE OF SARDINE OIL IN OIL SARDINE PACKS

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Canned pack of sardine in oil is an important product of commerce in India and abroad. Olive oil, cottonseed oil, corn oil, and groundnut oil are generally used in such packs. However, fish oil is also used in many countries. In Norway, highly refined first class herring oil is used. Fish oil improves the flavour and increases the acceptability of the product. In our country due to high price of vegetable oil, use of fish oil in such packs has an added importance.

Sardine oil is the only fish oil in India which has got potentiality for such use. Traditionally produced commercial sardine oil with its inferior quality cannot and should not be used for the purpose. Oil should be carefully prepared and if required refined, and should conform to ISI specification (IS-5734-1970) for Grade I oil.

Central Food Technological Research Institute, Mysore, at its Experiment Station at Mangalore, carried out experiments to find out the possibility of using sardine oil in oil sardine packs. Sardine oil prepared from fresh oil sardine fish and with a free fatty acid less than 0.5% (as oleic acid) was used. Oil was filtered free of "Stearine" separated out at room temperature (25-30°C). The oil thus prepared was used as such and in combination with refined groundnut oil in various proportions. The products prepared were distributed to 75 persons of Mysore and Mangalore, who were selected on the basis of their familiarity with such products. Ninety three percent of the people declared the packs with sardine oil-groundnut oil mixture (1:1) as acceptable. Corresponding figure for the pack with sardine oil only was 84%. Of the six commercial packers to whom samples were sent, reports from five were favourable while one concern gave an adverse report. Change in free fatty acid content and visual colour of the oil of pack during storage was nominal. Products stored for 1 year were also found to be equally acceptable; however, sardine oil-groundnut oil combination (1:1) received the preference.

It appears that sardine oil-groundnut oil combination (1:1) can be used with success for oil sardine packs. Investigation on the use of sardine oil in packs of other varieties of fish is in progress.

41. CONVERSION OF A TRAWLER 'M. F. V. MEENAKHOJINI' INTO A PURSE-SEINER FOR CATCHING MACKERELS AND SARDINES

P. TAGORE

Deep Sea Fishing Station, Bombay-1

'M. F. V. Meenakhojini', a 17·5 m (57') steel vessel indigenously constructed was primarily designed as a fishing trawler. It was

proposed to see whether the same vessel could be converted into a purse-seiner with some alterations. The following alterations were made.

WEIGHTS REMOVED	*WEIGHTS TO GO ON BOARD*
1. Original derrick	1. Purse-seine net
2. Star-board gallow	2. Smaller derrick
3. Two outrigger boom	3. Purse gallow
4. Two otter boards	4. One skiff
5. Trawl nets	5. One Inflatable Life Raft

Stability tests were carried out and the alterations and addition of weights did not affect the stability of the vessel. The vessel did purse-seining off Goa during 1970-'71. Detailed results of the operation have been given and discussed in the paper.

PURSE-SEINE OPERATIONS

Date	No. of fishing days	No. of sets	Fishing grounds	Total catch in kgs.	Amount
12-10-70	5	2	15·73 1F	5834	10648
3-11-70	5	3	15·73 3E,3D.	9800	10928
11-11-70	5	4	15·73 3D,3E,4E.	2130	758
20-11-70	4	2	15·73 3E.	12525	5823
29-11-70	5	6	15·73 2E,2F.	11975	4712
16-12-70	4	2	15·73 3E,5F.	11245	4402
12-1-71	7	4	15·73 1F.	12335	3113

42. UTILIZATION OF SARDINES

P. MADHAVAN AND T. S. UNNIKRISHNAN NAIR
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Oil Sardine, *Sardinella longiceps* stands out as the single largest pelagic fishery in India contributing to about 30% of total marine fish landings. Commensurate with the volume of the fishery, efforts at proper utilization of the fish by processing into canned and frozen products or by distributing in fresh state to internal consuming centres by quick transport have remained rather very poor. The paper presents the problems and prospects with regard to the utilization of the fish on the above lines. Results of investigations made at C. I. F. T. on the utilization of sardine body oil into industrially useful products such as factice, vehicle for paints, additive in lubricating oil and base for printing ink have also been discussed.

43. CERTAIN TECHNOLOGICAL ASPECTS OF UTILISATION OF TUNA, SEER FISH AND ANCHOVIES

M. R. NAIR AND V. K. PILLAI
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Preliminary experiments have shown that storage in RSW (Refrigerated Sea Water) is an effective method for pre-process preservation of large sized pelagic fishes like tuna and seer fish compared to normal icing method. Biochemical differences between the red and dark meat of tuna and their amenability to freezing and frozen storage have been worked out. The method already standardised for canning of tuna meat in oil has been adopted for the large scale production of canned tuna in Kavaratti, Laccadive Administration. Development of techniques for canning of seer fish in oil and anchovies in oil and in sauce has helped to further utilize these fishes into diversified products. Modification suggested in the preparation of traditional product 'masmin' gave a product of longer shelf-life particularly by warding off mite infestation. Artificial solar dryer and multideck tunnel dryer developed at the Institute could be profitably employed to obtain dried anchovies of superior quality. Beach dried anchovies have been shown to be cleaned off the adhering sand content to an extent of over 80% in a mechanical cleaner designed for the purpose.

ABSTRACTS RECEIVED LATE

44. ON A COLLECTION OF OIL SARDINE EGGS FROM THE FISHING GROUNDS OFF COCHIN

T. R. CHANDRASHEKHARA GUPTA

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During a cruise on board 'M. V. Blue Fin' on 4th August 1972, a surface plankton haul was made at 1100 hrs at the station 9°58'N and 76°20'E. off Cochin and it yielded about 1,12,400 *Sardinella* eggs. The number of eggs per m^3 of water filtered was estimated as 927. The eggs were transparent and spherical in shape. The diameter of the eggs ranged from 1.08 to 1.37 mm; the majority measured 1.20 to 1.28 mm. The perivitelline space was wide. The yolk, more or less spherical in shape, varied in size from 0.71 to 1.20 mm, with the majority in the range of 0.71 to 0.91 mm. Most of the eggs contained only a single oil globule, but a few had two or even three. When single, the diameter of the globule ranged from 0.04 to 0.21 mm, with the mode at 0.12 to 0.13 mm.

The temperature of the surface water at the place of collection was 26.0°C and salinity 28.3°/$_{oo}$. Dissolved oxygen was 5.7 ml/l.

From the general characteristics as well as the various measurements, it is concluded that the eggs are those of oil sardine, *Sardinella longiceps* Val. A map showing the areas from where the oil sardine eggs have been recorded is also given. These areas may be regarded as part of the spawning grounds.

45. POSSIBILITY OF EXPLOITATION OF PLANKTON FROM THE SEA

T. S. S. RAO

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Among the pelagic resources, exploitation of zooplankton and phytoplankton, which constitute the largest volume of marine life, is

still in its infancy. The main hurdle for their exploitation is their diffused distribution and small size. A plankton collecting ship is estimated to yield about 125 kg. of dry plankton per day and another estimate puts the cost of producing a ton of dry plankton at $ 5040-8400, a prohibitive and an uneconomic figure.

The recent International Indian Ocean Expedition has revealed the existence of zooplankton in great abundance in some areas of the Arabian Sea and Bay of Bengal and it would be useful to initiate a pilot research project for developing new methods of exploiting plankton in such rich areas and also to produce artificially abundant plankton. Usefulness of plankton to man is discussed.

46. EXPLOITATION AND MANAGEMENT OF PELAGIC RESOURCES

M. KRISHNAN KUTTY

Regional Centre, National Institute of Oceanography, Cochin-18

The use of mathematical models has become one of the important methods of studying the exploited fish populations because of its great predictive value. Fish populations can generally be divided into two groups: those that can easily be overfished and those that can withstand fairly high fishing pressure. This feature of the population is largely dependent on the nature of recruitment of young ones to the adult stock. Generally different models are required for these two types of populations. The main drawback in applying some of these models to tropical fish populations is the difficulty of obtaining the estimates of growth and mortality rates. However, when these parameters cannot be obtained other models such as that of Schaefer or the stock recruitment relation of Ricker may still be used, especially if there are only a few year classes in the fishery.

Scientific management of a resource is particularly useful to stocks where the size of recruitment is maximum at some intermediate stock size. When recruitment is not related to stock size and fluctuations in abundance are also very large the estimate of the optimum fishing effort obtained from the simple Beverton-Holt model need not be strictly imposed.

47. ABUNDANCE OF CEPHALOPOD JUVENILES IN THE INDIAN OCEAN

P. N. ARAVINDAKSHAN AND M. SAKTHIVEL
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The cephalopod juveniles sorted out from the International Indian Ocean Expedition zooplankton collections reveal that they are present in 65% of the total collections from all over the Indian Ocean. They are abundant in the Bay of Bengal, south-west of Ceylon, off Kutch, South Arabian coast and the Somali coast. Of all these areas the Bay of Bengal accommodates the largest nursery in the Indian Ocean. The maximum percentage of frequency is found in the Bay of Bengal (80%) followed by the Equatorial zone (71%), the Somali Sea (71%), the North Arabian Sea (69%), the West Australian Sea (54%) and the South African Sea (25%). The highest abundance is noticed in the North Arabian Sea (8.7/haul) followed by the Bay of Bengal (7.0/haul), the Somali Sea (5.6/haul), the Equatorial zone (5.1/haul), the South African Sea (3.9/haul) and the West Australian Sea (3.0/haul). The cephalopod juveniles reach their peak abundance (5-10/haul) during the south-west monsoon period (April-September) in the Bay of Bengal and the Equatorial zone including the Somali Sea and in November-December (17.7-19.6/haul) and June-July (6.6-10.2/haul) in the North Arabian Sea. Similar seasonal cycles have been reported earlier along the west coast of India. The abundance of cephalopod juveniles in the Bay of Bengal indicates vast scope for the development of cephalopod fisheries in India.

48. ABUNDANCE AND DISTRIBUTION OF PENAEID LARVAE IN THE IIOE COLLECTIONS AS AN INDEX OF PENAEID PRAWN RESOURCES OF THE INDIAN OCEAN

V. T. PAULINOSE AND M. J. GEORGE
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Based on the study of the density of larvae of penaeids sorted out from 1927 plankton samples collected during the International Indian Ocean Expedition (1960-1965) an attempt is made to correlate

the occurrence and abundance of these larvae with the penaeid prawn fishery of the various regions, especially in the Arabian Sea and Bay of Bengal. Out of 1518 standard samples from which decapod larvae have been obtained, 353 samples contained larvae of prawns of the family Penaeidae. Larvae of several of the genera and species of commercial importance in the coastal areas of the Indian Ocean have been identified from the collections in the work carried out so far. Developmental stages of nearly 16 species belonging to 10 genera have been located in different areas. Particular mention may be made about the identification of most of the larval stages of the deep water prawn *Penaeopsis rectacuta* Bate. Larvae of penaeid species are found in large numbers in the Bay of Bengal, more especially in the waters around the Andaman and Nicobar Islands and off the Madras coast, in the west coast of India, mainly in the Gulf of Kutch region and Malabar coast and off Somali coast, indicating the possibility of higher concentrations of the adults in those regions which are likely to prove highly potential grounds for the prawn fishery.

49. ON THE DISTRIBUTION OF LARVAE OF SOME OF THE PELAGIC FISHES IN THE ARABIAN SEA

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The distribution and seasonal variation of the larvae of Clupeidae, Engraulidae, Synodontidae, Exocoetidae, Bregmacerotidae, Carangidae, Stromateidae, Coryphaenidae, Trichiuridae, Gempylidae, Scombridae, Scomberomoridae and Thunnidae have been discussed in this paper based on the 694 collections (vertical hauls from 200-0 m) made during the International Indian Ocean Expedition. Majority of the collections (88%) are from the offshore and oceanic waters and hence coastal species are not well represented.

Though 92% of the samples contained fish larvae, the above groups in total are represented only in about 13% of the collections with a seasonal coverage of twelve months of the year. Three peak

periods of abundance have been noticed, one in July, next in November and the third in April. The south-west and north-east monsoons seem to play an important role in the distribution of larvae of these groups. The larvae of some of the coastal fishes especially Engraulids are found in the offshore waters too. Bregmacerotidae, Carangidae and Stromateidae though found in large numbers in the offshore waters, are also present in the oceanic and coastal areas. Among Scombroids, Thunnidae and Scomberomoridae are mainly collected from offshore and oceanic regions, their concentrations being along the equatorial zone. Scombridae are recorded from two regions, Red Sea and Persian Gulf. Exocoetidae, Coryphaenidae, Trichiuridae and Gempylidae are concentrated mainly in the offshore and oceanic waters. Engraulidae, Bregmacerotidae, Carangidae, Stromateidae, Gempylidae, Scomberomoridae and Thunnidae are found in almost all months of the year.

50. EXPORT POTENTIALITY FOR PELAGIC FISHES

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The paper deals with the export potentiality for the major groups of pelagic fishes such as oil sardine, mackerel and tuna, and makes definite recommendations for a better preservation and processing of the catch once it gets ashore. Further, it emphasizes the need to undertake studies relating to economic and marketing aspects of the export potential of the canned oil sardine, tuna and mackerel. The paper also highlights the urgent need for diversification of products by our processors and exporters and lays stress on the importance of quality control and pre-shipment inspection of fish and fishery products which constitute important commodities in international trade.

51. PLANNING FUTURE RESEARCH ON PELAGIC MARINE FISHERIES

G. N. MITRA

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Exploitation of pelagic marine fisheries in India is confined to the inshore zone and the gear is almost entirely manually operated. According to an available estimate the production of pelagic fish from one square mile of inshore sea area up to the 10 fathom contour is 37·59 tonnes as against 32 tonnes for the rest. The principal fisheries are the oil sardine, Indian mackerel, anchovies, Hilsa, Bombay duck, ribbon fish, Frigate mackerel, mackerel tuna, seer, skipjack and possibly the juveniles of yellowfin tuna. Some of these fish are also partly demersal in their habit.

It is generally known that at the present level of fishing effort, there is no apprehension of depletion of any of these stocks. The immediate problem of research is the study of the behaviour of these fishes with particular reference to speed of movement both horizontal and vertical, temperature preference and reaction to colours. This study is essential to evolve more specific and effective gear, which would, in its turn, determine the type of craft.

On a long term basis the study of the delimitation of stocks in each fishery and composition of the catch as to year groups is an essential requisite for Management Research, besides completion of our knowledge on the life history and bionomics. The paper outlines some specific problems of research on major pelagic fisheries.

AUTHOR INDEX

(ABSTRACT NUMBERS INDICATED)