THE INDIAN MACKEREL *RASTRELLIGER KANAGURTA* (CUVIER) AN ANNOTATED BIBLIOGRAPHY

A. Noble
P. Geetha

CMFRI SPECIAL PUBLICATION
Number 52

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
(Indian Council of Agricultural Research)
P. B. No. 2704, Dr. Salim Ali Road
Cochin - 682 031, India

DECEMBER 1992

Published by

Dr. P. S. B. R. James
Director

Edited by

Dr. K. J. Mathew
Mr. K. N. Krishna Kartha
Mr. K. Kanakasabapathy

Editorial Assistance

Mrs. P. Geetha
Mr. K. Solomon

Price

Rs. 45 US $ 15

PREFACE

Research and development activities on marine fisheries of the country have contributed to a rapid increase in accumulation of literature. Recently, for the benefit, largely of the community of research workers and fishery managers, bibliographies on important resources like the prawns, oil sardine and silverbellies have been published by the Institute. The present issue on the Indian mackerel, *Rastrelliger kanagurta* (Cuvier) will be a valuable addition to the series of 'Annotated Bibliographies' being issued by the Institute.

Efforts have been made to include all the relevant literature in these bibliographies. There could be some omissions and so the bibliography is not claimed to be complete in itself. The Institute would welcome information on omissions of any citation.

Annotations have been done carefully to give at a glance the contents of the original publications. Wherever the authors' abstracts were found sufficient, these were reproduced as such and in other cases the available abstracts were modified or fresh ones made based on the contents of the original articles.

The bibliography mainly includes the work done in the Indian region. However, a few references pertaining to the species from the adjacent seas are also referred to. I hope this will be useful for the scientists and others in the field by enabling them to have a rapid survey of relevant literature.

I appreciate the interest taken and efforts made by Dr. A. Noble, Principal Scientist of the Institute who has been investigating on the mackerel resource during the past three decades and Mrs. P. Geetha of the Library and Documentation Section for the compilation of this annotated bibliography.

Cochin - 682 031,
30 - 11 - 1992.

P. S. B. R. JAMES
DIRECTOR

CONTENTS

I. FISH AND FISHERIES

1. ABDUL NIZAR M, BALACHANDRAN K, BANDE V N, GEOGRE K C, GOPINATHA MENON N, GRACE MATHEW, JAYAPRAKASH A A, KESAVAN ELAYATH, NARAYANAN KUTTY V A, NARAYANA SWAMY J, NOBLE A, PUTHRAN PRATHIBHA, REGHU R, SIVAKAMI S, SOMASEKHARAN NAIR K V 1988. Marine fish calendar 4. Cochin. *Mar. Fish. Infor. Serv. T & E Ser.*, No. 82, p. 1 - 23.

   Particulars of Indian mackerel are given with a figure of the fish. Based on the data collected during 1981 - '85 it is stated that *R. kanagurta* formed 11% of the total catch. Figures showing their seasonal abundance (purse seine & drift net) are also given.

2. AGGER P 1973. Yemen Arab Republic. Fishes and fisheries. A report prepared for the FAO Food and Nutrition Programme. *FAO- FI-DP-YEM*-71-513-1, 49 pp.

   The artisanal coastal fishery is considered and King fish (*Scomberomorus commersoni)* and Indian mackerel (*Rastrelliger kanagurta*) are stated to be the main components.

3. ALAGARAJA K 1987. An appraisal of the marine fisheries of Lakshadweep and Andaman & Nicobar Islands. *CMFRI Special Publication* No. 39, 20 pp.

   Landings of the Indian mackerel in Andaman islands during 1975 to 1984 are given in tables.

4. ALAGARAJA K, BALAN K, SCARIAH K S, VIJAYALAKSHMI K, JOSEPH ANDREWS, PRASAD C J 1992. Marine fish production of maritime states of the west coast of India. *Bull. Cent. Mar. Fish. Res. Inst.*, No. 45, p. 38-55.

   Information on mackerel landings, state by state along the coast is given. Tables provide the catch during 1984 to 1988. Gearwise split up of catch is presented.

5. ALAGARAJA K, YOHANNAN K C, AMMINI P L, PAVITHRAN P P 1987. An appraisal of the marine fisheries in Andhra Pradesh. *CMFRI Special Publication* No. 33, 52 pp. and Appendix.

   Data on mackerel is included in the quarterwise and specieswise marine fish landings in the state during 1975 - '84 tabled in Appendix. For 1980 - '84, gearwise data is also available. Landings of small trawlers at Visakhapatnam Outer Harbour and Kakinada Fisheries Harbour during 1980 - '84 form another 2 tables. Districtwise percentage catch of marine fishes including mackerel form part of the body of the text. Groupwise contribution expected in 2000 AD in Andhra Pradesh in marine sector discussed considers the case of mackerel too.

6. ALAN R LONGHURST, WARREN S WOOSTER 1990. Abundance of oil sardine (*Sardinella longiceps*) and upwelling on the southwest coast of India. *Can. J. Fish. Aquat. Sci.*, **47** : 2407-2419.

While dealing with the oil sardine landings on the Malabar coast during 1900-1986 in time series, data for mackerel during 1925- '86 and anchovy during 1963-'86 were also incorporated. The success in sardine fishery is statistically related to sea level at Cochin just prior to onset of the monsoon. Sea level at this time indicates remote-forcing of upwelling, rather than the wind-driven upwelling that occurs during the monsoon. Unusually remote-forcing appears to inhibit subsequent recruitment perhaps through exclusion of spawning fish from the neritic zone by oxygen defecient upwelled water. Correlation between landings of both mackerel and anchovy with monthly sea level incidentally is much weaker than for oil sardine and shows no seasonal pattern although these are also shoaling species taken in the same fishery during approximately the same season as that of oil sardine. Influence the ecology on these resources are indicated as probable reasons for this. The paper is well supported with good illustrations.

7. ALIKUNHI K H, GEORGE P C 1969. A national co-operative programme for mark-recovery studies on commercially important marine fishes of India. *Proc. Symp. Indian Ocean*, New Delhi, 1967. NIS/Incor; *Bull. natn. Inst. Sci. India* 38 (2) : 778-785. *Int. Indian Ocean Exped. Newsl*, **4** (4) : 2 (Abstract) 1967.

A workable programme of large scale tagging of mackerels and sardines from different centres with specific objectives, has been outlined in the abstract. The relative merits of different types of tags that could be considered for large scale tagging have been discussed. The feasibility of adopting similar programmes on other important species is also indicated in the paper.

8. ANON 1949. Marine fisheries of India. *Proc. Indo-Pacif. Fish. Coun. 1st meeting, Sec.*, **3**, p. 73-81.

In this brief report on the proposed function of the then established Marine Fisheries Research Station on the south east coast of India, with three sub-stations on the west coast, at Bombay, Calicut and Karwar; mention is made about the importance of mackerel as a resource and the need for information to be generated for the development of its fishery. The trend then existed of the mackerel at Karwar, is also given.

9. ANON 1953. Annual Report of the Chief Research Officer for the year ending 31st March, 1953. *Indian J. Fish.*, **1** : 377-401.

The percentage of yield of mackerel for 1950, 1951 and 1952 are given on p. 382. The mackerel investigations at Karwar showed that the fishery was a partial failure, the landings totalling 736 tons as compared to about

1,500 tons in 1951. The average size of mackerel during different months of the season was also studied.

10. ANON 1955. Annual Report of the Chief Research Officer, for the year ending 31st March, 1954. *Indian J. Fish.*, 2 (1) : 373-404.

The catch data and percentage of mackerel for nine centres are given. Bulk of the catch of mackerel during the year 1953 was from Karwar and Calicut. At Karwar the mackerel was the fish of the year, constituting nearly 81% of the total catch.

11. ANON 1956. Annual Report of the Chief Research Officer for the year ending 31st March, 1955. *Indian J. Fish.*, 3 : 387-435.

The mackerel fishery was a failure in 1954 forming 4.8%. The percentage composition of landings for the year 1950, 1951, 1952, 1953 and 1954 is given on p. 398.

12. ANON 1957. Annual Report of the Chief Research Officer for the year ending 31st March, 1956. *Indian J. Fish.*, 4 : 387-418.

Landings of mackerel for the years 1954 and 1955 with percentages are given on p. 397. Catches of mackerel showed a decline during the year 1955.

13. ANON 1957. Annual Report of the Chief Research Officer for the year ending 31st March, 1957. *Indian J. Fish.*, 5 : 402-439.

Annual landings of mackerel for the period 1955 and 1956 are shown on p. 411. The catches of mackerel showed some decline in 1956 which was mainly due to the failure of fisheries on the Malabar and Kanara coasts.

14. ANON 1957. The biology of the Indian mackerel — a critical appraisal of accumulated data. *Central Marine Fisheries Research Institute.* RTC/63. IPFC. *Rastrelliger* Centre, Bangkok.

The mackerel is a plankton feeder feeding on copepods, diatoms, dinoflagellates and also blue green algae. The fish is said to spend much of the feeding time nearer the bottom when in inshore waters.

15. ANON 1959. Lecture notes — *International Training Centre on the Methodology and Techniques of Research on Mackerel (Rastrelliger)*, Bangkok, Thailand, 20 October - 28 November 1958, FAO/59/2/1404.

Detailed methodologies in the study of fishery, biology, population etc. by various authors like Gulland, Holt, Tiews and Rao are included. Some information on craft and gear for mackerel fisheries in Malaya is provided by a participant. A critical appraisal of accumulated data and some pointers towards the reformulation of objectives in *Rastrelliger* research — a compilation made at Mandapam in 1957 — are also available.

16. ANON 1959. Annual Report of Central Marine Fisheries Research Institute — 1958. *Indian J. Fish.*, **6** : 416-460.

Landings of mackerel for the period 1956 and 1957 are given on p. 429. The mackerel fishery was highly successful in 1957 and the total catch was the highest since 1951.

17. ANON 1960. Annual Report of the Chief Research Officer of Central Marine Fisheries Research Institute for the year ending 31st March, 1960. *Indian J. Fish.*, **7** (2) : 496-552.

Landings of mackerel for the years 1958 and 1959 are given on p. 506. Mackerel fishery was a failure in 1959 which accounted for 31% of the gross decrease during the year.

18. ANON 1961. Annual Report of the Director for the year ending 31st March, 1961. Central Marine Fisheries Research Institute, Mandapam Camp. *Indian J. Fish.*, **8** (2) : 449-525.

Annual landings of mackerel for the period 1959 and 1960 are given on p. 457. The total catch of mackerel exceeded even that of 1958 and was the highest since 1950.

19. ANON 1962. *The Wealth of India —Raw Materials.* Vol. IV, Supplement, Fish and Fisheries. Council of Scientific and Industrial Research, New Delhi, 132 pp.

Rastrelliger kanagurta is included in the list of economic fishes, giving its local names, distribution, characters etc. A sketch of the fish is also furnished. Description and annual landings for 1950 to 1959 are provided.

20. ANON 1962. Fisheries. In : *Handbook of Animal Husbandry.* Indian Council of Agricultural Research, (Reprint 1985), p. 716- 717.

A brief description of the fishery of mackerel in India is included, giving the distribution, season, fluctuations in catch, size, occurrence in the estuarine waters etc.

21. ANON 1962. Annual Report of the Director for the year ending 31st March, 1962. Central Marine Fisheries Research Institute, Mandapam Camp. *Indian J. Fish.*, **9** (2) : 746-82.

Landings of mackerel for the period 1960 and 1961 are given. The fishery was a failure during 1961.

22. ANON 1963. Annual Report of the Director for the year ending 31st March, 1963. *Indian J. Fish.*, **10** (2) : 667-717.

Annual mackerel landings for 1961 and 1962 are given. Mackerel catch declined by about 5,000 tonnes during 1962. Biological aspects like size, stages of maturity and food and feeding habits were studied.

23. ANON 1967. Tagging of the spiny lobsters, mackerel and oil sardine. *Souvenir, 20th Anniversary, Central Marine Fisheries Research Institute,* (Appendix VII) 1967.

The particulars of experimental tagging carried out by the Institute are given, including the steps taken in its publicity for the sake of recovery.

24. ANON 1967. Tagging experiment for sardine and mackerel. *Seafood Trade J.,* **2** (11) : 35-37.

Giving a summary on the activity of the National Tagging Programme under Central Marine Fisheries Research Institute, the article says about the importance of tagging experiments in fisheries research, particularly of mackerel and sardine.

25. ANON 1969. Marine fish production in India, 1950-'68. *Bull. Cent. Mar. Fish Res. Inst.,* No. 13, 144 pp.

This is a mimeograph presenting (in tables) and discussing the annual and quarterly trends in marine fish production in the maritime states and union territories for a period of nineteen years commencing from 1950 as estimated by the institute. Statistics of fishing villages, fishermen population, fishing craft, mechanised/motorised fishing vessels and exports of marine products from India during 1960-'68 are given in appendices.

26. ANON 1969. *Annual Report for* 1969. Central Marine Fisheries Research Institute, Cochin, 94 pp.

The mackerel fishery showed a recovery in 1969 after eight years. The catch recorded the highest yield since 1960. The total estimated landings during 1968 and 1969 and landings at the different major observation centres of the west coast during the year, in comparison with the totals of the previous two years are given. The best monthly catches at the different centres during 1969, the total length-ranges, the modal sizes noticed at the different centres during different parts of the year and stages of maturity of the fish are studied.

27. ANON 1970. Marine fishery resources of India. *Symposium on Development of Deep-sea Fishing, 3-5 February, 1970, Cochin, Proceedings,* p. 55-79.

The composition of the all-India marine fish landings including mackerel during the period 1964-'68 and the variety-wise composition of the fish catch from the inshore area of each maritime state are given in tables.

28. ANON 1970. The Indian mackerel. *Bull. Cent. Mar. Fish. Res. Inst.,* No. 24, 102 pp.

A review of the work so far done on Indian mackerel is presented in this mimeograph, giving the identity of the fish, distribution, bionomics and life history, population, exploitation etc., as had been recorded by different authors. The concepts hitherto existed regarding the age, rate

of growth, breeding behaviour etc. are modified and a future line of research is suggested. Figures, tables and plates are furnished.

29. ANON 1970. *Annual Report for* 1970. Central Marine Fisheries Research Institute, Cochin, 104 pp.

An all time record catch of 147,038 tonnes of mackerel was recorded in 1970. Total estimated landings of mackerel for 1969 and 1970 are given. Statewise landings of mackerel for the two years are given in table.

30. ANON 1971. *Report of the Working Party on Sardine and Mackerel Resources.* Indian Council of Agricultural Research, New Delhi, 52 pp.

Reviewing briefly the status of knowledge so far generated on the biology and fishery of mackerel and sardine including the common names, distribution, food and feeding habits, migrations and shoaling behaviour, maturity, fecundity, spawning, eggs, larvae, juveniles, size, age, growth, fishing season, fishing area, gears used in India, factors responsible for fluctuation in the fishery and the percentage of fish of different sizes caught at 4 different places, the report recommends a future line of work to be adopted for enhancing the yields of the resources. Maps are presented to show the distributions of surface temperatures and salinities, relative abundances of mackerel and sardine and their modal sizes and year classes.

31. ANON 1971. The R/V *Sardinella* and her work from June to October 1971. *UNDP/FAO Pelagic Fishery Project, Progress Report,* No. 1, 14 pp.

Large adult mackerel in good condition were caught from mid August onwards with purse seine. The fish was observed as more numerous in the northern part generally 6 to 20 miles offshore, only at Cannanore where its schools were seen nearer to the shore.

32. ANON 1971. *Annual Report for* 1971. Central Marine Fisheries Research Institute, Cochin, 69 pp.

Mackerel fishery showed a significant increase in 1971. The catch was estimated at 184,815 tonnes which is an all time record. Estimated mackerel landings in India, state-wise composition during 1970 and 1971, month-wise total catch at the various centres during 1971 are shown in tables. Data on some biological aspects are also given.

33. ANON 1972. Five year plan of work. *UNDP/FAO Pelagic Fishery Project (IND 93),* 16 pp.

Explaining the purpose of the project, namely the process of assisting through resource surveys in the development of pelagic fisheries in the southwest coast and the various activities of the programme with particular reference to the objectives and methodology, the report presents briefly the status of knowledge regarding the life history of

mackerel at the time. Spawning season, growth rate, feeding habits, occurrence etc., are mentioned. Estimated seasonal landings of mackerel in Kerala, Mysore and Maharashtra are shown in graph.

34. ANON 1972. *Annual Report for* 1972. Central Marine Fisheries Research Institute, 86 pp.

The landings of mackerel during 1972 declined considerably after a record increase in the landings during 1971. Estimated landings during 1971 and 1972, statewise composition, estimated monthly landings (in tonnes) at different centres are shown in tables. Studies on maturity stages, food and feeding habits are also furnished.

35. ANON 1972. Results of 1972 aerial survey. *UNDP/FAO Pelagic Fishery Project (IND 69/563), Progress Report,* No. 4, 16 pp.

In early October, a narrow, nearly continuous belt of 6 to 20 miles offshore, with numerous surface schools of mackerel and sardine, extending for at least 200 miles from Karwar and southwards were located. The shoals comprised of small mackerel of average 10 g weight and the assessment of observed schools amounted to 73,000 tonnes. It is concluded that this estimate if extrapolated to the time of capture, would indicate resource of atleast twice the season's catch, and probably several times larger.

36. ANON 1973. Results of the first year's survey with the *Sardinella. UNDP/ FAO Pelagic Fishery Project (IND 93), Progress Report,* No. 2, 40 pp.

Reviewing the survey work done by the project during its first year of sea operations ending September 1972, the article reports that the mackerel schools were present in shallow waters from November to April, which moved to deeper waters with the beginning of upwelling. After the SW monsoon, migrations towards the coast started again. Spawning is stated to have taken place from March to September, with the most intense spawning probably in the pre-monsoon period. A more-offshore fishing during the beginning and end of the fishing season is suggested for better results. The sampling stations and the data of sampling are tabulated. Monthwise observations of mackerel schools, echo surveys and the cruise track with fishing stations are furnished.

37. ANON 1973. Biological sampling data and catch statistics of mackerel and oil sardine from different fishing centres during the seasons 1971/72 and 1972/73. *UNDP/FAO Pelagic Fishery Project, Progress Report (IND 93),* No. 5, 11 pp.

The catch statistics and biological data collected for determining vital parameters of the exploited mackerel resources in co-operation with the directorates of fisheries of Kerala, Mysore and Goa at 13 centres on the south west coast of India are reported. The occurrence of mackerel fry in the pelagic trawl catches during Apr.-Jun. 1972 and Mar.-Jul. 1973 is

pointed out in support of the hypothesis that the pre-monsoon spawning season was the most important for the Indian mackerel. Map of sampling centres and histograms showing estimated monthly landings of juvenile and adult mackerel are given. Monthly length-frequency distributions and monthly mean lengths of mackerel and main growth curves are shown in graphs. Monthly distribution of sex ratio and maturity stages of mackerel at Karwar, Malpe, Tellicherry and Cochin during the period 1971-'73 are tabulated. From the observations, the mackerel is suspected to be a short- lived species having a rapid growth and a rather restricted longevity, reaching sexual maturity at the end of their first year of life.

38. ANON 1974. Survey results 1972/73. *UNDP/FAO Pelagic Fishery Project (IND 69/593), Progress Report*, No. 6, 64 pp.

The results of the echo surveys and fishing experiments carried out during 1972/1973 by two project vessels *Sardinella* and *Rastrelliger* are presented, indicating the occurrence and the schooling behaviour of mackerel. Presence of surface ripples is stated to have helped in distinguishing mackerel schools from others. The observation is also claimed to have provided sufficient indication to the spawning of mackerel in the area during 1973 as having taken place in Feb.-Jun.

39. ANON 1974. Plankton, fish eggs and larvae studies. *UNDP/FAO Pelagic Fishery Project (IND 69/593), Progress Report*, No. 7, 21 pp.

Based on 1,388 standard plankton samples collected from September 1971 to August 1973 and about 100 shallow-water plankton samples from 50 stations during July-August 1973, the occurrence of mackerel larvae in November as well as from April to September all along the coast from Tuticorin to Ratnagiri is reported, inferring a possibility of spawning over an extended period and area. Post-larvae and early juveniles (2-10 cm) are stated to have been occurring on the shelf from March to August within 8° - 16° N, where the depth was upto 50 m, indicating this to be the nursery ground of the fish. The sampling stations and the other data of sampling are tabulated, and maps are given, showing the isopleths of plankton and larval densities and positions of samplings.

40. ANON 1974. Results of the 1973 aerial survey. *UNDP/FAO Pelagic Fishery Project (IND 69/593), Progress Report*, No. 8, 11 pp.

Based on aerial survey supported by simultaneous sea-borne observations with 7 vessels, the mackerel stock in 1973 is stated to have been assessed to be about 450,000 tonnes. The distribution of fish schools and the flight and cruise tracks are shown in maps. The purse seine catches and the number of schools and their sizes (in m^2) as estimated sub-areawise from aerial photos and echo recordings are given in tables.

41. ANON 1975. Results of the 1974 aerial survey. *UNDP/FAO Pelagic Fishery Project (IND/69/593), Progress Report*, No. 9, 10 pp.

The results of surveys conducted in 1974 from an aircraft as well as several vessels along the coast from Goa to Trivandrum and from 6 vessels along the coast between Trivandrum and Ratnagiri are reported. The surveys have shown the mackerel stock as relatively small. As was deduced from sonar observations, the most abundant area of mackerel was south of 12° N, 80% of which being between 10° 30'N and 12° N. The stock is assessed to be roughly 10,000 tonnes. A comparative discussion is given on the 3 aerial surveys, conducted in 1972, 1973 and 1974. Tables showing the flight records, the observed school areas, computed school numbers and volumes are given, as well as figures on flight and cruise tracks, length frequency, school distribution etc.

42. ANON 1975. Young fish studies. *UNDP/FAO Pelagic Fishery Project (IND/69/593) Progress Report*, No. 10, 14 pp.

Based on pelagic trawling during June 1971-December 1974, mackerel juveniles are reported to be distributed almost all over the area between Tuticorin and Ratnagiri. Fish egg and larval surveys are stated to have shown the mackerel larvae occurring in the shelf waters in most of the months. The data on density distributions pooled for 1972-'74, are presented in 3 charts to represent the average pictures for February-April, May-July and August-October periods. Modal sizes in the samples are said to have been indicating the possibility of multiple broods. Distribution and abundance of young mackerel, relative abundance during the period, and the size distribution are given in figures.

43. ANON 1975. Survey of mackerel and sardine schools in 1975. *UNDP/FAO Pelagic Fishery Project (IND 69/593), Progress Report*, No. 11, 8 pp.

The report is on the sonar observations made from R. V. *Rastrelliger* between Ratnagiri and Trivandrum. The distribution of schools and densities, and the biomass estimated are given. The estimated biomass of mackerel is given approximately as 300,000 tonnes. The volumes, numbers and weights of schools are estimated and tabulated, and the cruise tracks of R. V. *Rastrelliger* and the length distribution of mackerel during September-October 1975 are shown in graphs.

44. ANON 1975. Survey results 1973/'74. *UNDP/FAO Pelagic Fishery Project (IND 69/593), Progress Report*, No. 12, 32 pp.

The results of echo surveys and fish samplings carried out from September 1973 to October 1974 are presented. Better catches were between 9° and 10° N. Observations have shown the fish confined only to the shelf waters. Trawl catch composition, percentage weight proportion in purse seine catches, length distribution, sex ratio and maturity condition are tabulated.

45. ANON 1975. *Annual Report for 1975*. Central Marine Fisheries Research Institute, Cochin, 109 pp.

The mackerel catch increased by about 8,500 tonnes during 1975. Mackerel landings in India during 1974 and 1975 are tabulated and landings for the period 1971 to 1975 are shown in histograms. The age composition, cpue (in Nos) of mackerel at different centres during 1973-'74, 1974-'75 and the cpue (in Nos) of mackerel of different age groups at important centres in the second halves of 1974 and 1975 are also given.

46. ANON 1976. Survey results 1974/'75. *UNDP/FAO Pelagic Fishery Project (IND 69/593), Progress Report*, No. 13, 30 pp.

The survey had covered the area along the south west coast and Gulf of Mannar. Mackerel was found mostly distributed in the upper layers. Most of the catches were taken during March/July. Visual and acoustic observations are said to have indicated that the species remained in the shelf waters year round. Figures and tables for the data base are given.

47. ANON 1976. Catch statistics, growth and sexual maturity of mackerel and oil sardine as analysed from data collected at fishing centres on the south west coast of India. *UNDP/FAO Pelagic Fishery Project, (IND/593), Progress Report*, No. 14, 12 pp.

The data pertains to 1973/'74 and 1974/'75, based on samplings of commercial catches in Goa, Karnataka and Kerala. Though the reliability of the survey itself is doubted, it has been claimed that the results were sufficient to show that the mackerel landings had increased in 1973/'74 and dropped severely in 1974/'75. The data on maturity are said to have indicated spawning throughout the year except in November and December, the peak period being 2-3 months preceding the monsoon. Calculated age and length at first spawning are given. Tables, map, histograms and graphs for the data base are provided.

48. ANON 1976. Plankton, fish eggs and larvae studies. *UNDP/FAO Pelagic Fishery Project (IND 69/593), Progress Report*, No. 17, 22 pp.

The results of plankton work carried out from September 1973 to September 1975 and some overall results of eggs and larvae surveys for the whole project period (1971-'75) are reported. Mackerel larvae are stated to have formed about 10% of the scombroid larvae occurring in greater abundance in March-August and November. The area within 8° - 15° N, especially the southern part, appeared the main spawning area. Larvae were also found, though in small numbers, in the Wadge Bank. Tables and figures are given to show the larval distribution.

49. ANON 1976. A synopsis of the information on pelagic resources along the south west coast of India. *UNDP/FAO Pelagic Fishery Project, (IND 69/593), Progress Report*, No. 18, 18 pp.

The report on the project's activity during 1971-'75, records an observation of mackerel spawning from April to October, with peak in April-May. Larvae and juveniles are stated to have been observed

between 9° and 13° N along the 30 m depth line. Modal sizes of mackerel observed are plotted.

50. ANON 1976. *Annual Report for* 1976. Central Marine Fisheries Research Institute, Cochin, 123 pp.

The mackerel catch increased during 1976 by about 20,000 tonnes than that of 1975. Estimated landings during 1975, 1976 and the cpue of the mackerel of different age groups at important centres of observations in the second halves of 1975 and 1976 are shown in tables. Landings during 1971-1976 are also shown in histograms.

51. ANON 1977. *Indian Fisheries* — 1947-1977. Issued on the occasion of the 5th Session of the Indian Ocean Fishery Commission held at Cochin from 19th to 26th of Oct. 1977. CMFRI/MPEDA.

A comprehensive available information on the fishery, biology and population is given. Studies on the exploited resource indicate that scope for further increase in production from coastal zone employing traditional and artisanal methods during conventional season is just marginal. It further says that the resource in offshore area still remains untouched and hence has chance for development.

52. ANON 1977. *Annual Report* 1977. Central Marine Fisheries Research Institute, Cochin, 148 pp.

The landings of mackerel during 1977 declined by about 3,400 tonnes as compared to 1976. Estimated landings for 1976 and 1977 are given. Landings during 1972-1977 are shown in histograms. The cpue in numbers of the mackerel of different age groups at important centres of observations in the second half of 1976 and 1977 is also given in table. Statewise composition of landings during 1977 is also presented.

53. ANON 1978. Trends in total marine fish production in India in 1977. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 2, p. 2-3.

Statewise marine fish landings in India in 1976 and 1977 and specieswise landings in 1977 are given. The catch of mackerel in 1977 showed a marginal decrease as compared to 1976.

54. ANON 1978. Marine fish production in India during January to June 1978. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 2, p. 4-12.

The monthwise total landings of marine fish in the various maritime states of India (excluding Andamans and Lakshadweep) and the species-wise catch details for the period January to June, 1978 are presented. Figures and tables are given.

55. ANON 1978. *Annual Report* 1978. Central Marine Fisheries Research Institute, Cochin, 151 pp.

The catches of mackerel improved by about 23,000 tonnes in 1978 as

compared to that of 1977. The estimated landings during the two years are given. Landings of mackerel during 1969 to 1978 are shown in histograms.

56. ANON 1979. Marine fish production in India during July to September 1978. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 5, p. 1-9.

The total marine fish production in India (excluding Andamans & Lakshadweep) for the period July to September 1978 is given. The monthwise total landings of marine fish in the various maritime states of India and the specieswise details of landings for the period are shown in tables and the figure given.

57. ANON 1979. Small-scale fisheries at Lawson's Bay, Waltair. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 6, p. 10-13.

Rastrelliger kanagurta is reported to form 2.9% in the pooled data for 9 years during 1970-'78. Gearwise catches in these years are provided in six tables. Bottom set gill net contributed the major share in the catches of mackerel.

58. ANON 1979. Trends in total marine fish production in India — 1978. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 9, p. 7-22.

Composition of marine fish landings in India during 1978 is given. The mackerel landings showed an increase of about 23,000 t as compared to 1977. The total all India marine fish production and its species composition for the years 1969 to 1978 given show the minimum in 1974 and maximum in 1971. The landings of mackerel during 1969 to 1978 are shown in histograms.

59. ANON 1979. Marine fish production in India during January to June 1979. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 11, p. 1-9.

The monthwise total landings of marine fish in the various maritime states of India and the specieswise catch details for the first half of 1979 are given in tables. The statewise distribution of pelagic and demersal groups of fishes is shown in histograms.

60. ANON 1979. *Annual Report 1979*. Central Marine Fisheries Research Institute, Cochin, 202 pp.

The mackerel fishery showed a decline of about 14,000 tonnes in 1979. Estimated annual landings during 1978 and 1979 are given. The catches for the period 1969 to 1979 also shown in histograms.

61. ANON 1980. Indian mackerel. *Indian Fishery Atlas*. The Marine Products Export Development Authority, Cochin, p. 128-129.

Scientific and popular names of Indian mackerel, its salient features and

distribution are included with figures for common use. Estimated resource potential is presented.

62. ANON 1980. Trends in total marine fish production in India — 1979. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 22, p. 1-19.

Specieswise composition of total marine fish landings in India during 1979, all India marine fish production and its species composition for the 11 year period 1969 to 1979, the trends in marine fish production in respect of various maritime states of India are shown in tables. The landings of mackerel during 1979 showed a decline of about 14,000 tonnes as compared to 1978. Landings of mackerel during 1969 to 1979 are shown in histograms.

63. ANON 1980. Bangladesh — Status paper on coastal fishery resources. *Stock Assessment Consultation*, Vol. 2, *BOBP/REP/10.2*, p. 1-22.

Mentioned *R. kanagurta* as one of the most abundant commercial species of the Bay of Bengal in p. 14.

64. ANON 1980. *Annual Report* 1979-'80. Exploratory Fishery Project, 1980.

In the catches of *Matsya Shikari* operated along Andhra coast, good catches of mackerel were seen in area 19-85/86. The item was more at 60-69 m depths in upper east coast. *Matsya Vigyani* trawling also had mackerel in the catches.

65. ANON 1981. Commercial trawl fisheries off Kakinada during 1969-1978. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 31, p. 1-6.

The catch data collected during 1969-'78 by the trawl fisheries off Kakinada is reported. Some information on the craft and gear are given. Mackerel forms 0.13% of the fish catch and ranks only 33rd in importance. Figures showing the map of fishing ground, details of types of boats and tables are available.

66. ANON 1981. Trends in total marine fish production in India — 1980. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 32, p. 1-6.

The statewise total marine fish landings in India in 1979 and 1980 and catch statistics of fish production in India during 1980 are provided. Landings of mackerel during 1971 to 1980 are shown in histograms. A decline in the catch to the extent of about 16,000 tonnes in the catch of mackerel in 1980 as compared to 1979.

67. ANON 1981. *Annual Report* 1980-'81. Central Marine Fisheries Research Institute, Cochin, 180 pp.

Mackerel catch declined to the extent of 16,000 tonnes during 1980. Estimated landings of mackerel during 1979 and 1980 and age composition in the catch per unit effort at different centres during 1979 and

1980 are presented in tables. Statewise mackerel landings in India during 1980 (in tonnes) are also given.

68. ANON 1981. Utilization of fishery survey vessels obtained under Indo-Danish Technical Co-operative Programme. *Exploratory Fishery Project. Progr. Rep.*, Aug. 1981, 14 pp.

In the survey along Andhra coast from Visakhapatnam base *Matsya Darshini* conducted bottom trawling during March 1980 - June 1981, mackerel were caught and good catches were obtained at 60-79 m depth.

69. ANON 1981. *Annual Report* 1980-'81. Exploratory Fisheries Project — 1981.

While no mackerel were seen in the surveys of medium vessels in Gujarat, Maharashtra, Goa and Karnataka, Kerala had a little, Tamil Nadu a little more and Andhra still more. Orissa and West Bengal had no mackerel as also the Andamans. Bottom trawling by *Matsya Nireekshini, Matsya Varshini, Matsya Shikari* and *Matsya Darshini* along east coast had mackerel in the catches, more in deep waters than shallower depths. Midwater and pelagic trawls by *M. Darshini* too had mackerel catches. Purse-seining by *Matsya Harini* along the southwest coast in December 1980 - March 1981 had only poor catches.

70. ANON 1982. Trends in marine fish production in India — 1981. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 41, 32 pp.

The total marine fish production in 1981 is estimated. The catch of mackerel showed a decline of about 6,600 t (12%). The all India total marine fish production and species composition for the 11 year period 1971 to 1981 are presented in figures and tables. The maximum mackerel catch was in 1971 and the minimum in 1974.

71. ANON 1982. Planning the fisheries development in Zanzibar, Tanzania. Project findings and recommendations. *FAO, Rome (Italy), FAO FI/DP/URT/75/090 —terminal rep.* 33 pp.

The report explains the aims and functions of the project adopted by the Tanzanian government, outlining the background provided by the artisanal fishery then existed in Zanzibar, in which the Indian mackerel had been a main species involved.

72. ANON 1982. *Annual Report* 1981-'82. Central Marine Fisheries Research Institute, Cochin, 167 pp.

The catch of mackerel showed a decline of about 6,600 tonnes (12%) during 1981. Landings during 1981 and 1982 and estimated statewise landings are tabulated. An evaluation of the fishery and resources of mackerel is given.

73. ANON 1983. Trends in marine fish production in India 1982- '83. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 52, 21 pp.

Specieswise composition of total marine fish landings in India is given. Statewise landings of marine fish by mechanised and non-mechanised fishing crafts, landings from mechanised boats at major fish landing centres along the east and west coasts of India are provided in tables. Landings of major pelagic groups of fishes between 1981-'82 and 1982-'83 compared are shown in histograms. The landings of mackerel (25,000 tonnes) during the year was the lowest ever recorded in the last one decade.

74. ANON 1983. *Annual Report* 1982-'83. Central Marine Fisheries Research Institute, Cochin, 235 pp.

The landings of mackerel (25,000 t) during the year was the lowest ever recorded in the last one decade. As compared to 1981-'82 about 17,300 t of mackerel were reduced during 1982-'83. The results of the investigations carried out on the unit stocks of mackerel are presented in this final report. Fishery and resource of the fish is evaluated.

75. ANON 1983. Results of exploratory survey of the fisheries resources of Wadge Bank. *Fishery Survey of India Prog. Rep.* No. 3, p. 1-25 and 33 tables on pages 1-66.

Haulwise, areawise and depthwise catch on mackerel obtained of *Matsya Nireekshini* and *Matsya Vigyani* is provided.

76. ANON 1984. *Annual Administration Report* 1983-'84. Govt. of Pondicherry, Fisheries Department.

Mackerel landing along with other fishes in Pondicherry, Karaikkal, Mahe and Yanam in 1983-'84 is listed in Annexure.

77. ANON 1984. Meet your fish. (2) Indian mackerel. *Seafood Export Journal,* **16** (4) : 18-19.

The distinguishing characters, distribution, biology, fishery and utilization of Indian mackerel are presented for popular knowledge. Local names of the fish are also given.

78. ANON 1984. *Annual Report* 1983-'84. Central Marine Fisheries Research Institute, Cochin, 114 pp.

During 1983-'84 an increase of about 34.27% in the exploited resources of mackerel was noticed as compared to 1982-'83, the estimated figures for the two years respectively being 0.34 and 0.25 lakh tonnes.

79. ANON 1985. *Annual Report* 1984-'85. Central Marine Fisheries Research Institute, Cochin, 96 pp.

The landings of mackerel (40,000 tonnes) showed an increase of about 6,800 tonnes in 1984-'85 compared to the landings of 33,500 of 1983-'84.

Age composition of mackerel (No./gear/day) in the non-selective gear at different centres during the period is shown.

80. ANON 1985. Mackerel in the Malacca Straits. Bay of Bengal Programme. *BOBP/WP/30*, 63 pp.

A treatise on the mackerel resources of the Malacca Straits believed to have been shared by Indonesia, Malaysia and Thailand; the working paper contains summary reports and individual country papers. *Rastrelliger kanagurta* is estimated to have been forming 13% of the pelagic catch or about 40% of the mackerel catch along the west coast of Thailand. The spawning season, maturation and fecundity, and feeding habits are discussed. Purse seines from Thailand and China are involved in the fishery. The area of distribution and fishing grounds, catch and catch per unit effort on the upper and lower west coasts of Thailand are listed. Total annual catches during the period 1971-'81 are given in tables. A review of the chub mackerel fishery on the west coast of Thailand given as Appendix I provides annual catch of *R. kanagurta* and its percentage and gearwise production during 1971-'81 and month-wise and province-wise catch in 1980 are given in tables. Areawise catch, effort and catch per day are available in another table. The catch and cpue related to effort in Thai purse seine fishery on upper and lower west coast during 1972-'81 are given in figures.

81. ANON 1986. Marine fish production in India — 1983-'84 and 1984-'85. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 67, 78 pp.

The estimated marine fish landings in India during 1983, 1983- '84 and 1984-'85 are provided. The marine fish landings by mechanised and non-mechanised fishing crafts in the maritime states during 1983-'84 and 1984-'85 (in tonnes), estimated gearwise and quarterwise landings by mechanised boats at major landing centres are shown in tables. The landings of mackerel (40,000 t) showed an increase of about 6,900 t in 1984-'85 compared to that of 1983-'84.

82. ANON 1986. *Annual Report* 1985-'86. Central Marine Fisheries Research Institute, Cochin, 104 pp.

There was an increase of about 25,000 tonnes in the landings of mackerel during 1985-'86 as compared to that of 1984-'85. Age composition of mackerel (No./gear/day) in the nonselective gear at different centres during the period is shown in the table presented.

83. ANON 1987. Investigations on the mackerel and scad resources of the Malacca Straits. Bay of Bengal Programme, *BOBP/REP/39*, 149 pp.

The summary findings on the mackerel resource of the Malacca Straits for the period 1984-'86 are given. The fisheries, species composition, catch rates and seasonality, length-frequency distribution, maturity and

spawning, growth, migratory trends, morphometric comparison and state of the fisheries of mackerel are given besides giving future activities and recommendations. From the production trend for 1972-'85 given, the *R. brachysoma* appears to be more prevalent than *R. kanagurta* in Malaysia and Thailand, while the reverse is true for Indonesia. The MSY seemed to have been exceeded in Thailand and Indonesia in 1985 and in Malaysia in 1984. $L\infty$, K, L_c L mean, M, Z, F and E at all 3 places are provided in a Table. Mean catch rates in 1985 are illustrated in a figure. Restricted frequencies and growth curves (ELEFAN I analysis) on the west coast of Thailand is shown in another figure and the hypothetical migration pattern in Malacca Straits in yet another one. Separate studies at the west coasts of Thailand and Malaysia, in the Malacca straits and Bay of Bengal are given as Annexures.

84. ANON 1987. *Annual Report* 1986-'87. Central Marine Fisheries Research Institute, Cochin, 108 pp.

Landings of mackerel showed an increase from about 11,000 t in 1985 to about 35,600 t in 1986 in the southeast region and a decline by about 5,300 t from the previous years landings of about 48,800 t in the southwest region. Estimated landings in India during 1986 and 1985 are given. Number of mackerel per unit of effort in different year classes during 1986-'87 is also shown in table.

85. ANON 1988. Preliminary assessment for the Indian mackerel (*Rastrelliger kanagurta*) in Seychelles waters. *Proceedings of the Workshop on the Assessment of the Fishery Resources in the Southwest Indian Ocean. Albion, Mauritius, September 14-25, 1987*, FAO, Victoria (Seychelles) RAF/79/065/WP/41/88/E. En. p. 248/253.

Details are given of analyses made of length frequency distributions of the Indian mackerel in Seychelles waters in order to obtain estimates of growth parameters and mortality rates.

86. ANON 1988. *Annual Report* 1987-'88. Central Marine Fisheries Research Institute, Cochin, 97 pp.

A marginal reduction of about 6,000 t in the landings of mackerel is reported. Estimated landings for the periods 1986-'87 and 1987-'88 are presented.

87. ANON 1988. *Annual Report* 1988. Central Marine Fisheries Research Institute, Cochin, 97 pp.

Landings of mackerel during the period recorded 104,000 t registering an increase of about 25,000 t (32%) against that of 1987.

88. ANON 1988. *Statistics of Marine Products Exports* 1988. The Marine Products Export Development Authority, Cochin, 206 pp.

Estimated annual mackerel landings in India for the period 1950 - '88, statewise landings for the period 1986-'88 including Lakshadweep, Andaman & Nicobar and Pondicherry are given on p. 178-199.

89. ANON 1989. Marine fish production in India — 1985-'86. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 91, p. 1-32.

In the catch statistics of fish production statewise and all-India mackerel landings are given for the financial year. Landings by mechanised boats at major centres are also given. Estimated landings for the calendar year 1985 is also provided at the end. All together, 33 tables are provided.

90. ANON 1990. Results of demersal resources survey along northwest coast. *Resour. Infor. Ser.*, Fishery Survey of India, Bombay, 1 (1) : 1-2.

Catch rates of mackerel obtained from demersal trawl survey along northwest coast of India from 18° N to 23° N by the vessel *Matsya Mohini* during the quarter ending 30-6-'89 in 0-50 m and 50-100 m depth range are recorded as 5.8 kg/hr and 16.8 kg/hr respectively.

91. ANON 1990. Results of demersal resources survey along upper east coast between lat. 16° N and 18° N. *Resour. Infor. Ser.*, Fishery Survey of India, Bombay, 1 (1) : 8-9.

Catch rates of mackerel recorded during the survey by the vessel *Matsya Darshini* during the quarter ending June in 0-50 m and 50 - 100 m depth range are given as 2.83 kg/hr and 0.12 kg/hr respectively.

92. ANON 1990. Results of demersal resources survey along upper east coast between lat. 18° N and 20° N. *Resour. Infor. Ser.*, Fishery Survey of India, Bombay, 1 (1) : 10-11.

Catch rates of mackerel recorded during the survey by the vessel *Matsya Shikari* during the quarter ending June in 0.50 m and 50 - 100 m depth range are given as 4.51 kg/hr and 3.68 kg/hr respectively.

93. ANON 1990. Results of demersal resources survey along north west coast between latitudes 18° N and 23° N. *Resour. Infor. Ser.*, Fishery Survey of India, Bombay, 1 (2 & 3) : 1-3.

Catch rates of mackerel obtained from demersal trawl survey by the vessel *Matsya Mohini* during July to December 1989 in 0-50 m and 50-100 m depth range are recorded as 2.67 kg/hr and 3.07 kg/hr respectively.

94. ANON 1990. Results of demersal resources survey along lower east coast between latitudes 10° N and 16° N. *Resour. Infor. Ser.*, Fishery Survey of India, Bombay, 1 (2 & 3) : 11-13.

Catch rates of mackerel obtained during the survey by the vessel *Matsya Jeevan* during July-December 1989 from 0-50 m and 50-100 m depth range are recorded as 2.50 kg/hr and 1.28 kg/hr respectivley.

95. ANON 1990. Results of demersal resources survey along upper east coast between lat. 16°N and 18°N. *Resour. Infor. Ser.*, Fishery Survey of India, Bombay, **1** (2 & 3) : 14-15.

Catch rates of mackerel recorded during the survey along Andhra Pradesh coast by the vessel *Matsya Darshini* during July-December 1989 in 0-50 m depth range and 50-100 m depth range are given as 0.24 kg/hr and 4.91 kg/hr respectively.

96. ANON 1990. Results of demersal resources survey along upper east coast between lat. 18°N and 20°N. *Resour. Infor. Ser.*, Fishery Survey of India, Bombay, **1** (2 & 3) : 16-17.

Catch rates of mackerel recorded during the survey along Orissa coast by the vessel *Matsya Shikari* during July-December 1989 in 0-50 m depth range and 50-100 m depth range are given as 3.98 kg/hr and 5.34 kg/hr respectively.

97. ANON 1990. Results of demersal resources survey along Karnataka, Goa and south Maharashtra coasts between latitudes 11°N and 18°N. *Resour. Infor. Ser.*, Fishery Survey of India, **1** (4) : 4-5.

Catch rates of mackerel obtained in the survey by *Matsya Shakti* and *Matsya Vishwa* in 0-50 m and 50-100 m depth range during January-March '90 are recorded as 3 kg/hr and 1 kg/hr respectively.

98. ANON 1990. Results of demersal resources survey along upper east coast between latitudes 16°N and 18°N. *Resour. Infor. Ser.*, Fishery Survey of India, **1** (4) : 13-14.

Catch rates of mackerel obtained in the survey by *Matsya Darshini* during January-March 1990 in 0-50 m and 50-100 m depth range are given as 5 kg/hr and 6 kg/hr respectively. Latitudewise and monthwise catch rates (kg/hr) are shown in figure.

99. ANON 1990. Results of demersal resources survey along upper east coast between latitudes 18°N and 21°N. *Resour. Infor. Ser.*, Fishery Survey of India, **1** (4) : 15-16.

Catch rates of mackerel obtained in the survey by *Matsya Shikari* during January-March 1990 in 0-50 m and 50-100 m depth range are given as 3 kg/hr and 6 kg/hr respectively. Latitudewise and monthwise catch rates (kg/hr) are also shown in figure.

100. ANON 1990. *Annual Report* 1989-'90. Central Marine Fisheries Research Institute, Cochin, 95 pp.

An increase of 187,000 t in the landings of mackerel over 104,000 t of 1988 was recorded. Estimated landings for 1988 and 1989 are given.

101. ANON 1991. Bumper catch of mackerel. *CMFRI Newsletter*, Oct.-Dec. 1991, No. 54, p. 6.

Heavy landings amounting to a total of 705.1 tonnes of *Rastrelliger kanagurta* by gill nets in Pamban region during Oct.- Dec. '91 are reported. The catch showed an increase of 643.9 tonnes over that of the corresponding period of previous year. The fish were at 220 mm mode and were in spent condition.

102. ANON 1991. *Annual Report 1990-'91.* Central Marine Fisheries Research Institute, Cochin, 111 pp.

The landings of mackerel registered a decline of 107,000 t during the period. Estimated landings for 1989 and 1990 are given.

103. ANON 1992. *Statistics of Marine Products Exports 1990.* The Marine Products Export Development Authority, Cochin, 133 pp.

Species-wise annual marine fish landings in India for 1987 to 1990 given include the Indian mackerel also and its catch in 1989 was given as 213,696 tonnes. The state-wise fish landings given for 1988, 1989 and 1990 also give data on the mackerel.

104. ANTONY RAJA B T, BANDE V N 1972. An instance of abnormally ripe ovaries in the Indian mackerel, *Rastrelliger kanagurta* (Cuvier). *Indian J. Fish.*, **19** (1 & 2) : 176-179.

A specimen measuring 228 mm TL obtained from Karwar with a large additional ovarian lobe in stage VI, apart from the normal pair in stage IV, is reported. The number of ripe and maturing ova in this lobe are estimated to be 18,600 each. The disposition of the ovarian lobes are diagramatically shown besides a figure showing the ova-diameter frequency.

105. APPANNA SASTRY Y 1968. On the occurrence of the juveniles of the Indian mackerel *Rastrelliger kanagurta* (Cuvier) in the inshore water of Kakinada. *J. mar. biol. Ass. India,* **10** (1) : 179-181.

The occurrence of 46-57 mm sized mackerel in March 1964 and 80-168 mackerel in April-May 1968 from 3 fishing centres is reported. Gut contents of some fishes of 49-148 mm sizes is also given.

106. AZAD I S 1983. Morphometric relationships of the Indian mackerel *Rastrelliger kanagurta* (Cuvier) with a note on its reproduction. M.Sc. Theses, University of Agricultural Sciences, College of Fisheries, Mangalore, 61 pp. *Catalogue of Thesis, 1976-1985.* Abstract No. 126.

The relationships and the study on reproduction reported are based on monthly samples of purse seine catches landed at Mangalore during 1982-'83 fishing season.

107. AZAD I S, UDUPA K S 1989. Length-weight relationship of the Indian mackerel off Mangalore. *Indian J. Anim. Sci.,* **59** (1) : 202-206.

Utilising 611 mackerel randomly sampled from purse-seine catches between September 1982 and April 1983 at Mangalore, length-weight relationships were found out separately as $W = 0.00341^{3.372}$ for male and $W = 0.00441^{3.299}$ for females. Homogeneity of the relations tested with the analysis of covariance technique showed significant difference between the two. Males and females showed allometric growth pattern. The relative condition factor showed minimum values in January for females and in March for males. Tables and figures are given.

108. BAL D V, RAO K V 1984. The Indian mackerel. In : *Marine Fisheries*. Tata McGraw Hill Publishing Company Limited, New Delhi, Chap. 6, p. 93-115.

Accounts on distribution, food and feeding, growth, maturity, reproduction, migration, fishery, landings etc. are reviewed. Synonyms, local names, distinctive characters and figures are also given. The length-weight relationship from different centres is presented. The fishery is stated as supported mainly by 160-180 mm sizes. Chief types of craft and gear employed for the capture in different states along the west and east coasts are described. Annual mackerel catches for 1958-'79 and their percentages in the all-India marine landings are given.

109. BALAKRISHNAN V 1957. Occurrence of larvae and young mackerel, (*Rastrelliger kanagurta* Cuvier) off Vizhinjam, near Trivandrum. *Curr. Sci.*, **26** (2) : 57-58.

The note records the occurrence of spawners, juveniles, young ones and post-larvae of mackerel off Vizhinjam during Mar.-Aug. both in 1955 and 1956 as an indication of a spawning ground having been in existence between Vizhinjam and Cape Comorin. The number of days when young fish appeared, the number of fish measured and their size range are shown in a table.

110. BALAKRISHNAN V 1965. On the utility of the dorsal and anal fins of the Indian mackerel, *Rastrelliger kanagurta*, in determining races. *Indian J. Fish.*, **12** (1) : 60-76.

The number of rays of the first dorsal is stated to decrease with increase in size of fish making this parameter unsuitable for race studies. It is also stated that *R. kanagurta* has six each of dorsal and anal finlets and not five as has been popularly hitherto reckoned. Instances of increase or decrease in the number of finlets are also noticed; but this was always made up by a corresponding decrease or increase in the number of D_2 or anal fin rays. A photograph of an alizarine-stained specimen measuring 160 mm and figures showing the pattern of arrangement of fin-rays and their endo-skeletal are given in support of the findings. Tables are also included.

111. BALAKRISHNAN V 1970. The Indian mackerel — Distribution. *Bull. Cent. Mar. Fish. Res. Inst.*, No. 24, p. 15-16.

Distribution of *Rastrelliger kanagurta* in the Indo-Pacific region in general and India in particular are given. Differential distribution of eggs, larvae and juveniles are dealt with.

112. BALAKRISHNAN V, CHAKRABORTY D 1972. On the nature of variability in the inshore area off Karwar and its probable implication as a measure of total mortality of mackerels. *Symp. Pelag. Fish. Resour., CMFRI, Cochin, Abstracts,* No. 20.

Analysing the mackerel data for the seasons 1959-'60 to 1966-'67, 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. Assuming the population to belong to the same age group, the rate of decline has been taken as the estimate of instantaneous rate of total mortality.

113. BALAKRISHNAN V, NARAYANA RAO K V 1967. Some post-larval and juvenile stages of the Indian mackerel, *Rastrelliger kanagurta* (Cuvier) with notes on the changes in body form. *Indian J. Fish.,* **14** (1 - 2) : 97-114.

Mackerel measuring 8.7 mm to 53.7 mm, a size-range hitherto not reported, are described based on materials collected during 1956 - '59 from the inshore waters off Vizhinjam and Cannanore. The changes noticed in the body proportions based on seven morphometric characters are also recorded. Tables showing the morphometric measurements of post-larvae and juveniles and figures of a selected series of stages are given.

114. BALAN K, SIVARAMAN P, GEORGE K P, RAMACHANDRAN M 1987. An appraisal of the marine fisheries of Gujarat. *CMFRI Special Publication,* No. 38, 51 pp. and Appendix.

Quarterwise landings including mackerel in Gujarat during 1975- '84 are presented. Catches are very poor and trawl nets and drift nets account it.

115. BANDHUKUL S 1961. The *Rastrelliger* research programme in Thailand. *9th Indo-Pacific Council Session,* Karachi, Pakistan. 6-12 Jan. 1961, Occasional Paper 61/1-IPFC/C61/WP 20.

Collection of catch statistics for management purposes listed and certain measures introduced are presented. Points for fishery biology work are listed. Mackerel is said to migrate against wind direction over a fair range of route from south to north during feeding season and move south to spawn. Some experiments on tagging were carried out to gain experience in handling and transporting live fish and also in the making of fish tags. Phytoplankton consisting chiefly of diatoms and dinoflagellates form the food along coastal waters.

116. BANERJI S K 1962. Some considerations in the study of pelagic fish stocks with special reference to Indian mackerel, *Rastrelliger kanagurta. Proceed-*

ings of the Symposium on Scombroid Fishes, Marine Biological Association of India, Mandapam Camp, 12-15 January 1962, Part II, p. 565-567.

Briefly discussing on the merits and demerits of the methods of stock assessment such as Beverton and Holt (1957), Beverton and Gulland (1958) etc. it is pointed out that in the case of mackerel which is migratory and its fishery seasonal, the need for more information on the biology, movement etc. of the fish, should assessment be reliable.

117. BANERJI S K 1963. On the pattern of decrease in the abundance of mackerel in the waters off Karwar within a fishing season. *Indian J. Fish.*, **10 (1)** A : 182-189.

Analysis of the data from Karwar for the period from 1948-'49 to 1958-'59 is claimed to have indicated that, in spite of variations in the levels of abundance from year to year, the instantaneous rate of decrease of mackerel remained constant. It is argued that if the mackerel fishery mainly depended on one age group the instantaneous rate of decrease was an estimate of the coefficient of instantaneous total mortality, the best estimate of which was found to be 0.64. The component of fishing mortality was relatively negligible and that of natural mortality predominant. It is concluded that the mackerel fishery mainly depending on the numerical strength of the incoming age group, was highly unstable from year to year. Tables are included.

118. BANERJI S K 1970. The Indian mackerel — Population. *Bull. Centr. Mar. Fish. Res. Inst.*, No. 24, p. 41-54.

Sex ratio, sex and age composition, size and density, average size, changes in density, natality and recruitment, mortality, morbidity, etc., dynamics of population, population parameters, length-weight relationship, identity of sub-population and relation of population to other fisheries are considered. Statewise catch and gearwise cpue for 1950-'66 period are given in tables.

119. BANERJI S K 1973. An Assessment of the exploited pelagic fisheries of the Indian seas. *Proceedings of the Symposium on Living Resources of the Seas around India.* Central Marine Fisheries Research Institute, Cochin, Dec. 1968, p. 118-120.

The exploited mackerel resource is studied with a view to estimate the probable magnitude of potential yields. The relative abundance of various year-classes in the commercial catches at Karwar is shown in table.

120. BANERJI S K, CHAKRABORTY D 1962. Examination of the efficiency of mackerel fishing. *Indian J. Fish.*, 9 (2) A : 499- 505.

A method of quantitative measurement of the mackerel fishing efficiency of the fishermen of Karwar is derived from the ratio of the unweighted

index of abundance to the weighted index of abundance. The regression coefficient between these, which is claimed to have provided the best estimate of fishing efficiency, was not significantly different from 1, indicating that the fishing efficiency was not significantly better than what would have been in the case of random fishing. Inadequacy of transport and marketing facilities are attributed as the main causes for such inefficiency. Tables showing the monthly catches of mackerel at Karwar, the amount of effort spent in each month and catch per unit effort for the period from 1948-'49 to 1958-'59 and graph showing the relationship between the unweighted index and the weighted index of abundance during the period are included.

121. BAPAT S V, RADHAKRISHNAN N 1966. A note on the occurrence of abnormal specimens of *Rastrelliger kanagurta* (C) on the Karwar coast. *J. mar. biol. Ass. India*, 8 (2) : 363-364.

Two mackerel specimens of sizes 177 mm and 189 mm in total length with abnormal body proportions caught in *Rampan* at a fishing village near Kumta in December 1955 are reported, with figures.

122. BASHEERUDDIN S, NAGAPPAN NAYAR K 1961. A preliminary study of the juvenile fishes of the coastal waters off Madras City. *Indian J. Fish.*, 8 (1) : 169-188.

From the appearance of large numbers of young ones of various species including mackerel, a general and intensive breeding activity in the area in the months following the north-east monsoon is inferred. The time when *Rastrelliger kanagurta* had occurred, their size range, number of specimens examined, gut contents etc., are shown in a table.

123. BEAUFORT L F De, CHAPMAN W M 1951. *The Fishes of the Indo - Australian Archipelago*. V. 9. Leiden, E. J. Brill Ltd. Rep. by A J Reprints Agency, New Delhi, p. 212-215.

Synonyms, description, habitat and a figure of *Rastrelliger kanagurta* are given.

124. BEENAKUMARI, DWIVEDI R M, NARAIN A, SUBBARAJU G, NAIR P V R, SILAS E G 1985. Sea truth data collection : Estimation of diffuse attenuation coefficient in ocean colour mapping. *Proceedings of the Seminar on Remote Sensing in Marine Resources*. Central Marine Fisheries Resarch Institute, Cochin, India, April 17-18, 1985, p. 3-1 to p. 3-12.

Based on data collected from the coastal waters north of Cochin during October-December 1981 and November 1982, an algorithm for estimating diffuse attenuation, K has been developed. By estimating K, an indirect estimate of chl-a concentration, which in turn to be taken as indicative of fish stock, is obtained. Graphs and a colour coded K-map are given.

125. BHIMACHAR B S, GEORGE P C 1952. Observations on the food and feeding of the Indian mackerel *Rastrelliger kanagurta* (Cuvier). *Proc. Indian Acad. Sci.*, 36 B (3) : 105-117.

Based on periodical examination of stomach contents of mackerel collected from Calicut during 1949 and 1950, the food elements are relatively quantified, by the number method and the points method. Planktonic copepods, cladocerans, larval and adult decapods, peridinians and diatoms are listed as the main items found in the stomach and the trend in their abundance in the stomach is stated to have been in close correlation with their trends in the plankton examined simultaneously of the inshore area. The feeding intensity was found low during the pre-spawning and spawning periods and high in the 16 to 20 cm size groups. Tables and figures are included.

126. BHIMACHAR B S, GEORGE P C 1953. Observations on the food and feeding of the Indian mackerel, *Rastrelliger kanagurta* (Cuv.) *Curr. Sci.*, 33 : 13.

Noctiluca is avoided and sometimes salpae and medusae are used (but denied again in summary). A close correlation between organisms in the gut content and those occurring in the plankton collections, both in respect of species and their relative abundance is mentioned.

127. BILQESS F M, MASOOD S 1975. Two new trematode species of the genus *Hamacreadium* Linton, 1910 (Opecoelidae : Plagioporinae) from the Indian mackerel, *Rastrelliger kanagurta* (Cuv.) off the Karachi coast. *Norw. J. Zool.*, 23 (2) : 135-139.

The trematods described, namely *H. rastrelli* sp. nov. and *H. karachiensis* sp. nov., were from mackerel collected at Karachi. The species are distinguished from one another mainly on the basis of presence or absence of a prepharynx, location of cirrus pouch, variations in the sucker ratio, position of genital pores, structure of terminal genitalia, egg sizes, host and locality.

128. BLANC M, BAUCHOT M L 1962. Les Scombroidei (Poissons Teleosteen Perciformes) de Museum National D'Histoire Naturelle de Paris. *Proc. Symp. Scombr. Fishes.* Mandapam, Jan. 12-15, 1962. Marine Biological Association of India, Part I, p. 443- 458.

Photographs, and standard length and total length of mackerel synotype specimens in the museum collected from Pondicherry, coast of Malabar and Mer Rouge are given as *Scomber kanagurta = Rastrelliger kanagurta.*

129. BLINDHEIM J, CHAKRABORTY D, DEVIDAS MENON M 1975. The pelagic fishery resources off the south-west coast of India. In : *Fish Processing Industry in India.* (Symposium held at CFTRI, Mysore on 13 & 14 February 1975), p. 3-11.

The paper, reviewing the season and area of best occurrence of mackerel in relation to the hydrographic conditions, gives a broad appraisal of the harvestable resources available off the south-west coast of India. The observations that had been made by aerial surveys in 1972 and 1973 in regard to mackerel schools are also discussed and the biomass estimates arrived at are given. Tables are presented.

130. BOONPRAKOB U 1963. Preliminary results of fish egg survey in the Gulf of Thailand. *Proc. Indo-Pacif. Fish. Counc.*, **10** (2) : 10-19.

Eggs of mackerel are described.

131. BOONPRAKOB U 1965. The identification of pelagic eggs and larvae of chub mackerel, *Rastrelliger* sp., in the Gulf of Thailand with additional study on their distribution. In : *Reports on mackerel investigations 1963-'65.* Mar. Fish. Lab., Division of Res. & Invest., Dept. of Fish., Bangkok, Thailand, Contri. No. 4, p. 115-151.

Eggs and larvae of mackerel are described.

132. BOONPRAKOB U 1967. Study of the fecundity of the Indo-Pacific mackerel, *Rastrelliger* spp. in the Gulf of Thailand. *Proc. Indo-Pacif. Fish. Coun.*, **12** (2) : 124-138.

Based on a specimen collected in 1965 the fecundity of *Rastrelliger kanagurta* is estimated to be 86,000 and a female to release approximately 20,000 eggs per batch. Ova diameter frequencies showing development of maturity are given.

133. BORGES F, GISLASON H, SOUSA M I 1984. A preliminary assessment of the scad and mackerel stocks at Sofala Bank, Mozambique. *Rev. de Inv. Pesq.*, **12** : 37-107.

Distribution, reproduction, length-weight relationship and growth and mortality of *Rastrelliger kanagurta* are studied based on samples collected from the commercial catches and on surveys at Sofala Bank and Boa Paz from 1979 to 1983. The observations are stated to have shown that there was one spawning peak and that the spawning season extended from July to April. The age of the fish is estimated from otoliths. The total mortality at Sofala Bank is calculated from the age readings, and that at Boa Paz from length-frequency. Z is estimated by the ELEFAN II. Tables and figures are included.

134. BYKOV V P (*Ed.*) 1983. *Marine Fishes.* Amerind Publishing Co. Pvt. Ltd, New Delhi, 322 pp.

Page 224 contains a figure of mackerel and such information as the weight proportions of individual body parts, percentage and chemical composition of meat, percentage of mackerel caught from western shelf of India and East China sea, etc.

135. CHACKO P I 1949. Food and feeding habits of the fishes of the Gulf of Mannar. *Proc. Indian Acad. Sci.*, 29 (3) B : 83-97.

The food components and feeding habits of 59 species including *Rastrelliger kanagurta* occurring in the area are given. The species is said to be a phyto and zooplankton feeder. Eighty fish of size 22-26 cm were studied.

136. CHACKO P I 1954. Fish statistics of the west coast of Madras State. *Madras Fish. Statistics Rep.*, No. 1.

Data on mackerel along the coast for the year 1931-'32 is available.

137. CHACKO P I 1955. A review of the 1953-'54 fishery of the *Rastrelliger kanagurta* of the west coast of Madras State. *Proc. 42nd Indian Sci. Congr.* Abstract, p. 308.

From a review of the fishery of 1953-'54, November is reported as the peak month of mackerel landings. The estimated age and the size composition of the fish landed in each month are given. Prospects for improvements in the fishery in 1954-'55 and succeeding 2 years are discussed.

138. CHACKO P I 1955. Fish statistics of the west coast of Madras State for the years 1932-'33 to 1949-'50. *Madras Fish. Statistics Rep.*, Nos. 2 to 4, 6 to 17 and 19.

Mackerel data for the said years along the coast concerned are provided.

139. CHACKO P I, THOMAS S D, MALU PILLAI C 1962. Scombroid fisheries of Madras State, India. *Proceedings of the Symposium on Scombroid Fishes*, Marine Biological Association of India, Mandapam Camp, Jan. 12-15, 1962 Part III, p. 1006-1011.

The fishery for *Rastrelliger kanagurta* is considered. Seasons, gear and stomach contents are briefly given.

140. CHAKRABORTY D, NAIR R V, BALAKRISHNAN G 1973. Some characteristics of marine fish production in India. *Proceedings of the Symposium on Living Resources of the Seas around India.* Central Marine Fisheries Research Institute, Dec. 1968, Cochin, India, p. 102-113.

The quarterwise catches of mackerel have been studied and indices showing their seasonal and regional occurrence have been constructed and discussed. The seasonal index at all-India level reaches the highest point during October-December and the regional index is the highest at Mysore (Karnataka) closely followed by Kerala. In the country two-thirds of the quantity of mackerel in a year is reported to occur in October-December and one-fourth in January-March.

141. CHENNAPPA GOWDA N, ANNIGERI G G 1990. A note on the largest mackerel, *Rastrelliger kanagurta* caught off Karwar. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 104, p. 10.

A mackerel measuring 366 mm in total length and weighing 592 g caught off Karwar by a purse seiner on 11.9.84 is reported. Detailed morphometric measurements and figure of the fish are given.

142. CHIDAMBARAM K 1942. On the alleged inhibitory influence of *Trichodesmium*. *Curr. Sci.*, **11** : 406-407.

Commenting on the inhibitory influence of the alga along Travancore coast as a regional case, it is reported that *Trichodesmium* form an item of diet frequently enough, not to be regarded as accidental inclusions. The inhibition, therefore, may be inferred as due to occasional profusion than to its unpalatable qualities. The exclusion of fish eggs in the food along sea off Travancore may likewise be due to absence of spawning of fishes in the area.

143. CHIDAMBARAM K 1944. Food of the Indian mackerel, *Rastrelliger kanagurta* (Russell) of the west coast of Madras Presidency. *Curr. Sci.*, 13 : 214-215.

A detailed examination of the different components of the food of mackerel is made. Fish eggs are observed regularly in the stomachs. Copepods and larval crustaceans form the bulk as staple food. Presence of fish scales is doubted to be due to feeding occasionally on dead fish. Inclusion of white bait in the stomach contents of young mackerel hints at their carnivorous nature. *Trichodesmium* is said to fatten the fish and improve the taste.

144. CHIDAMBARAM K, KRISHNAMURTY C G 1951. Growth rings on the otoliths of Indian mackerel, *Rastrelliger kanagurta* Russel. *Proc. Indian Sci. Congr., 38th Sess.* Bangalore. Abstracts, pt. 3, p. 223.

Though rings were noticed, it was too difficult to read the numbers in otoliths of specimens 20 cm and above in length.

145. CHIDAMBARAM K, KRISHNAMURTY C G, VENKATARAMAN R, CHARI S T 1952. Studies on mackerel : Fat variations and certain biological aspects. *Proc. Indian Acad. Sci.*, 35 B (2) : 43-68.

The seasonal variation of fat in mackerel is correlated with the availability of food, the intensity of feeding and spawning conditions. The major fatty condition is attributable to the feeding activity of all sizes of fish. Two peaks in the fat content are reported, one to be in October-November when the catches mostly comprised of 16-20 cm fish and the other in March-April when the fish were 20 cm and above. Graphs showing the monthly percentage-size composition of catches in 1949-'50 and fat variation in the size groups 12.1 cm to 16.0 cm, 16.1 cm to 20.0 cm and 20.1 cm above in 1946-'49 are furnished.

146. CHIDAMBARAM K, VENKATARAMAN R S 1946. *Tabular Statements on the Natural History of Certain Marine Food Fishes of the Madras Presidency, West Coast.* Govt Press, Madras, p. 1-26.

Mackerel is dealt with in this account.

147. CHULLASORN SOMSAK, PURWITO MARTOSUBROTO 1986. Distribution and important biological features of coastal fish resources in South East Asia. *FAO Fish. Tech. Pap.*, (278), 84 pp.

The biological features of *Rastrelliger kanagurta* are presented in Table 2 and its geographic distribution and the seasonal migratory patterns determined from tagging experiments are shown in figures 3 and 21, respectively. The future perspectives are discussed.

148. COLIN PATRICK L 1976. Filter feeding and predation on the eggs of *Thallosoma* sp. by the scombroid fish *Rastrelliger kanagurta. Copeia,* 3 : 596-597.

Observations of *Rastrelliger kanagurta* filter-feeding along a near-vertical reef face at Mbengga Island, Fiji, in depths 10-30 m, on the newly spawned eggs of *Thallosoma* sp. are reported. The feeding mechanism is described. Figures are given.

149. CORPUZ A, SAEGER J, SAMBILAY V 1985. Population parameters of commercially important fishes in Philippine waters. *Tech. Rep. Dept. Mar. Fish.*, (6) : 1-99.

Revised versions of the length-frequency-based computer programmes, ELEFAN I and II, used to estimate population parameters of 41 commercially important fish species including *Rastrelliger kanagurta* in Philippine waters based on two surveys during 1979-'80 and 1981-'83 and the results are presented in the report. The parameters estimated are: $L\infty$ and K of the von Bertalanffy growth equation; Z and M, and the mean selection length, L_c. The data base is presented in Tables 68 and 69.

150. CUSHING D H 1971. Survey of resources in the Indian Ocean and Indonesian area. *IOFC/DEV/71/2, FAO, Rome,* 123 pp.

Considerable quantities of sardines and mackerel resources are opined to exist over coral reef areas of the Indian Ocean as local concentrations.

151. DAVIDSON ALAN 1976. *Sea Food of South East Asia.* Federal Publications (S) Pte. Ltd., Singapore, 366 pp.

A catalogue entry of *Rastrelliger kanagurta* is made on page 108, giving the scientific name, figure, area of occurrence etc. Methods of preparing the fish for the table and additional signposts to recipes are included in the cookery section.

152. DAY F 1865 (1981). *The Fishes of Malabar.* Bernard Quaritch, London. Rep. by Bihen Sing, Mahendra Pal Sing, Dehradun, 293 pp.

The Indian mackerel is described under the name *Scomber kanagurta* on pages 68-69. Morphometric measurements, identification characters and habitat are given.

153. DAY F 1878 (1981). *The Fishes of India.* 2 Volumes. William Dawson & Sons Ltd., London. Rep. by Today and Tommorrows Book Agency, New Delhi, 778 pp.

Mackerel is described under the name *Scomber microlepidotus* on pages 250-251. The names used by different authors, identification characters, habitat etc. are given. Figures of 3 specimens (plate LIV) — a young one from Sind, an immature one from Madras, and an adult from Andamans — are furnished.

154. DAY F 1889 (1963). *The Fauna of British India : Fishes.* Vol. 2. Taylor and Francis, London, p. 203-204.

Indian mackerel is described under the name *Scomber microlepidotus.* Local names, morphometric measurements, identification characters, colour, habitat and a figure are given.

155. De JONG T K 1940. A preliminary investigation on the spawning habits of some fishes of Java Sea. *Treubia,* 17 : 307- 27.

This paper deals with ova diameter studies. Second batch of mature eggs is more likely to be disintegrated and re-absorbed than reaching maturity, as the number of eggs in it was always smaller than the first and that there was an excessive number of degenerated eggs.

156. DELSMAN H C 1926. Fish eggs and larvae from the Java Sea. 9. *Scomber kanagurta* C. V. *Treubia,* 8 (3 - 4) : 395-399.

Descriptions of the eggs and the larvae at 4 stages of mackerel are presented under the old name *Scomber kanagurta* with illustrations. This appears to be the earliest description of *Rastrelliger* eggs.

157. DELSMAN H C 1931. Fish eggs and larvae from the Java Sea. *Treubia,* 13 : 401-410.

The larvae presumed by the author to be that of *R. kanagurta* in 1926, are identified as that belonging to *Euthynnus affinis.* Doubts about the correctness of identification of mackerel eggs made earlier are expressed.

158. DEVANESAN D W 1942. Plankton studies in the Fisheries Branch of the Department of Industries and Commerce, Madras. *Curr. Sci.,* 11 (4) : 142-143.

In the studies, mackerel was found to regularly and normally feed on the fish eggs occurring in the plankton. *Noctiluca* is said to be inedible. But mackerel seems to have taken advantage of it to lay eggs by instinct in a place where *Noctiluca* abounds and derive natural protection from predation. *Leucifer* in plankton is commented as a remarkable link in the food chain and the mackerel is observed to feed on this.

159. DEVANESAN D W, CHIDAMBARAM K 1948. The mackerel. In : *The Common Food-Fishes of the Madras State.* Government Press, Madras, p. 32-34.

A popular account is presented on Indian mackerel, giving the scientific names used, local names, distinguishing characters, colour, bionomics, economic importance, etc., along with a figure. The fishing centres on the east and west coasts from where the specimens had been collected, methods of capture and the centres producing the heaviest catches are also given. The catch statistics for the years 1929-1939 for the west coast and for 1934-'39 for the east coast are presented in tables.

160. DEVANESAN D W, JOHN V. 1940. On the natural history of *Rastrelliger kanagurta* (Russell) with special reference to its spawning season and eggs. *Curr. Sci.*, 9 (10) : 462-64.

The mackerel fishery in Malabar is reported to commence in August and continue till May with peak in October December. The fish is found to feed on both phyto and zooplankton. Spawning seasons to start in June and extent till September end. The fish is presumed to spawn at night and the fecundity is found to be 94,000. Eggs and just hatched larvae are reported but no details given. Larvae and adults of cestodes are identified from the pyloric caeca of the alimentary tract.

161. DEVARAJ M 1979. Management problems in the Indian oil sardine and mackerel fisheries of the south west coast of India. *India Today & Tommorrow*, 8 (3) : 120.

While providing general information, mainly for the industry, on the traditional and modern fishing activities of Karnataka, Goa and Kerala, the article warns against overgrowth of purse seine fleet and the social problems that it might cause besides inflicting damage on the fish stock.

162. DEVARAJ M 1983. *Fish Population Dynamics Course Manual. CIFE., Bull.*, No. 3 (10) : 98.

Computations of $L\infty$, K, t_o rates of mortalities, etc. are given.

163. DEVARAJ M, FERNANDEZ I, KAMAT S S 1988. Dynamics of the exploited Indian mackerel *Rastrelliger kanagurta* (Cuvier), stock along the southwest coast of India. *Symposium on Tropical Marine Living Resources.* Marine Biological Association of India, Cochin, 12-16 January 1988. Abstracts, No. 130 : 67.

The mackerel fishery data for 4 decades from 1934 to 1975 are dealt with. From length frequency, length at ages are worked out. The growth is estimated applying the von Bertalanffy Growth Equation. The total mortality, natural mortality and fishing mortality are estimated. It is concluded that the year-class was accounted for by one major brood originating in the premonsoon season (February-May), though there was also a secondary brood occurring in November. Based on age cohort analysis, attempt is also made to quantify the population for the period.

164. DHARMARAJA S K, VIJAYALEKSHMI K, HAJA NAJEEMUDEEN S, PRASAD C J, SEYNUDEEN M B, ANANDAN K, KARTHIKEYAN M, BALAKRISHNAN G 1987. An appraisal of the marine fisheries of Tamil Nadu and Pondicherry. *CMFRI Special Publication*, No. 34, 63 pp. and Appendix.

Quarterwise landings of mackerel in 1975-'84, quarterwise landings of mackerel by trawlers at Pudumanikuppam, Cuddalore, Nagapattinam, Mandapam, Rameswaram and Tuticorin during 1980-'84, quarterwise landings in Pondicherry and Karaikal during 1975-'84, gearwise mechanised landings of mackerel in Pondicherry and Karaikal during 1980-'84, landings by mechanised and non-mechanised units in Pondicherry and Karaikal during 1980-'84 are presented along with those of other fishes in Tables and discussed.

165. DHAWAN R M 1973. On the occurrence of juvenile mackerel *Rastrelliger canagurta* (Cuvier) off Goa coast. *J. Bom. nat. Hist. Soc.*, 70 (1) : 213-215.

The occurrence of larvae and juveniles of *Rastrelliger canagurta* off Goa during 1964-'69 is recorded, reviewing the earlier records from the area. The details of the juveniles collected during 1964-'69 are presented in a table. A prolonged breeding season of the fish and even a possibility of different races coming into the commercial fishery with gonad in different stages of maturity are inferred from the pattern of the juvenile occurrence.

166. DHAWAN R M 1976. On the occurrence of giant mackerel, *Rastrelliger kanagurta* Cuvier off Goa coast. *Mahasagar*, 9 (1-2) : 87-88.

A male *Rastrelliger kanagurta* measuring 348 mm caught in a purse seine on 15-1-1976 from Siridao area near the opening of the river Zuari is recorded, claiming it to be the largest mackerel so far reported. The report also mentions about 5 juveniles caught in a trawl net in December 1975, discussing the probable message it would convey about the spawning and other habits of the fish. Figure is given.

167. DHAWAN R M 1981. Diversification of coastal fisheries with reference to purse-seine operations. Proc. Seminar on the role of small-scale fisheries and coastal aquaculture in integrated rural development 6-9 Dec.1978. Madras. *Bull. Cent. Mar. Fish. Res. Inst.*, No. 30 - A, p. 27-31.

Data on mackerel landings by purse seine in Goa in late nineteen sixties is given. Mackerel in general dominates the landings. Its shoals are said to occur and spread out mostly over a belt up to 30 km almost throughout the season of September-May.

168. DHAWAN R M, BELURKAR M K 1974. *Fisheries of Goa, Daman and Diu.* Directorate of Fisheries, Govt. of Goa, Daman and Diu Publication.

The book deals with the fisheries of the state and among other fishes, mackerel has prime position in Goa.

169. DHULKHED M H, ANNIGERI G G 1983. On a record-sized mackerel *Rastrelliger kanagurta* caught off Karwar. *Indian J. Fish.*, 30 (1) : 183-184.

A male mackerel of 360 mm in total length and 560 g in weight caught by a purse seiner off Karwar is reported. The morphometric measurements and a photograph of the specimen are given.

170. DHULKHED M H, ANNIGERI G G 1988. Marine fish calendar 10. Karwar. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 88, p. 1-13.

Mackerel is described with the aid of a figure. Based on the data collected during 1981-'85, mackerel is stated to have formed 14.97% of the total catch.

171. DHULKHED M H, MUTHIAH C, SYDA RAO G, RADHAKRISHNAN N S 1982. The purse seine fishery of Mangalore (Karnataka). *Mar. Fish. Infor. Serv., T & E Ser.*, No. 37, p. 1-7.

An appraisal of the purse seine fishery at Mangalore based on landings from 1979 to 1981 is presented. The composition of fish landed is shown in figure, of which mackerel formed the second major species. A table is also given.

172. DHULKHED M H, NAGESH C N 1976. Serological studies on oil sardine, (*Sardinella longiceps*) and mackerel, (*Rastrelliger kanagurta*). *Fish. Technol.*, 13 (1) : 9-12.

The serological study is claimed to have provided sufficient indication of the existence of genetically different groups of oil sardine and mackerel. Isoagglutinin tests revealed the presence of a reciprocal relationship with antigens A and B in both fishes.

173. DHULKHED M H, NARASIMHA RAO S 1976. Electrophoretic studies on serum proteins of oil sardine (*Sardinella longiceps*) and mackerel (*Rastrelliger kanagurta*). *Fish. Technol.*, 13 (1) : 16-19.

A blood test of mackerel attempted electrophoretically is claimed to have revealed that the blood was antigenically negative for both A and B, which is taken to have been indicative of the existence of genetically different groups of the species on the south-west coast of India.

174. DIOPHODE P V 1972. Occurrence of *Rastrelliger kanagurta* (Cuvier) in River Mandovi, Goa. *J. Indian Fish. Assn.*, 2 (1 & 2) : 108-109.

One juvenile mackerel measuring about 108 mm (total length) is recorded in a stakenet catch from the River Mandovi, about 8 km upstream. The salinity and temperature of the locality are given.

175. DIOPHODE P V 1974. Observations on the Indian mackerel, *Rastrelliger canagurta* (Cuvier) from purse-seine catches along Goa coast. *Indian J. Fish.*, 21 (1) : 85-88.

The length-frequency, length-weight relationship and gut contents of mackerel observed in 351 specimens ranging in length from 10.1 to 26.0 cm collected during October 1965 to January 1966 from the purse-seine catches at Panaji are reported. Tables are given.

176. DJAMALI A 1977. A study of certain biological aspect of kembung laki, *Rastrelliger kanagurta* (Cuvier) from Panggang Island waters, Seribu Islands. *Oceanol. Indones.*, (8) : 1-10.

Five hundred and fortyseven mackerel of 125-239 mm length were examined during May 1972 to February 1973. The length-weight relationship is expressed as $W = 10^{-6}\ 2.816\ L^{3.2595}$ and the male : female ratio was 1.0 : 1.1. The most advanced female gonad observed was stage III b, in February/May. Fecundity is stated to vary between 20,000 and 71,000.

177. DRUZHININ A D 1970. Indian mackerel, *Rastrelliger* spp. in Burma waters. *Proc. Indo-Pacif. Fish. Coun.*, 13 (2) : 59-81.

The report is based on data collected at Mergui and Kyaukpyu observation points and during the trip on trawler LINZIN, from 19 June 1966 to 30 September 1968. Details regarding the fishery such as species composition, species ratio, size and weight composition, length-weight relationships, sex ratio, state of gonads, condition coefficient, stomach fullness, etc. are given. *Rastrelliger kanagurta* from Burma waters is stated to have had a size smaller than those from Thailand and Philippines. Their distribution in Burma waters is claimed to have confirmed an earlier conclusion that the fish was an open sea form. Based on available data, a suggestion is made for the purse-seine fishery in Burma waters to be further developed. Tables and figures are included.

178. DRUZHININ A D, DAW TINTIN MYINT 1970. A morphometric study of *Rastrelliger* spp. from the Mergui Archipelago, Burma. *Proc. Indo-Pacific Fish. Coun.*, 13, Section 2 : 49-58.

Morphometric data on 98 specimens of *R. kanagurta* of 156-225 mm in fork length and 100 specimens of *R. neglectus* of 166-220 mm in fork length are presented and compared. The consistent differences observed in the species are defined. The measurements are compared with those given

by Jones and Silas (1964) for *Rastrelliger kanagurta* (Cuvier) and *Rastrelliger brachysoma* (Bleeker) from the Andaman Islands. A key for the identification of the species is given. Figures and tables are included.

179. DURAND J 1949. *Rastrelliger kanagurta* (Ruppell) — its fishery and biology. Summary of our knowledge — study of programmes. *Proc. Indo-Pacif. Fish. Coun.* 1st Session, Singapore, Contributed papers 5, 316, p. 94-96.

Stomach generally filled with a green pulp, probably formed of microscopic algae.

180. FAO 1961. *Yearbook of Fishery Statistics,* 1960, Vol. 12.

Estimated annual mackerel landings in India during the period 1955-'60 are given on p. C-35.

181. FAO 1970. Catches and landings 1969. *Yearbook of Fishery Statistics,* Vol. 28, 324 pp.

Nominal catches of Indian mackerel in India, Malaysia (West Malaysia), Philippines and Thailand during 1964-'70 are given in p. b-59. Thailand recorded highest catch during the years.

182. FAO 1976. Catches and landings. *Yearbook of Fishery Statistics 1975,* Vol. 40, 417 pp.

Catches of Indian mackerel from the east and west coasts of India, Seychellus, Yemen Ar Rp and Thailand for the period 1970- '75 are given on p. 149.

183. FAO 1980. Catches and landings. *Yearbook of Fishery Statistics 1979,* Vol. 48, 384 pp.

Catches of Indian mackerel from the east and west coasts of India, Bulgaria, Seychelles, Tanzania, Yemen Ar Rp, Thailand, Fiji and Philippines for the period 1976-'79 are given on p. 165. India recorded the highest catch. Thailand and Philippines recorded comparatively a good catch. Total catches of Indian mackerel from all fishing areas for the period 1973-'79 are provided on p. 76.

184. FAO 1983. Catches and landings. *Yearbook of Fishery Statistics* 1981, Vol. 52, 357 pp.

Catches of Indian mackerel for the period 1978 to 1981 from the east and west coasts of India, Bulgaria, Seychelles, Tanzania, United Arab Emerites, Yemen Ar Rp, Thailand, Fiji and Philippiness are provided on p. 157, 158. India recorded the highest catch. Philippines and Thailand also recorded comparatively a good catch. Total estimated catch from all fishing areas for the period 1975-1981 are also given on p. 77.

185. FAO 1987. Catches and landings. *Yearbook of fishery statistics* 1985, Vol. 60, 461 pp.

Total catches of Indian mackerel from all fishing areas for the period 1979 to 1985 are provided on p. 120. Catches from east and west coasts of India, Saudi Arabia, Seychelles, Tanzania, United Arab Em, Yemen Ar. Rp, Fiji, Thailand and Philippines are also presented for the years 1982-'85 on p. 224. Thailand and Philippines also recorded a high catch.

186. FAO 1990. Fishery Statistics — catches and landings. *FAO Yearbook 1988*, Vol. 66, 502 pp.

Total nominal catches of Indian mackerel from all fishing areas for the period 1985, 1986, 1987 and 1988 recorded 176,824, 158,574, 159,628, 188,371 mts respectively are presented in p. 90. Catches from the east and west coasts of India accounted the highest. Though catches are recorded from Oman, Saudi Arabia, Seychelles, Tanzania, Utd Arab Em, Yemen Ar Rp and Fiji, Thailand and Philippines accounted a good fishery. The catch data is provided on p. 240.

187. FATIMA E JEYASEELI, LAKSHMANA PERUMALSAMY P, CHANDRA MOHAN D, NATARAJAN R 1980. Bacterial flora in the alimentary canal of *Rastrelliger kanagurta* (Cuvier). *Bull. Dept. Mar. Sci. Univ. Cochin*, **11** (2) : 97-111.

Of the 3 regions of the alimentary canal studied, the stomach and intestine are stated to have been harbouring maximum bacterial flora. Significant relationship was also found between bacterial population and feeding index. *Bacillus corynebacterium* and *Vibrio* were common. The bacterial isolates are nutritionally classified into 7 groups, based on their requirements for amino acids and other growth factors. Variation in bacterial populations in relation to the type and quantity of ingested food and to the various nutritional requirements are discussed.

188. FISCHER W, BIANCHI G (Eds.) 1984. *FAO Species Identification Sheets for Fishery Purposes. Western Indian Ocean (fishing area 51)*, FAO of the UN, Rome, Vol. 4 : SCOMBR Rast 3.

Figure, synonyms, vernacular names, distinctive characters, distinguishing characters of similar species occurring in the area under reference, size, geographical distribution, behaviour, fishing grounds, catches, fishing gear and forms of utilization of *Rastrelliger kanagurta* are given.

189. FISCHER W, WHITEHEAD P J P (Eds.) 1974. *FAO Species Identification Sheets for Fishery Purposes. Eastern Indian Ocean (fishing area 57) and Western Central Pacific (fishing area 71)*. FAO of the U N, Rome, Vol. 4 : SCOMBR Rast 3.

The sheet pertaining to Indian mackerel contains the information on the fish such as the synonyms, vernacular names, distinctive characters,

distinguishing characters of similar species occurring in the area, size, geographical distribution, behaviour, present fishing grounds, catches, main fishing gear and principal forms of utilization of *Rastrelliger kanagurta* together with a figure.

190. FRASER BRUNNER A 1950. The fishes of family Scombridae. *Annals and Magazine of Natural History*, 3,(12th Series):131-163.

Two Species, the slender one with less gill rakers *R. canagurta* (Cuvier 1829) and deep one with higher number of gill rakers *R. brachysoma* (Bleeker 1850) are described.

191. GADAGKAR S R, SUNDARARAJ N 1985. Temporal behaviour of marine landings along coastal Karnataka. 1. Relative distribution and secular trends. *Fish. Technol.*, 22 (1): 14-23.

Based on data on fish landings including those of mackerel during the period 1956 to 1981, the relative (%) distributions of the important commercial fisheries in Karnataka are reported. Mean standard deviation and per cent coefficient of variation of the annual distribution are given in a table. Annual percentage distribution and secular trends are shown in figures. A six-year cyclical periodicity in mackerel fisheries is inferred from the data. A statistically significant inverse relationship is claimed to have been observed between the landings of mackerel and sardine.

192. GADAGKAR S R, SUNDARARAJ N 1985. Temporal behaviour of marine landings in Karnataka. II-Seasonal patterns. *Fish. Technol.* 22 (2) :92-98.

Seasonal patterns of 21 fisheries in Karnataka including mackerel (after isolation from time-series components) are presented. Harmonic analysis has been carried out using the seasonal indices.

193. GADAGKAR S R, SUNDARARAJ N 1986. Temporal behaviour of marine landings along coastal Karnataka. III Cyclical patterns. *Fish. Technol.* 23 (1): 32-37.

Marine landing data for Karnataka during 1956-78 were subjected to time series analysis and cyclical periodicities isolated in the case of mackerel (6-year cycle) and 6 other fisheries. 'Total' demonstrated an 8-year cyclical periodicity. Cyclical indices (quarterly) pertaining to the species and the 'Total' and harmonic analysis for cyclical indices are given. A figure showing the harmonic analysis of cyclical periodicities for different species/ groups is provided.

194. GEORGE K C 1965. On an unusual fishery for the mackerel in the Cochin backwaters. *J. mar. biol. Ass. India*, 7 (1): 219-222.

The entry of mackerel in the Cochin backwaters, contributing to a short-time fishery, during January 1961 is reported. The reason for the entry could not be determined. However, an over abundance of the pelagic

fishes in the coastal waters is suggested as a possible inducing factor. A map of the backwaters showing the fishing sites and the then environmental conditions, is provided.

195. GEORGE K C 1976. Ichthyoplankton surveys along the south west coast of India by the UNDP/FAO Pelagic Fishery Project, Cochin, 1971-75. *Aq. Sci. Fish. Abstr.*, **8** (5) Code No. 6167-IQ 8, p.238.

This is an abstract reproduced from the *Book of Abstracts of papers presented at Joint Oceanographic Assembly, Edinburgh, UK, 13-24 Sept. 1976*, which claims that the identities of eggs and larvae of the mackerel had since been established and the spawning grounds and periods defined. The spawning of the fish in the shelf waters is stated to have been protracted, with March to September, coinciding with the upwelling, as the peak period.

196. GEORGE K C 1989. Results of Ichthyoplankton surveys along the southwest coast of India with special reference to pelagic fish resources. *J. mar. biol. Ass. India*, **31** (1 & 2): 172-189.

The paper critically reviews the findings of the ichthyoplankton surveys carried out by the UNDP/FAO Pelagic Fishery Project, Cochin (1971-79) on the spawning, distribution and abundance of the larvae of the major pelagic fishes including mackerel and their resources along the southwest coast of India. Tables and figures are given.

197. GEORGE K C, BANERJI S K 1964. Age and growth studies on the Indian mackerel *Rastrelliger kanagurta* (Cuvier) with special reference to length-frequency data collected at Cochin. *Indian J. Fish.*, **11** A (2):621-638.

The length-frequency data collected at Cochin during 1957-'64 are analysed for age and growth. The length-frequency data published by Pradhan (1956) and Sekharan (1958) are also reanalysed. From the modal progression, the fish are found to attain about 22 cm in 1 year, and 24 cm in 2 years. A significant decrease in the growth rate after the juvenile stage is inferred. The growth estimation is tested by von Bertalanffy equation. Since the fishery is mainly on O-year sizes, the success depends on new recruits. Figures and tables are included.

198. GEORGE M K 1984. A critique of serological and electro-phoretic studies on the Indian oil sardine and mackerel. *Indian J. Fish.*, **31** (3):396-399.

A critical evaluation made on the electrophoretic and serological studies on mackerel and oil sardine by Dhulkhed and Nagesh 1976, Dhulkhed and Rao 1976, Menezes 1980 and Rao and Dhulkhed 1976, points out the invalidity of the methods adopted therein and the inexactness of conclusions drawn by the authors.

199. GEORGE P C 1962. Our current knowledge on the food and feeding habits of the Indian mackerel, *Rastrelliger kanagurta* (C). *Proceedings of the*

Symposium on Scombroid Fishes. Marine Biological Association of India, Mandapam Camp, 12-15 January 1962, Part II, p. 569-573.

Available information on food and feeding relationship is tabulated and mackerel is qualifed a surface column plankton feeder. The food of both young and the adult is said to be not radically different.

200. GEORGE P C, ANNIGERI G G 1960. On the occurrence of small sized mackerel (*Rastrelliger kanagurta*) (Cuvier) off Ratnagiri coast. *Curr, Sci.*, **29** (8):319-320.

Occurrence of 62-112 mm mackerel is reported from near Ratnagiri with comments on implied spawning behaviour of the fish. Their stomachs were observed to contain diatoms, dinophysids, copepods and penaeid protozoeae. Feeding pattern not different from that of adults.

201. GEORGE P C, ANTONY RAJA B T, GEORGE K C 1977. Fishery resources of the Indian economic zone. *Silver Jubilee Celebrations of IFP,* Souvenir, p. 79-116.

In region-wise catch, mackerel figures as an item along south-west coast and Andaman area. Out of the 2.0 million tonnes of potential from south-west coast, mackerel and oil sardine together is put as 650,000 tonnes. The average annual yields expected are respectively 200,000 tonnes of oil sardine and 100,000 tonnes of mackerel. Mackerel is said to be an important resource that could economically and successfully be exploited from Andaman & Nicobar area. The species, on the whole, may register only a limited increase from its present level of harvest. The average yield and the potential at different depth zones from 4 regions along the Indian coasts and Andamans are given in a Table.

202. GEORGE P C, DHULKHED M H, RAMAMOHANA RAO V 1959. Observations on the mackerel fishery of the Netravati estuary, west coast, south India. *J. Bombay nat. Hist. Soc.*, **56** (1): 32- 38.

The fishery that extended 10 km upstream from the river mouth in 1958 is reported. The occurrence not only indicates mackerel's ability to withstand lower salinity but also suggests a long spawning season if not a subsidiary one. Fish feeds on both zoo and phytoplankton. Copepods dominate. No indication of feeding at bottom.

203. GIRIJAVALLABHAN K G, GNANAMUTTU J C 1974. On a mackerel larva (*Rastrelliger* sp.) from the inshore waters of Madras. *Indian J. Fish.*, **21** (1): 293-295.

A 2.98 mm larva that occurred in surface plankton from 10-fathom zone off Madras in 1973 is reported giving morphometric characters and a photograph.

204. GISLASON H, SOUSA M I 1985. Biology, stocksize and catch of small pelagic fish along the coast of Mozambique. *Rev. de Inv. Pesq.*, (13): 27-81.

In a compilation of available information on the small pelagic fish resources of Mozambican waters, the distribution, reproduction, age, growth and stock size of the Indian mackerel are given. *Rastrelliger kanagurta* is caught from depths upto 100 m in Boa Paz to Angoche. Catch rates and length composition in catches at Sofala Bank during the surveys in June-July1981 and October-December 1982 are presented.

205. GISLASON H, SOUSA M I 1989. Results of a stratified random bottom trawl survey for scad and mackerel in Mozambican waters from May to June 1984. *Rev. Invest. Pesq.* (Maputo), No. 19, p. 1- 54.

The total abundance of small pelagic species in Mozambican waters was estimated to be 100 (±45) thousand tonnes of which scad and mackerel constituted 57 (±39) thousand tonnes. These abundance estimates must be considered as minimum estimates of biomass as the efficiency of the trawl was assumed to be equal to 1.0.

206. GISLASON H. SOUSA M I 1989. An assessment of the stock of scad and mackerel at Sofala Bank and Boa Paz, Mozambique. *Rev. Invest. Pesq.* (Maputo), No. 19, p. 89-141.

The report contains an updated assessment based mainly on information collected from July 1984 to May 1986.

207. GNANAMUTTU J C 1966. Osteology of the Indian mackerel *Rastrelliger kanagurta* (Cuvier). *Indian J. Fish.*, 13 (1& 2):1-27.

Illustrated and detailed descriptions of the bones of the entire skeleton are presented.

208. GNANAMUTTU J C 1971. On the occurrence of *Rastrelliger faughni* Matsui in the Indian waters. *Indian J. Fish.*, 18 : 170-173.

While recording the occurrence of the species titled, comparisons are made with *R. kanagurta* on certain morphological and meristic characters and osteology.

209. GOMAL H TAMPUBOLON, GEDE SEDANA MERTA I 1987. Mackerel fisheries in the Malacca Straits. *BOBP/REP/39. Annexure* 4, p. 101-116.

Rastrelliger spp. and *Decapterus* spp. are the species dealt with. Annual catch and cpue (kg/trip) from 1976 to 1985 in Malacca Strait and monthly catches and effort at Banda Aceh in 1985 at Idi along East Aceh district during November '84 to June '86 and at Asahan in 1984 and 1985 are given in tables. $L\infty$, K, Z, F, M, E, L_c, L and L' at Banda Aceh are given in another table. Shaeffer's production model applied to Indonesian catch and effort is given in a figure. Length frequencies likewise are provided in another illustration.

210. GOPAKUMAR G, GOPALAKRISHNA PILLAI N, OMANA T A 1988. The fishery characteristics of mackerel and its biological aspects at Vizhinjam. *Symposium on Tropical Marine Living Resources.* Marine Biological Association of India, Cochin, 12-16 January 1988, Abstracts No. 35, p. 17.

Mackerel landings in 1977-'86 at Vizhinjam are given with mention on season and gears. Problems caused by indiscriminate fishing of spawners and pre-recruits discussed, and possibilities to augment production suggested.

211. GOPAKUMAR G, GOPALAKRISHNA PILLAI N, OMANA T A 1991. The fishery characteristics and biology of mackerel at Vizhinjam. *J. mar. biol. Ass. India,* 33 (1 & 2) : 107-114.

The study is based on data collected during 1977-'86 at Vizhinjam. The annual mackerel landings averaged 191.5 tonnes. The season for mackerel here extends from October to May with peak in April-May. Drift net yielded 63% of the catch. Another 20% was caught by hooks and line. Mechanisation of traditional craft has increased the catch. The size of fish caught ranged between 50 and 290 mm. Peak spawning was once during April-May and again during September-October. Problems caused by indiscriminate exploitation of spawners during peak breeding periods and young fish in pre-recruitment phase are discussed. Possibilities for augmenting production are suggested. Observations on biology, length-weight relationship and present status of utilization and marketing are also dealt with in this paper.

212. GOPALAKRISHNAN K, BENJAMIN C VERGHESE, ALI M A, PAUL PANDIAN P 1991. Deep sea finfish resources of Indian Exclusive Economic Zone (Beyond 100 metres depth). *Proc. Nat. Workshop Fish. Resour. Data Fish. Indus.,* p. 80-88.

Mackerel stands 4th forming 6.9% among the 10 species categorized as deep sea resources in Indian waters. The south west coast seen to hold a biomass of 696 tonnes with MSY of 279 tonnes, the northeast abounds with a mackerel biomass of 24,302 tonnes and MSY of 9,740 tonnes. Except a negligible quantity found beyond 200 m in south west coast almost the entire resource appears to occur in 100-200 m depth at all coasts.

213. GOPINATH K 1950. The Malayan purseseine (*Pukat Jerut*) fishery. *Journal of Malayan Branch of Royal Asiatic Society,* 23 (3) : 75-96.

Existence of an onshore and offshore population of *Rastrelliger* is given, the latter being probably migratory.

214. GORBUNOVA N N 1963. Larvae of scrombroids (Pisces, Scombriformes) from the Indian Ocean. *Trudy Inst. Oceanol. Acad. Sci.,* 62 : 68-95 (In Russian).

A single larva measuring 9.3 mm collected from the Andaman Sea during *Vityaz* Expedition has been described.

215. GUNARSO W, BASKORO M S, TAUFIQ M 1991. A study on the estimation of jack mackerel stock (*Rastrelliger kanagurta*) in northern Java waters. *Maritek*, **1** (1) : 13-28.

Estimates on the biological parameters of chub mackerel (*R. kanagurta*) and the stock based on the length-frequency in North Java waters by means of ELEFAN program, were done. Growth parameter values of L and K were obtained. The age of the fish at the growth turning point and the life span of the investigated fish were determined. The equations of the length-weight relationship of the investigated fish showed the growth pattern as positive allometric. The exploitation rate of the investigated fish is 0.45 which means that it remains the level of 0.5 where F = M.

216. GUNTHER A 1860 (1964). *Catalogue of the Fishes in the British Museum. V. 2. British Museum*, London. Rep. by Wheldon & Wesley, Ltd. Codicote and Verlag J. Cramer, Weinheim : 360.

Indian mackerel is listed (Sl. No. 8) under the name *Scomber kanagurta* based on specimens collected from Red Sea and Indian seas.

217. HAMRE JOHANNES, ALIKUNHI K H, GEORGE P C, VARGHESE T J 1966. Preliminary report on tagging of the Indian mackerel, *Rastrelliger kanagurta* (Cuvier) and the lesser sardine, *Sardinella gibbosa* (Val.) off Marmagao Harbour, Union Territory of Goa. *Bull. Cent. Inst. Fish. Edn.*, (3) : 1-15.

A summary of account on the tagging experiments so far conducted in India on some pelagic fishes including mackerel is given. The paper gives descriptions of tagging kit, types of tags used, conditioning of fish, preferable size and maturity of fish for tagging, behaviour of fish after tagging, tag-recovery programme, recoveries reported, etc.

218. HARDENBERG J D F 1937. A preliminary report on a migration of fish in the Java Sea. *Treubia*, **16** : 295-300.

The migration of oceanic mackerel in Java Sea is given. The stock present at the beginning of the west monsoon moves westerly and disappears at the beginning of east monsoon. A new stock then enters from east. At the end of east monsoon 2 new stocks enter from northwest and southwest. The study though based on migration of *Decapterus*, observes the mackerel to closely follow, but one or two weeks behind it.

219. HARDENBERG J D F 1956. A review of current knowledge of *Rastrelliger*. *Proc. Indo-Pacif. Fish. Coun.* Rastrelliger Sub- Committee Session, Penang, September 1956.

Information on habitat, behaviour, food and migration are reviewed. In Java Sea the fish is said to be a plankton feeder, feeding mostly on copepods with negligible fraction of diatoms and also on medusae. A doubt on the identity of *Rastrelliger kanagurta* by Than A Kow in Singapore Strait is expressed and said that could have been *R. neglectus* in the light that the latter lives for a greater part on diatoms. Doubts on the identity of *R. kanagurta* from Gulf of Mannar by Chacko (1949) is also doubted on the same line. Being a plankton feeder, the mackerel tends to follow highest densities of plankton.

220. HOLT S J 1959. Report of the International Training Centre on the Methodology and Techniques of Research on Mackerel (*Rastrelliger*). *FAO Document No.* 59/2/1403 (Mimeo.).

A summary of the growth data available for some scombroids is given and indicated an approximate value for the factor *K* ("catabolic growth coefficient") for *Rastrelliger.*

221. HORNELL J 1910. The results of a fishery cruise along the Malabar coast and to the Laccadive Islands in 1908. *Madras Fish. Bull.,* **4** : 71-126.

The mackerel catch is said to be highly variable with absolute dearth or enormous abundance in certain years. A negative correlation between the fisheries of oil sardine and mackerel is mentioned but no reasons ascribed. The feed of mackerel collected from the inshore area off Malabar constituted wholly of planktonic copepods and daphniae and they feed a little away from bottom and even follow the minute crustaceans that do vertical migration. Sardine is qualified as a phytoplankton feeder against the mackerel, a zooplankton feeder.

222. HORNELL J 1924. Madras Fisheries Department Administrative Report for the year 1922-'23. *Madras Fish. Bull.,* **18** : 7-65.

Information on mackerel is provided.

223. HUTOMO, MALIKUSWORO, BURHANUDDIN, PINARDI HADIDJALA 1978. Observations on the incidence and intensity of infection of nematod larvae (Fam. Anisakidae) in certain marine fishes of waters around Panggang Island, Seribu Islands. *Mar. Res. Indones.,* (**21**) : 49-60.

Parasites of *Rastrelliger kanagurta, Decapterus russelli* and *Sardinella sirm* from waters around Panggang Island (Indonesia) were identified as *Anisaki* type I and *Terranova* type B. The former being most common had 54.2% average infestation in *R. kanagurta.* Infestation by these larvae increased with increased host length.

224. ISA M M 1989. Growth, mortality and recruitment of horse mackerel *Rastrelliger kanagurta* (Cuvier) from Malaysia. *Fish. Bull., Dep. Fish.* (Malays.) No. 59, 22 pp.

The length frequency data of the Indian mackerel *Rastrelliger kanagurta* were used to determine the growth, mortality and recruitment pattern. Analysis was done using the ELEFAN I and II programmes. It was found that the values of K and $L\infty$ were between 0.86-1.80 and 26.7-31.5 mm respectively. The fishing mortality in Kuala Perlis was higher than that in Teluk Bahang. The exploitation rate was more than the optimum level of 0.5. Growth of *R. kanagurta* in Malaysian waters was similar to that found in other waters.

225. JACOB P G, RAJAGOPAL M D 1980. Variations in stomach contents and bio-chemical compositions of tissues in some marine fishes. *Indian J. Mar. Sci.*, 9 (3) : 207-211.

Observed relationships between the calorific values, proteins, fats and carbohydrates of stomach contents and body tissues of some marine fishes including mackerel are reported with supporting figure and table.

226. JACOB T, DHARMARAJA S K, PANIKKAR K K P 1979. Socio-economics implications of purse seine operations in Karnataka. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 12, p. 1-8.

Annual catch of oil sardine and mackerel in South Kanara and North Kanara districts separately by *Rampani* and purse seine for 1976, 1977 and 1978 are given in diagrams. The percentages of them in the total catch at these places in 1977, 1978 and 1979 (1st half) only are tabulated and given.

227. JACOB T, RAJENDRAN V, MAHADEVAN PILLAI P K, JOSEPH ANDREWS, SATYAVAN U K 1987. An appraisal of the marine fisheries in Kerala. *CMFRI Special Publication*, No. 35, 42 pp. and Appendix.

Quarterwise marine fish landings including that of mackerel in the state during 1975-'84 are presented and discussed. The quarterwise mechanised and nonmechanised landings, landings by purse seine, trawl and drift/set gillnet at Cochin Fisheries Harbour and quarterwise trawl landings and gillnet landings at Sakthikulangara (Kerala), all during 1980-'84, are shown in tables.

228. JADHAV R N, NARAIN A, NAIR P V R, PILLAI V K, PONNIAH A G, BALACHANDRAN V K, SUBBARAJU G, SILAS E G, SOMVANSHI V S, JOSEPH K M 1985. Oceanographic parameters and their relationship to fish catch estimation : A case study in coastal waters north of Cochin during 1981. *Proceedings of the Seminar on Remote Sensing in Marine Resources*, Central Marine Fisheries Research Institute, Cochin, India, April 17-18, p. 4-1 to 4-12.

Estimation of fish biomass including that of mackerel from the data on chlorophyll-a, particulate matter, dissolved oxygen, temperature, salinity, etc, gathered by four vessels from north of Cochin during October-

December 1981, is attempted. Sea truth data on oceanic parameters and their standard deviations for October 22-24, November 27 and December 15, 16 and fish catch data for October, November and December (1977-'81) are given in tables. Figures are also included.

229. JAGANNATH N, SHIVAJI V, NINAN T V, JOSEPH P J 1990. Results of demersal resources survey along south west coast and Gulf of Mannar between lat. 7° N and 10° N. *Resour. Infor. Ser.*, Fishery Survey of India, Bombay, Vol. 1 (2 & 3) : 7-10.

The catch rate of mackerel obtained by the vessel 'Matsya Nireekshani' during July-December 1989 from 0-50 m and 50-100 m depth range is recorded as 1.31 kg/hr and 1.28 kg/hr respectively.

230. JAMES P S B R 1981. Exploited and potential capture fishery resources in the inshore water of India. *Bull. Cent. Mar. Fish. Res. Inst.*, 30 A, p. 72-82.

In the course of reviewing the status of the exploited and potential capture fishery resources in the inshore waters of India, the paper presents the trends in catches of mackerel both in the text and in a figure. Average annual mackerel catches in India for 1961-'65 and 1966-'76 and the average statewise annual landings during 1962-'74 are given in tables. Prospects for development are discussed.

231. JAMES P S B R, ALAGARAJA K 1991. Assessment of marine fishery resources of India. *Proc. Nat. Workshop Fish. Resour. Data Fish. Indus.*, p. 1-7.

Annual production from 1977 to 1986 of mackerel included in the table on estimated landings of selected stocks.

232. JAMES P S B R, JACOB T, GEORGE K C, NARAYANA PILLAI V, MATHEW K J, RAJAGOPALAN M S 1989. National strategy for exploitation and utilization of the potential marine fishery resources of India — a projection. Paper presented at the National Symposium on Research and Development in Marine Fisheries, Mandapam Camp, 16-18, September 1987. *Bull. Cent. Mar. Fish. Res. Inst.*, 44 Part I, p. 111-136.

The paper gives information on the exploited marine fishery resources in general, including mackerel. The potential resources and the additional infrastructure needed for exploiting these in the shelf and slope areas as estimated by the Institute and their probable utilisation are also given. Average annual composition of mackerel landings during the year 1983-'85 is shown regionwise in a table, so also the estimated potential yield of mackerel.

233. JAMES P S B R, KURUP K N, RAMAMIRTHAM C P, RAO D S, SUBBARAJU G, KUNJUKRISHNA PILLAI V 1987. Distribution and abundance of oil sardine and mackerel in relation to environmental

characteristics in the Indian coastal waters. *National Symposium on Research and Development in Marine Fisheries, Mandapam Camp,* 16-18 September 1987. Central Marine Fisheries Research Institute, Abstract, No. 7.

The direct and indirect relationships of mackerel with the environmental characteristics such as salinity, temperature, dissolved-oxygen content, ocean currents, plankton productivity and marine pollution are discussed, based on a look-back on the data for the past four decades.

234. JAMES P S B R, SANTHA JOSEPH P 1976. An instance of unusual feeding behaviour of the Indian mackerel *Rastrelliger kanagurta* (Cuvier) off Mangalore. *J Bombay nat. Hist. Soc.,* 73 (3) : 538-539.

An instance of adult mackerel feeding intensively and exclusively on *Acetes* is reported with comments on the probable implications. The stomach contents of 52 specimens ranging in size 218-250 mm and in stage II of maturity obtained from drift net catches off Mangalore in May 1975 form the data base.

235. JAYAPRAKASH A A 1989. Trends in drift gill net fishery off Cochin with special reference to effort inputs and returns during 1981-'82 and 1986-'87. *Studies on Fish Stock Assessment in Indian Waters. Fishery Survey of India — Special Publication,* No. 2, p. 87-105.

The paper presents an account on the drift gillnet fishery at Cochin from 1981 to 1987; the catch, effort, c/e and major groups of fishes including mackerel, that contributed to the catch. The average catch of mackerel for the period was 38 tonnes at a c/e of 1.9 kg. Special emphasis is given to the total income and effort relationship. The results of such studies conducted during 1986 and 1987 have been compared with that of 1981 and 1982.

236. JHINGRAN V G 1975. *Fish and Fisheries of India.* Hindustan Publishing Corporation (India), Delhi (Ed. 2, 1982), p. 542-544.

A general account on mackerel and its fishery is included. The main regions of occurrence, chief fishing centres on both the east and west coasts and the percentage composition of mackerel in the total landings are given. Also mentioned are the popular gears used, the size and age compositions in the fishery, the trends of fluctuation, etc. A probable correlation between mackerel abundance and environmental factors, such as rainfall, surface temperature, salinity, specific gravity of the water and planktonic abundance of the area of fishing, is indicated. Figures and tables are presented.

237. JOHN C C, MENON M A S 1942. Food and feeding habits of the oil sardine and mackerel. *Curr. Sci.,* **11** (6) : 243-244.

Differing from the regular findings of fish eggs in the gut of mackerel

at Calicut by Devanesan, the authors say that on the Trivandrum coast, the species is essentially a phytoplankton feeder with diatoms and dinoflagellates dominating in food. However, occasionally they are found to feed on macroplankton such as leucifers, mysids, *Acetes* and fish fry. Fish eggs have never been noted here. Mackerel catches are reported to occur more to north of Quilon than to its south. Plankton of Trivandrum and Calicut coasts being almost identical, the dissimilarity in the feeding may be due to some unknown factor which requires further investigation.

238. JONES S 1958. Progress of marine fisheries research. *Fisheries of the West Coast of India*. Souvenir issued on the occasion of opening of the new building of the Central Marine Fisheries Research Sub-station at Calicut, CMFRI, p. 8-17.

The works done so far, mainly by the Institute, for resolving problems related to marine fisheries in India including mackerel are reviewed.

239. JONES S 1962. The scombroid fishery of India — present and future. *Proceedings of the Symposium on Scombroid Fishes*, Marine Biological Association of India, Mandapam Camp, 12-15 January 1962, Part III, p. 994-1000.

As a retrospect on the scombroid fishery during 1950-'61, the paper gives the percentage composition of mackerel in the total scombroid fish production, and the coast-wise landings in tables and figures.

240. JONES S 1962. The mackerel fishery of Pangkor, Malaya. *Proceedings of the Symposium on Scombroid Fishes*, Marine Biological Association of India, Mandapam Camp, 12-15 January 1962, Part III, p. 1018-1024.

The article conveys the status of the mackerel fishing industry at Pangkor, Malaya, based on material collected and observations made during September 1956. Fishing operations, marketing of mackerel packed in ice, brine-boiled frozen fish and salt-cured dry fish, the economic condition of the industry, etc., are dealt with.

241. JONES S 1967. Two decades of marine fisheries research. *Souvenir, 20th Anniversary, Central Marine Fisheries Research Institute*, p. 5-21.

Evaluating the marine fisheries research of the Institute for the past two decades, the article refers to the then economic status of mackerel and the information the Institute had generated in regard to it.

242. JONES S, KUMARAN M 1962. Eggs, larvae and juveniles of Indian scombroid fishes. *Proceedings of the Symposium on Scombroid Fishes*, Marine Biological Association of India, Mandapam Camp, 12-15 January 1962, Part I, p. 345-378.

Some records on the occurrence of the earlier stages of *Rastrelliger kanagurta* are recounted. Two juvenile stages of mackerel collected from Vizhinjam are illustrated.

243. JONES S, ROSA H Jr 1962. Synopsis on the biological data on the fishes of the genus *Rastrelliger* Jordan and Starks 1908 with an annotated bibliography. *Proceedings of the Symposium on Scombroid Fishes,* Marine Biological Association of India, Mandapam Camp, 12-15 January 1962, Part III, p. 1190-1236.

A review account on the nomenclature, common names, distribution, ecological factors limiting distribution, bionomics and life history, reproduction, maturity, fecundity, fertilization, larval history adult history, maturation and growth, behaviour, population structure size and density of population, fishing areas, fishing equipment, fishing seasons and factors affecting the fishery of *Rastrelliger kanagurta* is given. World distribution is shown in a map. Keys to the stages of maturity are also given.

244. JONES S, ROSA H Jr 1965. Synopsis of biological data on Indian mackerel *Rastrelliger kanagurta* (Cuvier 1817) and short bodied mackerel *Rastrelliger brachysoma* (Bleeker 1851). *FAO Fish. Synop.,* (29) : 34 pp.

Information on taxonomy, distribution, bionomics, life history, population and exploitation of *Rastrelliger kanagurta* is reviewed. A graph showing the variations in 9 characters of the sample collected from Andaman Sea, photographs of the gill rakers and a map on world distribution of the species are given. Keys to stages of sexual maturity of male and female species are provided in tables.

245. JONES S, SILAS E G 1962. A systematic review of the scombroid fishes of India. *Proceedings of the Symposium on Scombroid Fishes,* Marine Biological Association of India, Mandapam Camp, 12-15 January 1962, Part I, p. 1-106.

Description, figure and key for identification of *Rastrelliger kanagurta* are given.

246. JONES S, SILAS E G 1962. Mackerel from the Andaman Sea. *Proceedings of the Symposium on Scombroid Fishes,* Marine Biological Association of India, Mandapam Camp, 12-15 January 1962, Part I, p. 255-282.

Description of mackerel from the Andaman Sea and a key for identification are given. *Rastrelliger kanagurta* and *R. brachysoma* of Andaman Sea are compared with regard to body shape, body proportion, colouration, dorsal and anal finlets, sex and maturity, gill rakers, length-weight relationship, scales, etc. Morphometric and meristic data on abnormal specimens of *R. kanagurta* from East African and South African waters are also recalled.

247. JONES S, SILAS E G, DAWSON E 1960. New records of scombroid fishes from the Andaman-Nicobar waters. *J. mar. biol. Ass. India,* 2 (1) : 136-137.

Three specimens of *Rastrelliger kanagurta* (Cuvier) of sizes between 225 and 250 mm from Port Blair, Andamans; collected during February-March 1960, are recorded.

248. JOSEPH K M 1986. Some observations on potential fishery resources from the Indian Exclusive Economic Zone (EEZ). *Bull. Fish. Surv. India*, (14): 1-20.

The fishery resource along the east coast is surveyed. The quantities caught and the percentages the mackerel form in the total landings are given in tables. The occurrence of mackerel in the trawl catches from deeper waters reported now and then has been deemed as an indication of the existence of a mackerel resource along the offshore waters of the upper east coast.

249. JOSEPH K M, JOHN M E 1987. Potential marine fishery resources, Seminar on potential marine fishery resources, *CMFRI Special Publication* No. 30, p. 18-43.

Regionwise estimates and potentials of underexploited pelagic resources including mackerel are given. A steady increase in the mackerel landings on the east coast over the past many years is demonstrated, giving the quantities of annual catches by mechanised trawlers. Demersal surveys too, are stated to have indicated the presence of mackerel along the entire east coast, with an increasing intensity northward, offering potentiality for developing a fishery. Specieswise catch-per-unit-efforts worked out are shown in table.

250. KALAWAR A G, DEVARAJ M, ARUN H PARULEKAR 1985. *Report of the expert committee on marine fisheries in Kerala,* Submitted to the Govt. of Kerala. Expert Committee, C/o Central Institute of Fisheries Education, Bombay 467 pp. (mimeographed).

Mainly recommending measures to be adopted for conservation of shrimp and fish resources and for eliminating the existing discord between the traditional and mechanised sectors in Kerala, the report delves deep into the nature and probable causes of fluctuations of the resources including mackerel exploited mainly traditionally but, later, in a smaller extent, also by mechanised purse-seines. Supporting data are given in tabulated form. Summary recommendations are given.

251. KAMANYI J R 1975. Biological observations in Indian mackerel, *Rastrelliger kanagurta* (Cuvier) 1816, (Pisces : Scombridae) from East African waters. *Afr. J. Trop. Hydrobiol.* Fish., 4 (1) : 61-78.

R. kanagurta is reported abundant from the end of southeast monsoon (Sep/Oct) through the northeast monsoon, the highest catch rate obtaining from Sept to Feb. Large mackerel were caught in Sept and Oct, when the majority of females were in stages IV and V. The mean

length was 168 mm fork length, with SD 5.77. A regression equation for length-weight relationship is given. The fish are also stated to have been observed during night to feed actively on organisms such as fish larvae, crustacea, etc.

252. KLUNZINGER C B 1879. *Sitzungsb. Akad. Wiss. Wien,* **80** : 375.

A 30 cm specimen from Queensland sent to the author by Baron von Mueller is dealt with.

253. KRISHNAMOORTI B 1957. Fishery resources of the Rameswaram Island. *Indian J. Fish.,* **4** : 229-253.

Estimated catch of *Rastrelliger kanagurta* for 1952-'53 and 1953- '54 is provided along with other fishes in a table. The fish though contributes to 0.475 and 0.12 per cent respectively only in the total fish catch, in value it ranks 11-12th position with respect to total yield in rupees.

254. KRISHNA PILLAI S 1979. On the occurrence of mackerel, *Rastrelliger kanagurta* (Cuvier) in distant waters off Bombay. *Indian J. Fish.,* **26** (1-2) : 225-226.

An incidence of mackerel in Stage V maturity occurring 60-80 nautical miles off Bombay in July 1975 is recorded, assuming that it might support an earlier view of mackerel probably making an inshore-offshore migration.

255. KRISHNA PILLAI S, JAYAPRAKASH A A 1978. Occurrence of juveniles of the Indian mackerel, *Rastrelliger kanagurta* (Cuvier) in Bombay waters. *Indian J. Fish.,* **25** (1 & 2) : 257-259.

Juvenile mackerels of 86-142 mm size, collected from a trawler catch from Bombay waters, are recorded. The trawler had operated at 30-40 m depth (lat 18°N - 19°N and long. 72°E - 73°E). In the total catch of 870 kg, the young mackerel constituted 9.2%.

256. KULKARNI G M 1976. Abnormalities in the vertebral column of Indian mackerel. *Indian J. Fish.,* **23** (1 - 2) : 269-270.

Some abnormalities noticed in the vertebral columns of 9 specimens collected from Karwar to Belampur inferred to have been caused by injuries in earlier stages are reported.

257. KULKARNI G M 1978. On an interesting specimen of *Rastrelliger kanagurta* (Cuvier) landed at Malwan Maharashtra. *J. mar. biol. Ass. India,* **20** (1-2) : 157-158.

A specimen with spots along the dorso-lateral region of the body from head to tail, caught in the shore-seine on 12-2-'70 from Dandi, Maharashtra is recorded. Figure and some morphometric measurements are given.

258. KUMARAN M 1973. The fishery potential of Andaman and Nicobar Islands. *Proceedings of the Symposium on Living Resources of the Seas around India,* Central Marine Fisheries Research Institute, December 1968, Cochin, India, p. 387-389.

Mackerel is said to form 9% of the fish catch of the Islands. Mackerel in large shoals are found in the east coast during Jun- Aug, which migrate to the west coast with the onset of north-east monsoon. Possibility of an year-round fishery is hinted at.

259. KUMARAN M 1978. Our fisheries resources and the role of upwelling in their fluctuations. Part I. Marine fish production of India. *Seafood Export Journal,* **10** (1) : 51-56.

All-India mackerel catch during 1962-'75 along with that of oil sardine and Bombay duck is tabulated and a few general observations on fishery are given.

260. KUMARAN M, YOHANNAN T M, FEROZ KHAN 1988. Marine fish calendar. 3. Calicut. *Mar. Fish. Infor. Serv., T & E Ser.,* No. 81 : 1-9.

Information on mackerel fishery in the Calicut region is given. The seasonal productions by boat seine, drift net and gill net are shown in figures. Mackerel is stated to have accounted for an average annual landings of 208.8 tonnes during 1981-'86.

261. KUMARASWAMY ACHARI G P 1972. The mackerel fishery resources of the Mangalore zone during 1963-1967. *Symp. Pelag. Fish. Resour., CMFRI, Cochin.* Abstracts No. 22.

The mackerel fishery during the seasons for 1963-'64 to 1965-'66 is studied. Estimates on standard effort is provided. In biological observations, occurrence of advanced maturity stages was high among fish caught in bottom set gill nets indicating the preference of deeper waters by the fish during spawning.

262. KURUP K NARAYANA, KRISHNANKUTTY NAIR G, ANNAM V P, ABHA KANT, BEENA M R, LATHA KHAMBADKAR 1987. An appraisal of the marine fisheries of Karnataka & Goa. *CMFRI Special Publication* No. 36, 104 pp. and Appendix.

Estimated mackerel landings by mechanised and nonmechanised units during 1980-'84 and the percentage contributions of mackerel in the all-fish catches of both Karnataka and Goa during 1975-'84 and districtwise estimated mackerel landings in the two states during 1980-'84 are presented and discussed. Estimated landings of mackerel at Mangalore, Malpe, Ganguli, Bunder, Bhatkal, Tadri and Karwar during 1981-'84 are included in Tables. Catch per unit effort of mackerel realized by purse seines are also given.

263. KUTHALINGAM M D K 1956. Observations on the food and feeding habits of the Indian mackerel, *Rastrelliger kanagurta* (Russell). *Jour. Zool. Soc. India*, **8** : 99-106.

Stomachs of post-larvae (5-6mm), juveniles (15-25mm) and adults (35-225mm) were examined for contents. Postlarvae prefer vegetable matter of which diatoms seem to be the most favourable items. With juveniles, the copepods predominate and fish is completely excluded from the diet. Adults also feed on copepods. Decapod crustaceans are present in fair numbers throughout the year. The diet of juveniles and adults, however, vary in composition in different areas and at different parts of the year. Mackerel is said to be a surface feeder throughout its life. While postlarvae are strictly herbivores, juveniles are omnivores. The adults are, however, confirmed carnivores. *R. kanagurta*, it is said, feeds even during the final stages of maturity.

264. KUTHALINGAM M D K, LUTHER G, SRINIVASAN P V, LAZARUS S 1984. Preliminary experiments on the rearing of the oil sardine, *Sardinella longiceps* and Indian mackerel, *Rastrelliger kanagurta* in floating cages. *Proceedings of the National Seminar on Cage and Pen Culture*, March 18-19, Tamil Nadu Agricultural University, Fisheries College, Tuticorin, 1983, p.87-88.

An experimental cage culture of mackerel attempted at Vizhinjam Bay, providing artificial feed, is reported, stating that the mackerel had survived for 127 days. Some information on the growth rate is given.

265. LIPTON A P, APPA RAO T, RAJE S G, GOPAL C, RANJIT SINGH, THUMBER P B, DHOKIA H K 1988. Marine fish calendar. 8. Veraval. *Mar. Fish . Infor. Serv., T & E Ser.*, No. 86: 1-20.

Particulars of mackerel appearing in the fishery at Veraval are given. Scientific and vernacular names, gear employed for their fishery, depth of occurrence and a figure are included.

266. LIVINGSTON P, SIVADAS M, BADRUDEEN M 1988. Marine fish calendar. 12. Mandapam. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 88 : 1- 13.

Vernacular name of *Rastrelliger kanagurta*, gear used to catch it, peak period of its occurrence, depth range of the place of fishing, length range in commercial fishery, size at first maturity and spawning seasons are given.

267. LUTHER G 1973. Observations on the biology and fishery of the Indian mackerel, *Rastrelliger kanagurta* (Cuvier) from Andaman Islands. *Indian J. Fish.*, **20** (2) : 425-477.

Based on samples from the landings around Port Blair during 1962- '64, the spawning season is inferred to have been during Oct- Apr, with eggs released in 3 batches at one month interval. Length at maturity is

calculated to be 250-259 mm. The estimated growth rate and length-weight relationship, the food and feeding habits, the catch trends, the gear used in the fishery, etc are given. Possibility of the Port Blair stock of mackerel being a different one is inferred.

268. LUTHER G, APPA RAO T, REUBEN S, APPANNA SASTRY Y, SOMARAJU M V, GOPAL C, RADHAKRISHNA K 1988. Marine fish calendar. 2. Visakhapatnam. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 80 : 1- 21.

Particulars of Indian mackerel fishery in Visakhapatnam are given based on the data collected from 1981 to 1986. The scientific and vernacular names, gear employed for the fishery, percentage composition of catch in the gear, peak period of occurrence, length range in commercial fishery, size at first maturity and spawning season are included. Figures are also given.

269. LUTHER G. RADHAKRISHNAN NAIR P N, GOPAKUMAR G, PRABHAKARAN NAIR K 1982. The present status of small-scale traditional fishery at Vizhinjam. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 38 : 1-17.

A study based on the data collected from 1968 to 1979 is reported. Composition of mackerel in the boat-seine, drift-net, shore-seine, 'kon-chuvala', 'nanduvala' (bottom set gillnet) and 'achil' catches and the percentage contribution by different gears to the annual landings are given. The seasonal trends in the catches are shown in histograms.

270. MANACOP P R 1956. A preliminary systematic study of the Philippine chub mackerels, Family Scombridae, Genera *Pneumatophorus* and *Rastrelliger*. *Philippine, J. Fish.*, 4 (2) : 79-102.

Two specimens of *R. chrysozonus* measuring 26 mm and 48 mm in length from the Philippine waters are described.

271. MANSOR MAT ISA 1987. On the status of the *Rastrelliger* and *Decapterus* fisheries of the west coast of Peninsular Malaysia in 1984-'85. *BOBP/REP/* 39. Annexure 3, p. 81-100.

Monthly cpue (kg/boat/day of *R. kanagurta* caught by trawlers and purse seiners at different centres are given in figures. Length distribution is presented in another, the frequency distribution, growth curve, recruitment, catch curve and selection pattern are provided in yet another one. Mean gonado-somatic index also are given in the illustrations.

272. MATSUI T 1963. The larvae of *Rastrelliger*. In : *Ecology of the Gulf of Thailand and the South China Sea. A report on the results of the Naga Expedition*, 1959-1961. *Southeast Asia Research Programme, Univ. Calif., Scripps Institution of Oceanography, La Jolla, California, SIO Reference* 63-6 : 59-69.

Rastrelliger larvae collected from the Gulf of Thailand during the Naga Expedition have been described. From the deep bodied larvae, changes

in stages in juveniles take place at 8-10 mm size. There are several records of the capture of larvae of the genus *Rastrelliger* from Gulf of Thailand during the Naga Expedition.

273. MATSUI T 1967. Review of the mackerel genera *Scomber* and *Rastrelliger* with description of a new species of *Rastrelliger*. *Copeia*, **1** : 71-83.

Characters distinguishing the 3 species of *mackerel, Rastrelliger kanagurta, R. brachysoma, R. faughni* are given. Number of gillrakers on the lower half of the first arch and number of interneural bones under the 1st dorsal fin of the species of *Rastrelliger* and *Scomber* are also included. Tables and figures are given.

274. MATSUI T 1970. Description of the larvae of *Rastrelliger* (Mackerel) and comparison of the juveniles and adults of the species *R. kanagurta* and *R. brachysoma*. *Scientific Results of Marine Investigations of the South China Sea and the Gulf of Thailand 1959-1961. Naga Report*, 5, Part I.

Distinguishing features between *Rastrelliger* and *Scomber* are given. A comparison of *R. brachysoma* and *R. kanagurta* is made. Description and distribution of *Rastrelliger* larvae are given. Plankton samples of Naga Expedition and International Indian Ocean Expeditions were used in the study.

275. MAY R GUANO 1991. Growth and mortality of Indian mackerel *Rastrelliger kanagurta* (Scombridae) in the Visayas Sea, Central Philippines. *Fishbyte*, **9** (2) : 13-15.

The estimate on growth based on length-frequency data from 1983 to 1987 and the Compleate ELEFAN programme is made. Results are TL_∞ = 38 cm and K = 0.8 $year^{-1}$. The estimates are commented to be tentative and other vital statistics could not be estimated due to the absence of small fish in available catch samples. Growth parameters of *R. kanagurta* at different locations in the Philippines by others are provied in a table.

276. MENEZES MARIA R 1986. An electrophoretic study of the soluble lens proteins from the Indian mackerel, *Rastrelliger kanagurta* (Cuv). *Mahasagar — Bull. natn. Inst. Oceanogr.*, **19** (1) : 69-71.

Soluble eye lens nuclei proteins of *R. kanagurta* were studied by cellogel electrophoresis to see whether there are any intra species variations. A distinct pattern characterised by the number of bands, mobility and staining intensity was observed. One fish, having patchy pigmentation externally, however, showed variations in the mobility and intensity of the bands.

277. MENEZES MARIA R, SANDEEP NAIK, MARIA MARTINS 1990. Genetic and morphological variations in the Indian mackerel *Rastrelliger kanagurta* (Cuvier 1817) from the Goa region. *Proc. Indian Acad. Sci. (Animal Sci.)*, **99** (6) : 457-465.

The population structure of *Rastrelliger kanagurta* from Panaji and Colva (south), both off Goa, was assessed from genetic and morphological characters. Seventeen loci were examined from 8 enzymes, sarcoplasmic proteins and haemoglobins. The allele frequencies were not significantly different between the two localities. Nei's genetic distance value was 0.0017. The proportion of polymorphic loci at 1% level was 47.1 at Colva and 52.9% at Panaji. The level of genetic variation, estimated by average observed heterozygosity at the 2 localities was 5.8 and 6.6% respectively. The sarcoplasmic protein-2 locus was found to be highly polymorphic. Significant ($P<0.001$) departures from Hardy-Weinberg expectations were observed at this locus. About 67-89% of variation in meristic characters was found to be within the groups. Tables and figures are given.

278. MENON M, RADHAKRISHNAN N 1974. Present status of knowledge regarding the biology of Indian mackerel *Rastrelliger kanagurta* (Cuvier). *Symposium on Coastal and High Seas Pelagic Resources. Proc. Indo-Pacif. Fish. Coun., 15th Session*, 18-27, October 1972, Section 3, p. 343-350.

Studies covering the life history, growth rate, reproduction rate, spawning intensity, tagging results, recruitment and abundance are reviewed. The programme of work taken up by the Pelagic Fishery Project for the species, as well as the inherent problems connected with it are presented.

279. MISRA K S 1959. An aid to the identification of the common commercial fishes of India and Pakistan. *Rec. Indian Mus.*, 57 (parts 1-4), 320 pp.

Identification characters, distribution and figure of *Rastrelliger kanagurta* are given on page 294. Identification key is given on page 77.

280. MUKUNDAN C 1967. Plankton of Calicut inshore waters and its relationship with coastal pelagic fisheries. *Indian J. Fish.*, 14 (1 & 2) : 271-291.

Describing the inshore plankton, qualitatively and quantitatively in time and space off Calicut from 1957 to 1964 in relation to changes in salinity and temperature, the paper attempts to correlate the plankton with the local landings of oilsardine and mackerel. It is suggested in conclusion that, in addition to favourable plankton and temperature conditions, the level of grazing pressure in the offshore regions too might create conditions conducive for the entry of the fishes into the inshore fishing areas in the postmonsoon months.

281. MUNRO I S R 1955 (1982). *The Marine and Freshwater Fishes of Ceylon.* Department of External Affairs, Canberra. Rep. by Narendra Publishing House, Delhi, 351 pp.

Names used by different authors, physical description, colour, habitat etc. of mackerel are given on page 218. A figure is given in plate 43.

282. MUNRO I S R 1958. *Hbk. Aust. Fish.*, **27** : 112

Record from Darwin in Northern Territory is given. Figure is provided on page 747.

283. MURTY A V S, VISHNUDATTA M N 1976. The seasonal distribution of some oceanographic parameters off south west coast of India relevant to pelagic fisheries. *Indian J. Fish.*, **23** (1 & 2) : 97- 104.

In this report an attempted correlation of the pelagic fishery with temperature, salinity and oxygen conditions associated with the thermocline off the southwest coast, based on the hydrographic data collected by R. V. *VARUNA* during 1964-'70 between Cape Comorin and Mangalore, mackerel fishery is considered.

284. MUTHIAH C 1982. Drift gillnet fishery of the Dakshina Kannada coast. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 37 : 8-15.

Catch composition and estimated month-wise landings by drift gillnet in 1979-'80 and 1980-'81 are given, in which large-sized mackerel is stated to have formed 10%. Tables and figures are given. The values of various fishes landed are shown in histograms.

285. NAGARAJA RAO S 1968. *An Introduction to Fisheries.* Fish Products Ltd., Rajamundry, 584 pp.

Mackerel fishery is briefly described on p. 232.

286. NAGARAJA RAO S, SAMUEL W C. *A Student's Guide to Fisheries.* Vol. 2, : 136 pp.

The book contains an elementary account on *Rastrelliger kanagurta*, giving the distinguishing features, method of capture, important fishing grounds, economics, etc., for the benefit of beginners.

287. NAIR R V, BANERJI S K 1965. A survey on the statistics of marine fish catch in India from 1950 to 1962. *Indian J. Fish.*, **12** (1) : 135-236.

A treatment of marine fish catches including mackerel during the said period is made under statewise and specieswise headings. Tables give annual landings from year to year at all-India level and for each state with species.

288. NAIR R V, VIRABHADRA RAO K 1970. The Indian mackerel — conclusions. *Bull. Centr. Mar. Fish. Res. Inst.*, No. 24 : 87-92.

Information on identity, distribution, reproduction, age and growth, food and feeding, population, exploitation and utilisation are summarised.

289. NARASIMHA RAO S, DHULKHED M H 1976. Electrophoretic characteristics of oil sardine (*Sardinella longiceps*) and mackerel (*Rastrelliger kanagurta*) eye lens proteins. *Fish. Technol.*, **8** (1) : 13-15.

Electrophoresis of eye lens proteins of oil sardine and mackerel showed separation of proteins into 3 and 4 components, indicating the heterogenous nature of the population.

290. NARAYANAN KUTTY M 1962. Observations on the Indian mackerel, *Rastrelliger kanagurta* (Cuvier) from the trawl catches along the Bombay coast. *Indian J. Fish.*, **9 A** (2) : 590-603.

The size composition and gonadial condition of the mackerel are reported, pointing out the similarity of these to the fish caught at Ratnagiri in the same period, suggesting to be an occasional sojourn in deeper waters probably in search of food. Tables and a figure are included.

291. NARAYANA PILLAI V 1991. Salinity and thermal characteristics of the coastal waters off southwest coast of India and their relation to major pelagic fisheries of the region. *J. mar. biol. Ass. India*, 33 (1 & 2) : 115-133.

A study of the sea water temperature and salinity of the coastal waters between Cape Comorin and Ratnagiri based on observations made along 6 sections for a period of 8 years is made use of for the study. Possible correlations between the observed parameters and the occurrence and migration of the major pelagic fishery resources such as mackerel in the area is attempted.

292. NARAYANA RAO K V 1962. Food of the Indian mackerel, *Rastrelliger kanagurta* (Cuvier) taken by drift-nets in the Arabian Sea off Vizhinjam, South Kerala. *Indian J. Fish.*, **9 A** (2) : 530-541.

Stomach contents of 720 specimens of size range 24-32 cm analysed using numerical and points methods during Oct-Apr 1958-59 form the material in the study. Volume of the food is found by displacement method. The fish is found to have fed on a veriety of micro and macro-planktonic organisms, depending on their availability and abundance in the area and copepods, stomatopod larvae, decapod larvae, *Lucifer* and *Acetes* forming the main items, in addition to Bacillariophyceae, Dinophyceae, etc. which were present regularly in large numbers. *Evadne, Penilia* and fish eggs are stated to have been recorded in certain months.

293. NARAYANA RAO K V 1962. Observations on the bionomics of the Indian mackerel, *Rastrelliger kanagurta* (C), caught in the Lawson's Bay, near Waltair, Andhra coast. *Proceedings of the Symposium on Scombroid Fishes*, Marine Biological Association of India, Mandapam Camp, 12-15 January 1962, Part II, p. 574-585.

Feeding habits of the juvenile, medium-sized and adult mackerel studied during 1954-55 are reported. Possibility of spawning during Oct-Apr is suggested. From the ova-diameter-frequency polygons fractional spawning is suspected, as also the individual fish spawning twice in a season.

From the length-frequency, a faster growth of 2-3 cm per month in juveniles is inferred.

294. NARAYANA RAO K V 1970. The Indian mackerel — Exploitation. *Bull. Centr. Mar. Fish. Res. Inst.*, No. 24, p. 55-76.

This deals with the fishing crafts, gear, efficiency and selectivity of gear, fishing areas, fishing seasons, fishing operations and results, effort and intensity, catch, factors affecting the fishery and forecasts. Graph and tables on catch up to 1968 are given.

295. NARAYANA RAO K V, MUTHIAH C, MADAN MOHAN 1988. Marine fish calendar. 1. Mangalore. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 79: 1-23.

The scientific and vernacular names, gears employed in the fishery, peak periods of occurrence, length range in the commercial fishery, size at first maturity and spawning season of *Rastrelliger kanagurta* in Mangalore region are presented along with a figure of the fish. Mackerel is stated to have formed 10.5% of the total marine fish catch during 1981-'85.

296. NARAYANA RAO K V, PAMPAPATHI RAO K 1957. Differences in the food of the young and adult Indian mackerel, *Rastrelliger kanagurta* (Cuv). *Nature*, 180 : 711-712.

In the study made in Lawson's Bay, Waltair, young mackerel of 32- 90 mm were found carnivorous and selective in feeding habits. In the stomachs of 90-243 mm sizes, relatively little zooplankton was found and a sort of avoidance macroplankters noticed. The relationship between the linear measurements of the alimentary canal and total and standard lengths is worked out.

297. NATARAJAN R, BENSAM P 1978. Eggs and early larvae of the Indian mackerel, *Rastrelliger kanagurta* (Cuvier) from nearshore waters of Porto Novo. *Curr. Sci.*, 47 (21) : 829-830.

Descriptions of some eggs collected at Porto Novo during Feb-Mar 1978, are given, assigning them to Indian mackerel. Ten eggs were reared in the laboratory for a short while and the size, shape and embryonic characters of the egg and some stages of development of the larva are described. Measurements and figures of the eggs and larvae are given.

298. NINAN T V, BASU S P, BHARGAVA A K 1984. Important observations on the demersal fishery resources made during 1983- 84. Observations on the demersal fishery resources along Andhra Pradesh Coast. *FSI Bull.*, No. 13, p. 18-21.

Mackerel formed 5-35% of the total catch. Maximum quantity was obtained from area 17-82 where the catch rate was 44.59/kg/hr. Maximum catches were recorded from 51-70 m depths at 28 kg/hr rate; followed by 26 kg/hr at 91-110 m. The common size in the catch was 21 cm.

299. NOBLE A 1962. The food and feeding habits of the Indian mackerel, *Rastrelliger kanagurta* (Cuvier) at Karwar. *Indian J. Fish.*, 9 A (2) : 701-713.

Results of investigations carried out at Karwar in 1960-61 using number method are presented. Relatively copepods and diatoms formed the main food constituents. The quantity and quality of the food was found to vary with the variations in planktonic elements in the inshore area. Intensity of feeding in different months, size and maturity stages are given. An alternation of high and low feeding appears in successive size groups except in 240 mm group where it was very low.

300. NOBLE A 1971. Some deformities noticed in the Indian mackerel *Rastrelliger kanagurta* (Cuvier). *Indian J. Fish.*, 18 (1 & 2) : 187-190.

A few abnormal mackerel caught at Cochin are described and one in every 800 fish were said to be deformed. Common deformities are twisted tails, hunch back and malformed jaws.

301. NOBLE A 1971. Fishery and biology of the mackerel, *Rastrelliger kanagurta* (Cuvier) at Cochin. *Symposium on Indian Ocean and Adjacent Seas. Their Origin, Science and Resources,* Cochin, India, 12-18 January 1971. Marine Biological Association of India. Abstracts. Part II. No. 319.

Both the juveniles and commercial sizes occurring at the commencement of a season are said to be about one year old but originating from 2 different broods.

302. NOBLE A 1972. The fishery of small sized Indian mackerel, *Rastrelliger kanagurta* (Cuvier) off the south-west coast of India during the rainy season of 1972. *Symp. Pelag. Fish. Resour.*, CMFRI, Cochin, Abstracts No. 21.

Landing of 902 tonnes of mackerel of 45-165 mm sizes was reported during Jun-Aug of which 60% occurred in the *Chakara* fishery at Ambalapuzha lasting just for a few days in the first week of July. Being small, the mackerel caught secured only Rs. 82,000/- as against an amount 68 times of it, had they been of commercial range of 170-220 mm sizes.

303. NOBLE A 1972. The Indian mackerel. *Seafood Export Journal,* 4 (9) : 17-26.

Information available on the Indian mackerel such as distribution, statewise landings, food and feeding habits, sex, growth, etc are presented in a popular style. Importance of tagging to study growth, migration and stock is mentioned giving diagrams of some types of tags used.

304. NOBLE A 1972. Surface temperature and its relation to the duration of mackerel fishery at Karwar. *Indian J. Fish.*, 19 (1 & 2) : 167-170.

Relationship between the mackerel season and the minimum surface sea

water temperature in the inshore waters of Karwar during the south-west monsoon is investigated with its applicability in predicting the duration of the fishery. The relations between the catch and the local rainfall and the catch and the dissolved oxygen are examined and are presented.

305. NOBLE A 1974. Entry of the small-sized mackerel, *Rastrelliger kanagurta* (Cuvier) into the Cochin backwater during the monsoon season. *Indian J. Fish.*, 21 (1) : 272-274.

An instance of about 5000 mackerel of length 45-109 mm range with mode at 85 mm caught in stake nets from Cochin backwater in June 1972 is reported. The stomach contents observed and some environmental data are given. Some disturbance in coastal waters is said to drive these fishes into the rivers and backwaters.

306. NOBLE A 1974. Fishery and biology of the mackerel *Rastrelliger kanagurta* (Cuvier) at Cochin. *J. mar. biol. Ass. India*, 16 (3) : 816-829.

The fishery and biology of mackerel at Manassery are studied for the period from May 1965 to April 1968. The fishery is stated to comprise of juveniles during May-Aug and commercial sizes during Oct-Apr, both at the commencement of the season being about one year old but belonging to two different broods. Results of tagging seem to support growth studies made through length frequencies. It is pointed out to avoid fishing of non- commercial sizes as it is uneconomical fetching no worthy price. Supporting figures and tables are given.

307. NOBLE A 1976. The mackerel fishery in India. *Seafood Export Journal*, 8 (11) : 31-35.

The average mackerel landing during 1965-'74 along Kerala- Maharashtra was 71.595 tonnes and it was got at a production ratio of 1:1:1/2:1/5 from a fishing zone restricted to 15, 5, 3 and 3 km width respectively yielding per sq. km 4.04 tonnes in Kerala, 18.30 tonnes in Karnataka, 40.35 tonnes in Goa and 7.14 tonnes in Maharashtra (up to Ratnagiri). If the zone is extended uniformly to 15 km throughout the coast, the area of exploitation and the catch theoretically increase thrice in Karnataka and 5 times each in Goa and Maharashtra making the total 196,030 tonnes against 71,595 tonnes and changing the ratio to $1:2^1/_2:2^1/_2:1$. Though the 199,120 tonnes catch in 1971 exceeded the theoretical value, the production ratio remaining 1:2/3:1/3:1/20 respectively, makes the theory far from real. On the other hand, if the 1965-'74 average catch is deemed to have come from 15 km wide zone, the catch per km^2 falls to 6.10 tonnes in Karnataka, 8.05 tonnes in Goa and 1.43 tonnes in Maharashtra making it more comparable with the 4.04 tonnes of Kerala. The fishery at Andaman and Nicobar Islands is suggested for improvement.

308. NOBLE A 1979. The Indian mackerel in 1978. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 8 : 1-11.

All India and statewise mackerel landings for 1978 is presented identifying important zones of fishing along the coast of each state. Monthwise catch is presented in an illustration to define seasons. Length distributions in the catches at important centres in each state are given. Information on growth, age, mortality, sex composition, maturity and spawning, feeding and forecast are given.

309. NOBLE A 1980. Is there a ten year cycle in the mackerel fishery? *Seafood Export Journal*, **12** (4) : 9-14.

All India and centrewise (along west coast) mackerel landings examined for the past few decades are said to indicate a pattern of recurring ups in and or around the confluence of 2 decades and downs in the middle of a decade suggesting possibility of predicting similar trends in future.

310. NOBLE A 1982. Distribution of the Indian mackerel, *Rastrelliger kanagurta* (Cuvier) along the coasts of India in 1979 and 1980. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 36 : 7-15.

Annual mackerel production, production in relation to total fish catch, catch in east and west coasts, catch in different states and seasonal distribution at all-India and state levels are given.

311. NOBLE A 1982. Strategy for research and development of marine fisheries in Karnataka. *Proceedings of the Seminar on Research Management in Fisheries Sciences*, College of Fisheries, University of Agricultural Sciences, Mangalore, 17.5.1982. Tech. Sess-II, Paper 2 - Proceedings, 33-39.

During 12 years of 1969-'80 period, mackerel in Karnataka is said to constitute 30.3% of marine fish catch and is in fact said as the only fish the state can claim propriety over.

312. NOBLE A 1982. Some observations on the resources of the Indian mackerel (*Rastrelliger kanagurta*) (Cuvier). *Symp. on Harvest and Post-harvest Technology of Fish*. Tech. Sess. on Harvest of Marine Fishery Resources. 24.11.1982, CIFT, Cochin. *Abstract* No. 2.

Average mackerel catch during 1950-'80 is given as 75,000 tonnes. However, during the seventies it was 92,000 tonnes. The potential estimated being only 127,000 tonnes, caution in mechanisation of fishing is hinted.

313. NOBLE A 1985. The mackerel fishery — A short review. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 63 : 1-6.

The trends in production of mackerel for the years 1950-'83 are reviewed at all India and state levels. Research highlights and the prospects for the mackerel fishery are discussed. The supporting data are presented in histograms, maps and graphs.

314. NOBLE A 1986. 2. The Indian mackerel. *R & D Series for Marine Fishery Resources Management,* Central Marine Fisheries Research Institute, Cochin, No. 2, 4 pp.

An extension folder, it contains a brief write up on the status of mackerel production in India. Based on the Institute's findings, the mortality rates, rate of exploitation, average annual yield, annual stock and standing stock are given. Studies on yield per recruit indicate the exploitation would be at its best when the fish is $1^1/_2$ years old, 200 mm in length and 80g in weight. Maximum sustainable yield is estimated to be around 218,000 tonnes. Indiscriminate fishing and proliferation of purse-seining are recommended to be avoided. Suspension of mechanised fishing during Jun-Aug as a measure of conserving spawners is also recommended.

315. NOBLE A 1986. Some insights into the resource of the Indian mackerel, *Rastrelliger kanagurta* (Cuvier). *Ph.D. Thesis.* University of Cochin, 147 pp.

The thesis embodies sections on identity of the species, information on its spatial and temporal distribution along the Indian coast, study on length-weight relationships, growth and age determination, population studies and stock assessment and discussions. The biological studies are based on commercial catches at Cochin during 1965-'80. Using 16 years data, a relationship between the 'a' and 'b' values in length-weight relationship is worked out. Growth parameters such as $L\infty$ $W\infty$, K, and t_0 are found out and the growth curve fitted using von Bertalanffy's equation. Estimates on mortalities, yield per recruit, eumetric fishing and yield curves, rate of exploitation, standing stock, annual stock and potential yield in India made. The observations and findings are amply substantiated with necessary tabulated data and appropriate illustrations.

316. NOBLE A 1991. Pelagic fishery resources of India — its exploitation and potential. *Training Programme on Marine Fisheries,* Nov 26 - Dec 4, 1991 CMFRI, 9 pp.

A note on mackerel, its catch, availability and gear is provided. The fish is said to add Rs. 75/- crores annually to national income. The stock may support only marginal increase in catches.

317. NOBLE A 1991. Trends in the mackerel fishery — past, present and future. *International Symposium on Oceanography of the Indian Ocean,* NIO, Goa, 14-16 Jan 1991, Abstract, No. B 35.

Annual landings of the Indian mackerel through past few decades showing 10-year cycle with peaks in and around the confluence of two decades and falls in the middle of each are presented. Based on trend in long-term fluctuations, forecasts made turned out to be true in nineteen eighties. After the low catches in 1974, the fishery recovered in 1978. Subsequently, it dropped during 1982-'84 but attained an all time high

of about 291,400 tonnes in 1989. Presently, it gives a glossy picture of the fishery. The trend, however, forewarns bad days by about the middle of the nineties and a 10 year wait for the next revival. The long-term fluctuations in the fishery seem to be caused by fishery independent factors and genetics is of doubtful influence in the case of the Indian mackerel.

318. NOBLE A 1992. Trends in the mackerel fishery of India — past, present and future. *International Symposium on Oceanography of Indian Ocean*, NIO, Goa, 14-16 Jan 1991. Oxford IBH Publishing Co., Pvt. Ltd., New Delhi.

Annual landings of past few decades depicting a 10-year cycle is presented. With very high catch of 291,400 tonnes in 1989, the trend presents a glossy picture. But it forewarns bad days by about the middle of nincteen nineties and a 10-year wait for the next revival. This long-term fluctuations seem to be caused by fishery independent factors and genetics is of doubtful influence in the case of the Indian mackerel. Occurrence of abnormal mackerel is significant as an indication of interbreeding by different strains in population.

319. NOBLE A, DHULKHED M H, YOHANNAN T M, GOPAKUMAR G, PILLAI N G K, KULKARNI G M 1992. Present status of exploitation of fish and shellfish resources — Indian mackerel. *Bull. Cent. Mar. Fish. Res. Inst.*, **45** : 85-91.

The catch trend at important centres like Vizhinjam, Cochin, Calicut, Mangalore, Karwar and Goa and biological aspects such as length composition, maturation during monsoon, premonsoon and postmonsoon seasons are dealt with. During monsoon period the mackerel contributes to only 3% of its annual total catch along west coast. In the light of the information presently available, a reduction in fishing effort in the latter half of premonsoon and monsoon is suggested for replenishment of stock.

320. NOBLE A, NARAYANAN KUTTY VA 1978. Economics of the indigenous fishing units at Cochin: a case study. *CMFRI, Special publication*, No. 4, 24 pp.

While dealing with the financial projections of *Thangu vala* and *Ayila vala* units at Manassery, Cochin, statistical data on catch and effort of fish landings including mackerel for 10 July-June fishery years during 1967-77 are presented. Mackerel forms an important item in terms of quantity landed and value in rupee realised.

321. NOBLE A, SATHIANANDAN T V 1991. Trends in all-India mackerel catches studied using ARIMA models. *Indian J. Fish.*, **38** (2): 47- 50.

Annual mackerel landings in India seem to exhibit a 10-year cycle in long-term fluctuations. To find a suitable forecasting model, the catch data

were studied following Box-Jenkins method for time series analysis ARIMA (1.0.0), and found it to hint at a 10- year cycle but seem to lack seasonal term.

322. OKERA W 1982. Observations of the maturation condition of some pelagic fishes from northern Australian waters. *CSIRO Mar. Lab. Rep.*, No. 144, 17 pp.

Among various fishes studied microscopically for maturity conditions *Rastrelliger kanagurta* taken from the Timor-Arafura seas during June-July and November-December 1980 had been either ripe or spent, whereas those from the Gulf of Carpentaria were in the early stages of maturity. Details of the surveys and the methods of study are given.

323. PAI M V 1972. Need for a critical review of the basic features of mackerel biology. *Symp. Pelag. Fish. Resour.*, CMFRI, Cochin, *Abstracts*, No. 18.

The paper presents the divergent views and urges the desirability to have an objective evaluation of the existing data and find solution on controversies existing on the biological features such as reproduction and growth of the Indian mackerel.

324. PAI M V, SOMASEKHARAN NAIR K V, JAYAPRAKASH A A, ABDUL NIZAR M 1983. Fluctuations in the mackerel catches at Cochin. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 48 : 9-11.

Some biological and statistical observations on unusually heavy mackerel catches of 294 tonnes on 21st and 109 tonnes on 28th of Sept 1982 are presented. The number of units, catch per unit, the size ranges and dominant modal sizes of the fish are also given.

325. PAI RAGHUVENDRA, REDDY M P M 1985. Effect of oceanographic features on the pelagic fisheries along Malpe coast. *Mysore J. agric. Sci.*, **19** (3) : 198-204.

Oceanographic data collected from Malpe coast are correlated with the landings of mackerel. The salinity and temperature are stated to be factors found influencing mackerel fishery. A map showing the location of sampling stations and graph showing the monthly fluctuations of mackerel landings, surface salinity, temperature and zooplankton dry weights are given. Vertical distribution of pH and extinction coefficient values at different stations are tabulated.

326. PAIROH SUTTHAKORN, RAVI SARANAKOMUL 1987. Biological aspects of chub mackerels and round scad on the west coast of Thailand. *BOBP/ REP/39*. Annexure 2 : 48-80.

The study is made dividing the coast into 3 areas. *R. brachysoma, R. kanagurta* and *Decapterus* spp. are studied. Sex ratio, maturity and spawning are dealt with. Size at first maturity is given. Peak periods

of spawning are mentioned. Monthly mean weight of gonads, gonadal index, percentage variation of stages of maturity are illustrated. Eggs and larval surveys were conducted in 1985. Postlarvae collected are figured. But they are identified at generic level as *Rastrelliger* spp. only.

327. PANDEY A K, SANDHU G S 1992. *Encyclopaedia of Fishes and Fisheries of India*. Anmol Publications, Vol. 7 : 177-178.

The mackerel is given here as *Scomber microlepidotus*. Characters are described and a few regional names are provided.

328. PANIKKAR K K P, SATHIADHAS R 1989. Marine fish marketing trend in Kerala. *J. mar. biol. Ass. India*, **31** (1 & 2) : 239-246.

The paper deals with the fish marketing system prevailing in Kerala, the price structure, seasonal and spatial price variations, marketing margins of commercially important varieties of fish including Indian mackerel and the share of fishermen as well as middlemen in consumer's rupee. The landing-wholesale- retail price relationship has also been studied. Tables are given.

329. PANIKKAR N K 1949. A survey of the pelagic fisheries of the world. Part II. The biology of pelagic fishes. *Proc. Indo- Pacif. Fish. Coun.*, Sec. I, p. 126-127.

Areas and pattern of occurrence of Indian mackerel along the south-west coast of India are presented, citing the probable implications. Biological factors on which the fishery might depend are discussed. The delay in monsoon is often followed by a delay in the commencement of the season.

330. PANIKKAR N K 1949. The biology of pelagic fishes. *Proc. Indo-Pacific Fish. Counc.*, Sec. 4, p. 123-132.

A full picture of the distribution will depend on the location of the spawning grounds and the discovery whether there is any deep sea mackerel existing in offshore regions of the coast.

331. PANIKKAR N K 1950. Fish and fisheries. *Progress of Science in India*, Section II, Zoology.

An account on the food and feeding of *Rastrelliger kanagurta* from information available in literature is given. Progress in investigation on the Indian mackerel is said as not commensurate with the importance of the species in marine fisheries of India.

332. PANIKKAR N K 1952. Fisheries research in India. Part I. *J. Bombay nat. Hist. Soc.*, **50** (4) : 764-765.

A brief account on Indian mackerel and its fishery is included, pointing out its peculiarities. Photographs of canoes, boats and rampani nets used

in the fishery along the N. Kanara coast, as well as of fresh mackerel gutted, salted and kept for drying are shown in plates VII & VIII. Enormous shoals of *Rastrelliger* is said to appear on the Konkan coast from October to January.

333. PANIKKAR N K 1956. *Fisheries Development in India* (Souvenir on the occasion of First All-India Fisheries Exhibition at Cuttack), p. 20-88.

Information on mackerel is given.

334. PANIKKAR N K 1967. Fishery resources of the Indian Ocean. *Proc. Symp. Indian Ocean., Bull. N. I. S. I.* No. 38, p. 1-22.

The paper gives a critical account of the fishery resources of the Indian Ocean against the background of oceanographic features. The fishery is important in the Indian ocean as it forms 9% of the marine fish catches. Countrywise it forms 4% in East African countries, 5% in Pakistan, 10% in the west coast of India, 14% on east coast of India, 4% in Bangladesh and 13% in Malaysia. *R. canagurta* is the most important species and it is opined to offer considerable scope for increased production especially from the Arabian Sea. Illustrations given are self explanatory.

335. PANIKKAR N K, JAYARAMAN R 1956. Some aspects of productivity in relation to fisheries of Indian neritic waters. *Proc. Pacific Science Congress*, 3 A : 1111-1122.

There is a distinct and unmistakable gap in the distribution of the major fisheries to the north of Ratnagiri and that north of this place shoals of mackerel are not known but the species is widely distributed having been found in the Persian Gulf and Bay of Bengal and stray specimens have also been taken in the trawls operated off Kathiawar.

336. PANIKKAR P A 1985. Pelagic fishery resources and its exploitation along Karnataka coast — An assessement. In : *Harvest and Post-harvest Technology of Fish*. Ed. by Ravindran K *et al.* Society of Fisheries Technologists (India), Cochin : 28- 30.

In the impact of purse seining on standing stock along Karnataka coast, the report says that the purse-seining on commercial scale though had increased the catch by about 30%, had produced signs of over exploitation that might lead to depletion of stock. The data for 1977-'81 was analysed using the method of surplus production mode, taking cpue as index of relative abundance. The standing stock, maximum sustainable yield, the optimum effort etc. of mackerel worked out are presented. The economic level of exploitation and effort for maximum sustainable yield are also discussed giving tables and figures.

337. PATHANSALI D 1962. A preliminary report on the *Rastrelliger* fishery in Malaya. *Proc. Indo-Pacif. Fish. Coun.*, 9 (2) : 37-48 (1961).

The *Rastrelliger* fishery at Pangkor Island, Perak, is described. *Rastrelliger kanagurta* Cuv. formed an important fishery along the east and west coasts of Malaya. A brief comparison of the trends in development of gear and boats is made for the years 1948 and 1959. Annual landings for the years 1949 to 1960 (to September) together with data on number of boats operating and catch/boat are compared. A similar comparison is made for the years 1958, 1959, 1960 (to September) for each month of the year, but with some additional information. The method of disposal of catches whether iced, boiled or salted, and the quantities for the three years are summarised. Seasonal trends and the size composition of catches are briefly discussed. Some results of biological investigations on spawning, size at first maturity, fecundity and on the feeding habit are included. Tables are given.

338. PATHANSALI D 1962. Note on the scombroid fishery in Malaya. *Proceedings of the Symposium on Scombroid Fishes,* Marine Biological Association of India, Mandapam Camp, Jan 12-15, 1962. Part III, p. 1001-1005.

Fish landings of *Rastrelliger* in 1958-'60 along with *Scomberomorus* spp. and tunas, their season, distribution, gears, etc. are given.

339. PATHANSALI D 1967. A note on a species of *Pneumatophorus* Jordan and Starks found in Malayan waters and the problem raised. *Proc. Indo-Pacif. Fish. Coun.,* **12** (2) : 112-115.

Some problems in obtaining reliable catch statistics when *Pneumatophorus* and *Rastrelliger* species (including *Rastrelliger kanagurta*) had occurred together are presented and discussed.

340. PATHANSALI D 1967. Observations on the gonad maturity stages of female *Rastrelliger kanagurta* Cuvier. *Tech. Pap. Proc. Indo-Pacif. Fish. Coun.,* 12th sess. Sec. II, p. 116-123 (1966).

The sequence of gonad maturation and spawning in female *Rastrelliger kanagurta* Cuvier is described, based on 90 ovaries collected at the Pangkor Island purse-seine landings in December 1960. The results of classifications of gonads based on the *Rastrelliger* Field and Laboratory Keys, are compared and the inadequacy of using ovary weights for such classification is discussed. Some observations are also made on the number of batches of ova that could be spawned in one reproductive season and on fecundity.

341. PETER K J 1967. A note on the record of *Rastrelliger* (Mackerel) larvae from the Indian Ocean. *Curr. Sci.,* **36** (10) : 273-274.

Three early larval stages are recorded attributing to the genus *Rastrelliger.* The specimens are reported as having been collected in an Indian Ocean Standard Net hauled vertically from 200 m to surface during night time. Details of the station from where the larvae were obtained are given. Description and figures of the larvae are furnished.

342. PETER K J 1967. Larvae of *Rastrelliger kanagurta* (Cuvier) from the Indian Ocean. *International Indian Ocean Expedition — Newsletter*, 4 (4) : 25-26.

The already recorded discovery of early larval stages alleged to be that of *Rastrelliger kanagurta* is recounted and importance highlighted.

343. PETER K J 1969. Larvae of *Rastrelliger* (Mackerel) from the Indian Ocean. *Proceedings of the Symposium on Indian Ocean*, New Delhi March 2-4, 1967. *Bull. Nat. Inst. Sci. India*, Part II, (38), p. 771-777.

Some additional details such as length measurements of already recorded 3 *Rastrelliger* larvae are presented and discussed as if they belong to the species *kanagurta*.

344. PETER K J 1973. Baby mackerel. *Seafood Export Journal*, 5 (2) : 31-33.

Description and figures of some larval and juvenile stages of mackerel are presented, stating how the findings could help in tracing the breeding season and spawning grounds of the fish.

345. PON SIRAIMEETAN, MARICHAMY R 1989. Observations on pelagic fish eggs and larvae in the coastal waters of Tuticorin. *Bull. Cent. Mar. Fish. Res. Inst.*, 44, Part I : 245-250.

The paper presented in the National Symposium on Research and Development in Marine Fisheries, Mandapam Camp, 16-18 September 1987 records 3.7-3.8 mm size larvae providing its percentage composition in plankton and peak period of occurrence.

346. PRABHU M S, ANTONY RAJA B T 1959. An instance of hermaphroditism in the Indian mackerel, *Rastrelliger canagurta* (Cuvier). *Curr. Sci.*, 28 (2): 73-74.

A hermaphrodite mackerel obtained from the fish market at Karwar, reportedly caught at Majali on 25-3-1958, is recorded, describing the nature of the abnormality.

347. PRABHU M S, VENKATARAMAN G 1970. Mackerel and oil sardine tagging programme 1966-'67 to 1968-'69. *Bull. Cent. Mar. Fish. Res. Inst.*, No. 17 : 1-38.

An account on the experimental tagging of fish including mackerel attempted by the CMFRI at several centres on the east and west coasts, the paper delves at length on the methodologies adopted for tagging, release and recovery. Information on the types of tags used are given.

348. PRADHAN L B 1951. Mackerel fishery. In : Chopra, B. N. (Ed.) *Handbook of Indian Fisheries*. Govt. of India, Ministry of Agriculture, p. 57-59.

The occurrence and seasons of the fishery of Indian mackerel (under the name *Scomber microlepidotus*) on the east and west coasts of India are

given. The west coast is divided into four zones namely (1) Konkan (2) North Canara (3) South Canara and (4) Malabar. The boats and nets are classified according to the places of operation. The existing and possible methods of preservation of catches are also given.

349. PRADHAN L B 1956. Mackerel fishery of Karwar. *Indian J. Fish.*, 3 (1) : 141-182.

The paper, based on investigations carried out at Karwar during the period from 1948-'49 to 1952-'53, is in fact the first contribution in the country embrasing a number of aspects on the fishery, biology, ecology, catch, craft and gear, methods of fishing, catch per unit of effort, season of abundance, total length, standard length, weight, weight-length relationship, morphometry of head, eye, fin origins; sex ratio, maturity, spawning, food, feeding, growth, predators, enemies, shoaling, migration, environmental aspects influencing the fish and fishery, incursions into estuary, marketing of catch, processing, utilization etc. Monthly size distribution and mode are given and age determined. Sex determination is stated possible only from 120 mm onwards. Minimum size at maturity is found as 224 mm. A description of Rampan unit and fishing by it is available.

350. PRADHAN L B, GANGADHARA REDDY C V 1962. Fluctuations in mackerel landings at Calicut in relation to hydrographical factors. *Indian J. Fish.*, **9 A** (1) : 100-109.

An attempt is made to correlate mackerel landings at Calicut with the hydrographical conditions during Oct 1957 to Sept 1960. Increase in temperature and salinity affect mackerel catch adversely. Effects of rainfall and wind are briefly discussed. The mean monthly values of temperature, salinity and mackerel landings are shown in figures. Average temperature and salinity variations during the mackerel season and total seasonal catch in metric tons are given in table.

351. PRADHAN L B, PALEKAR V C 1956. Key to the stages of sexual maturity of *Rastrelliger kanagurta* (C). *Indian J. Fish.*, 3 (1) : 183-185.

Following the maturity scales adopted by ICES in the Herring Scheme, a key is formulated to the various stages of maturity of mackerel. The extent of ovary, range of ova diameters, appearance of ova, and state of maturity, at the various stages and the extent of testes in body cavity, general appearance of testes and state of maturity of different stages are presented in a table.

352. PRADHAN L B, VIRABHADRA RAO K 1958. The mackerel. In: *Fisheries of the West Coast of India.* Souvenir issued on the occasion of the opening of the new building of the Central Marine Fisheries Research Sub-station at Calicut, CMFRI, p. 38-44.

Occurrence, food and feeding habits, shoaling behaviour, maturity and spawning, spatial and temporal extents of fishery, important fishing centres, gears used in the fishery, methods of disposal of catches, etc. are reviewed. The magnitude of the fishery is indicated in Table I, giving the landing figures as well as the proportion of mackerel in the total landings. Landing for the period 1950-'57 for the west and east coasts are shown comparatively in table II. Landings in 3 different zones, Cape Comorin to Ponnani River, Ponnani River to Mangalore and Mangalore to Ratnagiri are compared. Figures are given for catches etc., of shoreseine, *' chavittuvala'* and *Rampan.*

353. PRAKASH C CHETTY 1990. Bumper catch of mackerel at Panjim, Goa. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 104: 9-10.

A note is given on the bumper catches of mackerel ranging from 14 to 19 cm size by purse seines landed at Panjim jetty on 18th and 19th of September 1989. The catch per boat was as high as 1.5 to 5 tonnes during these days. A figure showing the catch is also given.

354. QASIM S Z 1972. The dynamics of food and feeding habits of some marine fishes. *Indian J. Fish.*, 19: 11-28.

The study of food and feeding habits of marine fishes can be attempted from the standpoint of transfer of energy from one trophic level to another. The mackerel is branded as a plankton feeder. The percentage of organic carbon in its food is found to be 29.86 dry weight and the energy units of food consumed is calculated as 4311.72 cal/g dry weight.

355. QASIM S Z 1973. An appraisal of the studies on maturation and spawning in marine teleosts from the Indian waters. *Indian J. Fish.*, **20** (1): 166-181.

A sort of review written on the subject. Mackerel is shown in a diagram to spawn in June-July and October-December period.

356. QASIM S Z 1973. Some implications of the problem of age and growth in marine fishes from the Indian waters. *Indian J. Fish.*, **20** (2) : 351-371.

The characteristics of some of the well-known growth parameters are described in this perspective, stating the various methods used for estimating the mortality rates of fishes including Indian mackerel. The methods employed by different workers in the study of age and growth, the length and age at first maturity deduced, and the maximum size and age recorded are tabulated and compared. It is concluded that the yield from a fishery could be determined by employing the Beverton-Holt approach and Shaefer approach.

357. QASIM S Z, JACOB P G 1972. The estimation of organic carbon in the stomach contents of some marine fishes. *Indian J. Fish.*, **19** (1-2) : 29-34.

By adopting a method that had been developed for determination of organic carbon in marine muds, the organic carbon in the stomach contents of mackerel and 3 other fishes were determined and compared with the values of the whole fishes and shown the ratios of body carbon to food carbon in zooplankton feeder and carnivore to be about 1, and of phytoplankton and detritus feeders between 5 and 7. It would be interesting to know whether the ratio would change seasonally depending upon the quality of food consumed and also influenced by maturity, spawning and growth.

358. RADHAKRISHNAN A G, ANTONY P D 1991. Pesticide residues in marine fishes. *Fishery Technology*, **26** (1) : 60-61.

Pesticide residues in mackerel *(Rastrelliger kanagurta)* and 3 other marine fishes are reported. Least concentration is found in mackerel. The contents of various pesticides present in fish under study are well below the action level prepared by FDA to cause any health hazard.

359. RADHAKRISHNAN N 1958. Observations on mackerel fishery at Karwar for the seasons 1954-'55 and 1955-'56. *Indian J. Fish.*, **5** (2): 258-269.

The mackerel fishery at Karwar during the two seasons is comparatively described. While dealing with the catch a tendency for a secondary peak was notified in the fishery towards the end of the season during Feb-Mar in both years. No marked differences were found in the size groups of the fish caught at Karwar, Majali, Ankola and Kumta. Length distribution in time and space is provided in tables and is discussed. Also the unit effort of fishing and price-index are also given.

360. RADHAKRISHNAN N 1962. Observations on the maturity and spawning of Indian mackerel, *Rastrelliger kanagurta* (Cuvier) at Karwar. *Indian J. Fish.*, **9A** (2) : 512-524.

Based on observations made during 1955-'58, the monthly length frequencies and maturity stages of mackerel at Karwar are presented. The monthly size progression of ova is shown by frequency polygons, commenting on changes that might be taking place in the intra-ovarian eggs, stage by stage. Measurements of ova from the anterior, middle and posterior regions are stated to have shown no significant difference. The spawning is inferred to commence in Jun-July, and shed ova in batches. The maximum size of the intraovarian eggs is 0.935 mm, and the fully transparent ovum to be with a single oil globule measuring 0.20-0.25 mm. The minimum size at maturity is observed as 210-220 mm TL.

361. RADHAKRISHNAN N 1964. Age and rate of growth of the Indian mackerel, *Rastrelliger canagurta* (Cuvier) with notes on its fishery at Karwar. *Indian J. Fish.*, **11A** (1) : 187-216.

Based on samples studied from Rampan catches, the length - frequency distribution of mackerel at Karwar during 1954-'59 is presented and

discussed. Comparative catch statistics of 7 centres in North Kanara for the 3 seasons commencing from 1956/1957 are presented.

362. RADHAKRISHNAN N S, VIVEKANANDAN E, KUTHALINGAM M D K 1988. Mackerel resources of Madras coast. *Abstracts —Symposium on Tropical Marine Living Resources*, Marine Biological Association of India, Cochin, 12-16 January 1988, Abstract No. 5: 3 .

Reporting high landings of mackerel by trawlers at Kasimedu in 1986, the paper points out the possibility of mackerel forming an exploitable resource of Madras coast. The incidental mackerel landings by the non-mechanised local gear during 1981-'85 are also considered for coming at the conclusion. The length measurements and maturity stages of the fish are given.

363. RADHAKRISHNAN N S, VIVEKANANDAN E, KUTHALINGAM M D K 1991. Some observations on the mackerel fishery resources of Madras coast. *J. mar. biol. Ass. India*, 33 (1& 2): 55-58.

Compared to earlier years, the landings of *Rastrelliger kanagurta* were unusually high at Madras in 1986. At Kasimedu, the landings from trawlers increased from the annual average of 19.1 tonnes during 1981-1985 to 219.0 tonnes in 1986. The catch from the non-mechanised *Eda Valai* (bag net) also exhibited a similar increase from the annual average of 16.6 tonnes during 1981-1985 to 914.5 tonnes in 1986. The catch rates were also very high in 1986. Data collected on length measurements and maturity stages are also presented in the text.

364. RADHAKRISHNAN NAIR P N, GOPALAKRISHNA PILLAI N, SADASIVA SHARMA P S, VELAYUDHAN A K, MATHEW JOSEPH, THOMAS K T, OMANA T A 1988. Marine fish calendar. 9. Vizhinjam. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 87: 1-15.

Mackerel is described with a figure. Based on the data from Vizhinjam from 1981 to 1985, the contribution of mackerel in the total landings is given as 3.54%.

365. RAMAMOHANA RAO V 1962. A note on a hermaphroditic gonad in the Indian mackerel, *Rastrelliger kanagurta* (Cuvier). *J. mar. biol. Ass. India*, 4 (2): 241-243.

A gonad with the right lobe as ovo-testis and the left as ovary found in an otherwise normal mackerel caught from Ullal, near Mangalore, on 1-5-1961 is recorded. The ova-diameter range and the number of transparent ova that were present in both the right and left gonads are given. Photographs and a camera-lucida drawing of the gonad are provided.

366. RAMAMOHANA RAO V 1967. Spawning behaviour and fecundity of the Indian mackerel, *Rastrelliger kanagurta* (Cuvier), at Mangalore. *Indian J. Fish.*, 14 (1-2) : 171-186.

Development of intra-ovarian egg was followed from stage I to VII. Maturing ova segregated into 3 groups by the time the ovary reached stage III and persisted in subsequent stages. Release of 3 batches of eggs during spawning is derived. The minimum size at maturity of the fish from the maturity curve is stated to be 217 mm. The maturity stages pooled for the period 1958-'61, details of material studied and descriptions of the ovary in different phases of spawning are given in tables and the ova diameter frequency is shown in a figure.

367. RAMAMOHANA RAO V, SEKHARAN K V, PRADHAN M J 1962. On the mackerel fishery of the Mangalore area during the period 1957-1961. *Indian J. Fish.*, 9 (2) : 653-678.

Observations on the mackerel fishery made during the years 1957- '61 at Ullal and other centres between Kasaragod and Malpe with emphasis on growth, maturity and trends of catches, are given in detail. According to von Bertalanffy Growth Equation, $L\infty$ is 316 mm and K (on annual basis) 0.6. The catch-per-unit-effort of different gears, length-frequency distributions and relation between catch and cube of length are given. Maturity stages and ranges of ova-diameter during different months are presented. An average rate of decrease per month was calculated from available data for Karwar, Malpe and Mangalore and the range given.

368. RAMANA T V, NATHANIEL D E, REDDY M P M 1988. Distribution of some oceanographic factors in the Arabian Sea off Manjeswar and their possible effect on the oil sardine and mackerel fisheries. *Abstracts — Symposium on Tropical Marine Living Resources*, Marine Biological Association of India, Cochin, 12-16 January 1988. Abstract No. 103 : 51-52.

Monthly vertical distributions of temperature, salinity, dissolved oxygen, etc., observed at 8 stations are treated in correlation with the 2 pelagic fisheries. Of these, temperature and salinity are concluded to have shown direct influence on the mackerel fishery. The observed relationship of the fishery with the different parameters are discussed.

369. RAMANA T V, NATHANIEL D E, REDDY M P M 1991. Distribution of some oceanographic factors in the Arabian Sea off Manjeswar and their possible effect on oilsardine and mackerel fisheries on the area. *J. mar. biol. Ass. India*, 33 (1 & 2) : 9-18.

Studies on the vertical and monthly distribution of sea water temperature, salinity, dissolved oxygen and some other oceanographic parameters carried out at 8 stations in the Arabian Sea off Manjeswar revealed that temperature and salinity of columnar waters to have direct effect on pelagic fisheries of oil sardine and mackerel in the area. Any deviation from their respective optimum values appeared to be responsible for the low catches. Rainfall, pH, dissolved oxygen and transparency were found to have indirect effect on the pelagic fishery of mackerel.

370. RAMBHASKAR B, SRINIVASA RAO K 1987. Comparative haematology of ten species of marine fish from Visakhapatnam coast. *J. Fish. Biol.*, **30** (1) : 59-66.

Of the ten species including mackerel studied from different niche along the Visakhapatnam coast for blood counts, etc. in relation to activity, mackerel is one, which was collected from the shoreseine catches, the values of erythrocyte numbers, haematocrit, haemoglobin and nucleo/ cytoplasmic ratio were high and values of leucocyte numbers and erythrocyte cytosome measurements low, in active species such as mackerel, indicating their higher oxygen demand.

371. RAMBHASKAR B, SRINIVASA RAO K, DURGA PRASAD Y V K, PANDURANGA RAO D. 1991. Eye opacity and fin erosion among fishes from Visakhapatnam harbour waters. *J. mar. biol. Ass. India*, **33** (1 & 2) : 436-437.

The report deals with the frequency patterns of deformities in the fishes from the harbour waters of Visakhapatnam. Caudal fin erosion observed in *Rastrelliger kanagurta* (39.1%) is reported. The photograph of the eroded fin is given.

372. RAO K N A, STEPHEN S, AGADI B M, NAGESWAR B, SUBRAMANYAM Y, BALIGA M 1975. Investigation into the source of epidemics of infantile gastro enteritis in Coondapur. *Indian J. Pediatr.*, **42** (334) : 319-325.

It reiterates that source of the epidemics that had occurred since 1972, causing 23 deaths, has been provingly traced to marine finfishes such as mackerel and shellfishes.

373. RAO P S, UDUPA K S, KULKARNI G K. Price behaviour of fishes at Mangalore. *Mysore J. agric. Sci.*, **12** : 475-478.

Relationship between wholesale and retail fresh fish price, retail fresh fish and retail dry fish prices of some fishes including mackerel during 1971-'72 at Mangalore fish markets are given. A direct correlation between the prices at the 2 markets exists but they are never observed to be uniform. In the case of mackerel the retail fresh fish price was 365% more than the wholesale price. The retail dryfish price, likewise was 833% more.

374. RATCLIFFE C 1981. Purse seine trials off Mahe for small pelagic fish 1973. *Bull. Fish. Div. (Seychelles)*, No. I, 9 pp.

The purse-seining trials made for small pelagic fish species in Seychelles waters in May 1973 by a French Tuna Clipper and the subsequent day and night fishing trials by the Fisheries Division had demonstrated the effectiveness of the method. The operational techniques employed in the trials are given. The apparent reactions of *Rastrelliger kanagurta*, among other three species caught at night, to different intensities of lights are briefly discussed.

375. REUBEN S, SUDHAKARA RAO G, LUTHER G, APPA RAO T, RADHAKRISHNA K, APPANNA SASTRY Y, RADHAKRISHNAN G 1989. An assessement of the bottom-trawl fishery resources of the north east coast of India. National Symposium on Research and Development in Marine Fisheries, Mandapam Camp, 16-18 September 1987. *Bull. Cent. Mar. Fish. Res. Institute,* 44, Part I, p. 59-77.

An overview of the fishery resources on the continental shelf of the north east coast as shown by the bottom-trawl surveys conducted by the Govt. of India fishing vessels during 1961-1985, the paper reports among other things the estimated potential yields of resources including mackerel. Area-wise potential yields and potential yields vs landings of mackerel in Andhra Pradesh, Orissa and West Bengal are shown in table. The distribution of catch rates of mackerel in the explored areas off Andhra Pradesh, Orissa and West Bengal are shown in map.

376. RIVONKER C U, REDDY M P M 1989. Hydrographic conditions off Hosbettu, South Kanara coast and its influence on pelagic fisheries. *Indian J. Fish.,* 36 (4) : 323-328.

Observations on the oceanographic parameters like temperature, salinity, pH, dissolved oxygen and transparency were made at four stations off the Hosbettu region, along south Kanara coast. Temperature and salinity of columnar waters were found to have direct effect on the fishery of Indian mackerel of this region. However, the fishery was indirectly influenced by pH, dissolved oxygen and transparency in the study area. Figures are given.

377. RIVONKER C U, REDDY M P M 1990. Hydrographic conditions in the region off Hosbettu, South Kanara coast and its influence on pelagic fisheries. *Fishery Technology,* 27 (1) : 20-24.

A systematic study of some of the hydrographic parameters were undertaken and efforts were made to correlate the same with the occurrence of fisheries population. Observations on temperature, salinity, pH, dissolved oxygen and transparency were made at four stations off the Hosbettu region, along South Kanara coast. Temperature and salinity of columnar waters were found to have direct effect on the fishery of Indian mackerel of the region. However, the fishery was indirectly influenced by pH, dissolved oxygen and trasparency in the study area. Figures are given.

378. ROSA H Jr 1956. Synopsis of data on the species of the genus *Rastrelliger* Jordan and Starks 1908. *Indo-Pacif. Fish. Coun., Rastrelliger Sub-Committee meeting, Malaya* 1956. Appendix 7 (4) : 1-18.

Feeding time, place, manner, season; type and volume of food and shoaling behaviour from available literature are presented.

379. RUSSELL P 1803. *Description and figures of two hundred fishes, collected at Visagapatnam on the coast of Coromandal.* Vol. II. 1-137. W. Blumer & Co., Shakespeare Press for G&W Nicol, Book-sellers to H.M. Pall-Mall (1803 MD CCCIII).

Original description of mackerel is given on page 27, Plate CXXXVI as *Scomber* with 5 pinnulae on the tail, above and below, a forked tail, the body of long-ovate and squamous. Called by natives as *Kanagurta.* The length given is 10 inches.

380. SADANANDA RAO D, RAMAMIRTHAM C P, KRISHNAN T S 1973. Oceanographic features and abundance of the pelagic fisheries along the west coast of India. *Proceedings of the Symposium on Living Resources of the Seas around India.* Central Marine Fisheries Research Institute, Cochin, India, Dec. 1968, p. 400-413.

The results of a study on the hydrographic properties such as temperature, salinity and Sigma-T (density) content of the surface waters along the west coast of India collected during the cruises of R.V. *Varuna* and other vessels are presented as an average distribution of the factors month-wise for each degree square. This has been used to investigate the relationship of the hydrographic conditions with monthwise pelagic fish landings such as those of the oil sardine and the Indian mackerel. Noticeable regional and seasonal variations in the abundance of the oil sardine and the mackerel along the coast are described. In general, the abundance of the mackerel is more in the regions north of 13° N than the south. The higher salinity values in the northern regions appear to be more favourable to mackerel. The low abundance durir g monsoon is conspicuous. The importance of coastal phenomena like upwelling and sinking in relation to fish landings is pointed out.

381. SADANANDAN K A, KUNJIPALU K K, GEORGE N A, JOSEPH MATHAI T 1975. Purse seines off Goa. *Fish. Technol.,* **12** (1): 45-51.

While dealing briefly with the design, construction and operational details of the purse-seines operated for sardines and mackerel, the season for these fishes are said to commence by the middle of October and lasts upto the end of December. However, in 1970-'71 the season continued up to March. The purse-seines here were found to operate in grounds limited to 20 m depth and below. The average landing of mackerel per day by a purse-seiner was 2 tonnes, the maximum got being 6 tonnes.

382. SAM BENNET P 1967. Seasonal abundance of small sized juvenile (*Rastrelliger kanagurta*) at Vizhinjam during 1960-'63. *Indian J. Fish.,* **11** (1) A: 391-406.

The fishery of mackerel at Vizhinjam Bay between July 1960 and July 1963 by boat seines, shore seines and drift nets is studied. Juveniles of size 3.5 cm and above supported the fishery. The length frequencies and estimated ages of the fish are given. Tables and figures are included.

383. SAM BENNET P 1967. On *Bomolochus jonesi* sp. nov. parasitic on the eye of the Indian mackerel, *Rastrelliger kanagurta*. *J. mar. biol. Ass. India*, 9 (1): 132-136.

The description is of female, of which over 200 specimens were collected from mackerel landed at Calicut between August 1965 and July 1966. Comparison is made with other known eye parasites from India. Figures are given.

384. SAM BENNET P, ARUMUGHAM G 1991. The present status of small-scale traditional fishery at Tuticorin. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 113: 1-16.

Average monthly landing of marine fish including mackerel during 1986-'90 are given. The mackerel in total marine fish catch amounts only to 0.27%. However, the information being the Ist account is important. Mackerel were caught here by drift nets forming 5.3% ranking 8th in its catch, shore seine with 2.8% and 7th rank and Hilsa net (Catamaran unit) with 13% and 3rd rank.

385. SAMUEL C T 1967. An analysis of the marine fish catch in Kerala from 1957-'58 to 1965-'66. *Bull. Dept. Mar. Biol. Oceanogr.*, 3: 61-73.

Based on catch data taken from several sources and on the data on raw material supply to the seafood industry, the paper presents an analytical profile of the marine fisheries of Kerala. The total annual catches of mackerel by non-mechanised craft from 1957-'58 to 1965-'66 worked out are presented in table, and the total annual catches in India shown in graph. The data are reported to have shown a gradually decreasing trend of abundance from south to north. Some suggestions are included aiming at increasing the mackerel yield.

386. SAMUEL C T 1968. The mackerel. In: *Marine Fisheries in India*. Chap. XVII, p.146-150.

Information on the fisheries of Indian mackerel, such as the occurrence, biological characters, fishing area, season, gears used, etc., are given in brief. Catch data for 1950-1965 are given.

387. SANDERS M J, KEDIDI S M, HEGAZY M R 1984. Stock assessment for the Indian mackerel (*Rastelliger kanagurta*) caught by purse seine from the Gulf of Suez and more southern Red Sea waters. *FAO/UNDP/RAB/83/023/03*, 42 pp.

It gives in brief the values obtained on an assessment of stocks of Indian mackerel caught in Egyptian Red Sea waters, including the Gulf of Suez. The study was based on catch sampling undertaken principally during the 3 seasons including and subsequent to 1979/'80. The estimates obtained for the growth constants relevant to the oscillating growth modification of the von Bertalanffy equation are L = 44 cm, K = 0.200,

t_c = -0.760 yr, t_s = 0.657 yr and c = 1.405; in respect to estimating length from age. The estimates obtained for the natural mortality coefficient are about M = 0.45; while Z is generally 2.0. The maximum yields are likely to be obtained from fishing mortality of about 1.0 (with an 8 months fishing season).

388. SATHYANARAYANA A V V, SADANANDAN K A 1962. 'Chala Vala' encircling gill nets, for sardines and mackerels of the Kerala coast with special reference to their design and construction. *Indian J. Fish.*, **9B** (1): 145-155.

The results of some observations on the traditional encircling surface gill net *Aila chala vala* used for the capture of mackerel at Chellanum, Southikkal, Narakkal and Azhikode in Kerala are reported. The details of take up, spread of net in water, buoyancy and weight per unit length of ropes and variations observed in the nets are discussed in addition to the description of its design and construction. Figures and tables are included.

389. SCARIAH K S, VARUGHESE PHILIPOSE, DAN S S, KARUNAKARAN NAIR P, SUBBARAMAN G 1987. An appraisal of the marine fisheries in Orissa. *CMFRI Special Publication*, No. 32, 36 pp. and Appendix.

Quarterwise landings of mackerel in 1975-'84, gearwise contribution by mechanised and non-mechanised units in 1980-'84 and quarterwise Indian mackerel landings by trawlers at Paradeep during 1980-'84 are included in the Tables in the Appendix.

390. SEKHARAN K V 1958. On the South Kanara coastal fishery for mackerel, *Rastrelliger kanagurta* (Cuvier) together with notes on the biology of the fish. *Indian J. Fish.*, **5** (1): 1-31.

The paper deals with the coastal fishery for mackerel between Baikampady and Tarapathy in the South Kanara District, with special reference to Malpe, during 1954-'56. Monthly catch data along the coast for 12 years from 1944-'45 is given. In support of 2 peaks in landings during a season, peak months from 1925-'26 onwards are tabulated. The centres of fishing, manpower and the number of nets employed are given. *Rampan* not being operated at night, it is suggested that only 50% of potential is caught. Stock that supports the fishery is said to touch the coastal waters only for a short period. The fish is opined to grow 12-15 cm in one year. They measure 21-23 cm by the end of 2nd year and then spawn for the first time. Spawning is said to start in April. Food is abundant in coastal waters when mackerel enters the area. But the coastward migration may not entirely be a direct response to plankton production.

391. SEKHARAN K V 1962. On the mackerel fishery of the Mandapam area. *Indian J. Fish.*, **9A** (2): 714-727.

Mackerel supports a minor fishery along Gulf of Mannar coast, but

generally it is negligible on Palk Bay side. Monthly catch-per-man-hour data during 1952-'56 show higher values for night hauls than day hauls, probably on account of their ability to avoid capture more easily during day than night. Between night and day catches, studies on size and age composition and length-weight relationships are given. Average cube length for each haul plotted against the catch in numbers showed a tendency in the latter to drop. The fishery is supported by a single age group. The fishery is studied in relation to certain hydrological characters.

392. SEKHARAN K V 1966. *Studies on the biology and fishery of some sardines and mackerel.* Ph.D. Thesis, Madras Univ., Madras.

Deals with fishery and biology of the species.

393. SEKHARAN K V 1972. An estimate of the stock of the mackerel in the present fishing grounds off the west coast of India. *Symp. pelag. fish. resour., CMFRI, Cochin.* Abstracts, No. 20.

The Z, F, M and U of mackerel of the west coast have been estimated respectively as 2.05, 1.15, 0.9 and 0.49. Estimates on stock are given.

394. SEKHARAN K V 1974. Estimates of the stocks of oil sardine and mackerel in the present fishing grounds off the west coast of India. *Indian J. Fish.*, 21 (1): 177-182.

By applying Beverton (1954) and Beverton and Holt (1957), M in the case of mackerel is estimated as 0.9 and F as 1.15. Taking the annual average catch in the west coast for the period 1960-'71 as 65,000 tonnes, the total annual stock in the fishing grounds is estimated around 130,000 tonnes and the average standing stock 57,000 tonnes. Stock estimates based on slightly different values of F and M are also attempted.

395. SEKHARAN K V, NAIR R V 1975. The fishery resources of the shelf waters around India. In: *Fish Processing Industry in India*, Symposium held at CFTRI, Mysore on 13 & 14 February 1975, p. 28-35.

The trends in mackerel fisheries are reviewed, estimating the potential yield from the continental shelf. The average annual catch in India during 1950-'54 and 1969-'73 with percentage and the annual potential catch are given in tables. The trends in the catches and the biological characteristics of the stock, stock assessment and potential catches as observed by various authors are discussed. The estimated annual catch in India during 1950-'73 is shown in graph.

396. SEKHARAN K V, NOBLE A, REGHU R 1975. Immigration of sardines and mackerel into estuaries. *Symp. Est. Biol., Cochin., Abstract* No. 7, p.14.

The young ones of typically marine sardines and mackerel are seen regularly entering estuaries during rainy season. Similarly adults go upstream in summer when salinity is high. A summer fishery for mackerel is found 30 km upstream in Godavary estuary.

397. SELVAKUMAR R A 1970. Cladoceran swarms in relation to mackerel fishery along the west coast of India. *Curr. Sci.*, 39 (21) : 481-482.

An observed relationship between cladoceran swarm and mackerel fishery is recorded based on a study made at Karwar during the 1966 fishing season and at Goa in 1969 season, citing some earlier findings on the two parameters as additonal support.

398. SERVENTY 1952. *Emu*, 52 : 49.

Specimens eaten by Boobies (*Sula lencogaster*) at Bedout Island, Western Australia are noted.

399. SESHAGIRI RAO C V 1991. Scientific, common and local names of commercially important edible marine fin and shell fishes of Andhra Pradesh. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 108 : 1-32.

Scientific, common and local names of Indian mackerel are given on p. 8.

400. SESHAPPA G 1958. Occurrence of growth checks in the scales of the Indian mackerel, *Rastrelliger kanagurta* (Cuvier). *Curr. Sci.*, **27** (7): 262-263.

Having examined the scales of 369 specimens collected from North Kanara during October-December 1957, it is claimed that in fish above 23 cms, clear rings in scales that are useful in maturity and racial studies could be discerned. Photomicrographs of scales and a table showing the distribution of rings among different size-groups are furnished.

401. SESHAPPA G 1969. The problem of age determination in the Indian mackerel, *Rastrelliger kanagurta* by means of scales and otoliths. *Indian J. Fish.*, **16** (1&2): 14-28.

Scales of Indian mackerel, collected from different centres during the periods 1955-'67 and 1969-'70 were studied. While scales from fish below 210 mm TL had no rings a small percentage in 210-229 mm and large percentage in 230 mm and above had rings. Two rings have been observed frequently in specimens above 250 mm and upto 4 rings were seen in very large specimens of Vizhinjam and Mandapam. The rings, it is said, are caused by the physiological strain that accompanies growth, ripening of gonads and spawning. The otoliths, however, had no annuli. The study shows the fish to attain 11-15 cm T^L by the end of first year, 21-24 cm by the end of 2nd year, 25-27 cm by the end of 3rd year and 28-29 cm by the end of 4th year. Six tables are given, projecting the database differently.

402. SESHAPPA G 1970. Mackerel — An important fish in the seas around India. *Indian Farming*, **20** (1): 39-41.

A compendium on Indian mackerel, the write up touches on its distribution, fishery, biology, ecology, etc.

403. SESHAPPA G 1985. On the homogeneity of the mackerel populations at Calicut during the years 1969 to 1976 as determined on the basis of C/L, C/W and TL/SL ratios. *Indian J. Fish.*, **32** (3): 359-374.

The counts of anterior circuli on the scales (C) are correlated with the length (L) and weight (W) of fish, and so also the standard length (SL) with the total length (TL). The weight of fish and the count of circuli are shown to bear a straight-line relationship. The difference of C/W ratios of successive years obtained by t-test is reported to be non-significant. The average TL/SL ratio for the data pooled for the entire period is found to be 1.24. Finally it is concluded that there had not been any genetic change in stocks at Calicut in the years of study.

404. SHANMUGHA VELU C R, MAHADEVAN PILLAI P K 1980. On the results of exploratory pure seining between Cochin and Goa. *Indian J. Fish.*, **27** (1 & 2): 183-192.

In the fishing along the Cochin-Goa coast by the experimental purse seiners of the Integrated Fisheries Project, Cochin, and the Exploratory Fisheries Project at Mangalore and Goa during January 1975 to June 1978, the Indian mackerel is said to have formed an important component of the catch. A map and tables are included.

405. SHINDO SHIGRAKI, CHULLASORN SOMSAK 1980. Economically important marine fishes in the Southeast Asian waters. *SEAFDEC Text/ Reference Book Series*, No. 17:484-486.

Synonyms, distinctive characters, distribution, biology, fishery, forms of utilisation and a figurre of *Rastrelliger kanagurta* are given. Diagrams showing catch and value of the fish caught in the Southeast Asian waters are included.

406. SHITLEY G P 1944. *Austr. Zool.*, **10** : 268.

The species *Canagurta* is recorded to have been caught from February to July in various years down to Yeppoon.

407. SILAS E G 1962. Bioluminescence and mackerel fishery. *Proceedings of the Symposium on Scombroid Fishes*, Marine Biological Association of India, 12-15 January 1962, Part III, p.1012-1017.

Sighting of cresentic luminescent patches of mackerel shoals off Ratnagiri is reported. Taking advantage of the bioluminescence of mackerel, desirability of exploring possibilities of purse-seining at night is drawn. However, some attendant problems are indicated.

408. SILAS E G 1974. Larvae of the Indian mackerel, *Rastrelliger kanagurta* (Cuvier) from the west coast of India. *Indian J. Fish.*, **21** : 233-253.

Prolarval and postlarval stages of sizes varying from 1.73 mm to 8.6 mm (T.L), picked out from plankton collected on board R.V. *Varuna* from the

south-west coast, are described with illustrations, arranging them into a development series. The distribution of larvae, their diurnal variation in occurrence, comparative abundance on the shelf and oceanic waters and among different latitudes and the environmental conditions are discussed on the basis of data collected from 92 stations in May 1964.

409. SILAS E G, JACOB T, GEORGE K C, GEORGE M J 1980. India — Status paper on coastal fishery resources along the east coast. *Stock Assessment Consultation*, Vol. 2. *BOBP/REP/10.2*: 23-44.

Brief information on the fishery and biological characteristics of mackerel is given on page 31. Estimated statewise fish landings on the east coast of India including Andamans during 1975-'79 in tonnes is also given.

410. SILAS E G, PARAMESWARAN PILLAI P, JAYAPRAKASH A A. AYYAPPAN PILLAI M 1984. Focus on small scale fisheries : Drift gillnet fishery off Cochin, 1981 and 1982. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 55: 1-12.

The study carried out on the mechanised drift gillnet fishery off Cochin and the cost-benefits of the operation during the period 1981 and 1982 are reported. Estimated monthwise landings of major groups of fishes during the period are shown. Annual catch, price (lower panel) and fluctuation in price per tonne (upper panel) of fishes are shown. Monthwise fluctuation in the price is also shown.

411. SIN-CHE LEE, HUNG-CHIA YANG 1983. Fishes of the sub order Scombroidei of Taiwan. *Bull. Inst. Zool. Academic Sinica*, **22** (2): 224.

Keys, diagnosis, synonyms and figures of *Rastrelliger kanagurta* are included.

412. SIVADAS M 1986. Occurrence of juvenile mackerel at Mandapam, Gulf of Mannar coast. *Indian J. Fish.*, 33 (4): 479-480.

Occurrence of juvenile mackerel of 80-110 mm total length at Mandapam, incidentally for the first time, is recorded.

413. SIVALINGAM S 1955. Wadge Bank trawl fishing — 1955. *Dept. Fish. Ceylon, Fisheries Station Progr. Rept. Biological and Technological*, 2 : 2-3.

Provides information on mackerel from the place.

414. SIVAPRAKASAM T E 1986. Potential trawl fishery for mackerel off Orissa and West Bengal coasts. *Occ. Pap. Fish. Surv. India*, No. 2, 7 pp.

A potential trawl fishery for mackerel is indicated based on the exploratory survey conducted by *Matsya Darshini* along off Orissa - West Bengal coasts in December 1985. The vessel had 81 tonnes of mackerel, forming 56% of the catch. The catch rate varied between 0.19 kg in 50 m to 210 kg in 101- 150 m depth. Tables showing the spatial and temporal abundances are furnished.

415. SIVAPRAKASAM T E 1986. A study of the demersal resources of the Wadge Bank and the Gulf of Mannar. *Bull. Fishery Survey of India,* No. 15: 1-37.

Relative abundance of mackerel in catch per hour and its percentage in Wadge Bank and Gulf of Mannar and depthwise distribution are provided in tables and figure. Results of Wadge Bank survey during October 1981 - December 1982 are dealt with and areawise and depthwise data on mackerel are also given.

416. SIVAPRAKASAM T E 1991. Pelagic and oceanic resources of the Indian EEZ. *Proc. Nat. Workshop Fish. Resour. Data Fish. Indus.,* p. 108-127.

In surveys by *Matsya Varshini* purse-seining along south west coast, about 15 tonnes each of mackerel and oil sardine were obtained. Sixty four per cent of the item shown as other fishes comprised of the mackerel.

417. SIVASUBRAMANIAM K 1987. Scads and chub mackerels (*Decapterus* spp. and *Rastrelliger* spp. in the Bay of Bengal. *BOBP/REP/39: Annexure* 5, p. 117-145.

Besides *R. kanagurta* occurring in India, *R. brachysoma* and *R. faughni* are also reported to occur at Andamans. Percentage contribution in catch by different species at different countries and gears used at each country are listed in tables. Production of mackerel in east coast of India during 1970-'82 is tabulated. Likewise gearwise production trends during 1971-'81 on the west coast of Thailand, annual catch during 1982-'85 along the coast of Peninsular Malaysia are given in tables. Catch rates, seasonality and occurrence, general distribution, size, age, growth, maturity, spawning, exploited and potential stocks, etc are reviewed. Countrywise size range, modal sizes, K, $L\infty$, t_o, size at first maturity, and spawning season are given in tables. Length distribution observed during the cruise of RV *Dr. Fridtjof Nansen* are given in figures. Correlations between production of mackerels by purse-seiners and bottom trawls on the west coast of Peninsular Malaysia in 1968-'85 is illustrated in a figure.

418. SIVASUBRAMANIAM K 1991. Kattumaram fisheries and fisherfolk. *BOBP/WP/70,* p. 1-45.

Mackerel finds a place in a table depicting the species/ species groups of varieties caught by various combinations of craft and gear and their individual catch rates (kg/fishing day), to indicate the relative proportions in the catches. Mackerel gets a price mostly of Rs. 2 to 3/-. The maximum price for it goes upto Rs. 5/-. During peak season the mackerel are gutted and salt cured in makeshift tanks on the ground, with large quantities of the viscera from the fish being dumped in the intertidal zone. The fishermen receive 83% of the consumer price in fresh condition at Ongole market.

419. SMITH J L B 1962. Scombroid fishes of South Africa. *Proc. Symp. Scombroid Fishes.* Mandapam 12-15, 1962, Marine Biological Association of India Part I: p. 165-183.

Description and systematic position given. Synonyms and local names available.

420. SOMVANSHI V S, JOSEPH P J 1983. Recent advances in fisheries resources survey along east coast. Discovery of new fisheries resources and location of new fishing grounds. *Exp. Fish. Proj., Newsletter, Special Number,* 4 (2), 9 pp.

Exploratory surveys off Andhra and Orissa report good concentrations of mackerel at 40-50 m depth range, 50-60 km away from shore during October-January period. About 12 tonnes of mackerel were caught in a single haul during this survey and the coast is suggested as highly productive for the species.

421. SORENTINO CARLOS 1979. Mercury in marine and freshwater fishes of Papua New Guinea. *Aust. J. Mar. Freshw. Res.,* 30 (5): 617-624.

The Hg content of 19 fish species including *Rastrelliger kanagurta* was surveyed. The content was found to be 0.5 µg/g which is limit recommended by WHO in all fishes except *Lates calcarifer* in a river system.

422. SORIANO M L, TAMPUBOLON G H, WIDODO J 1988. Discriminant analysis of morphometrics of Indian mackerel (*Rastrelliger kanagurta)* in the Malacca Strait and scad (*Decapterus russelli)* in the Java Sea, Indonesia. *FAO Fish. Rep.,* No. 389, p. 411-415.

Morphometric measurements of Indian mackerel in Indonesian waters were analyzed using the linear discriminant method in order to identify existence of homogeneous subpopulations of the fish. *R. kanagurta* was found to form two distinct groupings in the northwestern Malacca Strait.

423. SOUSA M I 1983. Report on the survey with R/V *Pantikapey* in June 7-23, 1981 on the Sofala Bank. Demersal fish and by-catch fish of horse and Spanish mackerel. *Rev. Invest. pesq.* (Maputo), (4).

This report of the research cruise (7 to 23 June 1981) surveying pelagic marine resources of the Sofala Bank (Mozambique) describes the size composition, distribution, length-weight relationships and sex ratio of the fish captured including *Rastrelliger kanagurta.* The by-catch was also studied.

424. SOUSA M I 1989. Results of a random stratified bottom trawl survey for scad and mackerel stocks in Mozambican waters. Small pelagic fish. December-January 1985. *Rev. Invest. pesq.* (Maputo), (19): 55-87.

The results obtained during the third phase of NAUKA are reported concerning the standing stock estimates, population, length structure and gonad development of scad and mackerel stocks and the catch composition in Mozambican waters.

425. SOUSA M I, HENRIK GISLASON 1985. Reproduction, age and growth of the Indian mackerel, *Rastrelliger kanagurta* (Cuvier, 1816) from Sofala Bank, Mozambique. *Rev. de Inv. pesq.*, (14): 1- 28.

Based on material collected since 1979 from commercial trawlers that had been fishing mainly in the Bank, some observations on reproduction, age, growth and mortality are presented. The spawning season determined from maturity progression is from August to March/April with peak in December or January. Growth curves based on both otolith readings and length-frequency distributions are presented. The total mortality values worked out for 1979, 1980 and 1981 are stated to be high, due to migration of bigger fish away from the fishing area.

426. SOUSA M I, JAKOB GJOSAETER 1987. A revision of growth parameters of some commercially exploited fishes from Mozambique. *Rev. de Inv. pesq.*, (16) : 19-40.

Some data on the age and growth of *R. kanagurta* are reviewed along with other species, and von Bertalanffy's growth curves fitted. Age determination is attempted on the basis of microstructures in the otoliths. Growth curves are given based on size-frequency distributions. The reliabilitiy of the data presented is discussed.

427. SRINATH M 1989. Trend of major exploited marine fishery resources of India during 1961-'85. *Bull. Cent. Mar. Fish. Res. Inst.*, No. 44, part I : 272-283.

The estimated annual mackerel landings in 1961-'85 are presented and discussed along with those of other resources. The mackerel landings in the southeast and southwest regions are compared, keeping aside the landings along the northwest coast as marginal.

428. SRINATH M, VARUGHESE JACOB, KANAKKAN A, MANI P T, KARBHARI J P 1987. An appraisal of the marine fisheries in Maharashtra. *CMFRI Special Publication*, No. 37: 46 pp. and Appendix.

Quarterwise mackerel landings in Maharashtra during 1975-'84 and the mackerel landings by mechanised boats during 1980-'84 are shown in tables in Appendix.

429. SRIRAMACHANDRA MURTY V, BANDYOPADHYAY M K, RAMALINGAM P 1988. Marine fish calendar. 5. Kakinada. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 83:1-17.

A description of Indian mackerel with figure is provided, besides giving information on the incidental fishery of the fish at Kakinada by traditional trawlers during the period 1981-'85 and by indigenous gear during 1980- '82.

430. SUDARSAN D, SIVAPRAKASM T E, SOMVANSHI V S, JOHN M E, NAIR K N V, ANTONY JOSEPH 1988. An appraisal of the marine fishery resources of the Indian Exclusive Economic Zone. *Bull. Fish. Surv. India*, No. 18 : 1-85.

Percentage occurrence of mackerel at various depths along the west and east coasts including Wadge Bank and Gulf of Mannar and the potentials are provided in tables. In east coast, mackerel having the highest aggregate percentage (39.7) in lat 20° N were observed to improve its contribution to the catches through shallow (forming 0.1 % at 20- 40 m depth) to deep water zones (forming 66.4% at 100-150 m). The increasing density and the proportion of mackerel should give higher catch and catch rates in deeper zones. About 28,000 tonnes comprising 23,000 tonnes from the east coast and 5,000 tonnes from west coast could be harvested annually by demersal trawling from Indian waters. The percentage of mackerel caught by FSI vessel was only 0.23. Experiments on purse-seining showed mackerel mostly within 60 m depth contour. No significant shoals have been recorded beyond this depth.

431. SUDARSAN D, SOMVANSHI V S, GOPALAKRISHNAN K, REDDY K S N 1991. Prospects of increasing pelagic fish production from the continental shelf along the north eastern maritime states of India. *J. mar. biol. Ass. India*, 33 (1&2): 198-206.

An attempt made to indicate the scope for increasing pelagic/columnar fish production as revealed by the exploratory surveys during 1980-87 is presented. Indian mackerel, hitherto known for its commercial pelagic fishery along the southwest coast, was observed to contribute significantly to the catches by high opening bottom trawl. The peak abundance of mackerel was traced to the 100-150 m depth zone of northern areas. The paper highlights the possibility of increasing production of pelagic components including mackerel.

432. SUDHAKARA RAO G 1974. Observations on the summer fishery for the Indian mackerel, *Restrelliger kanagurta* (Cuvier) in the Godavary Estuary. *Indian J. Fish.*, **21** (1): 275-278.

The paper reports a seasonally recurring fishery for mackerel in the Godavary Estuary near Yanam, in the summers of 1968, 1969 and 1970. It is stated that the fishery which was generally good in June, when salinity was high, came to a close with the beginning of monsoon. The catches composed of juveniles in size 118-183 mm. Gut content analyses made for finding the cause of entry of the fish into the estuary are discussed. Length-frequency distribution is shown in figure. Tables are also included.

433. SUNDARA RAJ B 1927. Fish landed on the west coast (South Kanara and Malabar). *Madras Fish. Bull.*, **21**.

Catch statistics on mackerel in the area for 1925-'26 provided.

434. SUNDARA RAJ B 1931. Fish statistics for 1926-'27. Supplement to the Administrative Report for the year 1927-'28. *Madras Fish. Bull.*, **23**.

Catch statistics on mackerel of South Kanara and Malabar area for the said period provided.

435. SUNDARA RAJ B 1933. Fish statistics for 1927-'28. Supplement to the Administrative Report for 1928-'29. *Madras Fish. Bull.*, **24.**

Catch statistics on mackerel of South Kanara and Malabar area for the period mentioned are given.

436. SUNDARA RAJ B 1939. Fish statistics for 1928-'29, 1929-'30 and 1930-'31. *Madras Fish. Bull.*, **27.**

Mackerel data of the referred years are available for the coasts of South Kanara and Malabar.

437. SURESH K, REDDY M P M 1980. Variations in oceanographic factors and their possible relation to fluctuations in oil sardine and mackerel catches off Mangalore coast. *Indian J. Fish.*, **27** (1-2) : 1-9.

Sea water temperature, salinity and phyto and zoo-planktons collected for one year from off Mangalore in 1976-'77 are studied monthwise against the availability of mackerel with a view to drawing a relationship between the environment and the fishery. Figures are given.

438. TAGORE P 1972. Conversion of a trawler 'M.F.V. *Meenakhojini*' into a purse-seiner for catching mackerels and sardines. *Symp. Pelag. Fish. Resour., CMFRI, Cochin, Abstracts*, No. 41.

Alterations on the vessel made are tabulated. Dates, grounds, catch etc. of purse-seine operations during October 70 to January 71 are given.

439. TAMPUBOLON G H 1987. Growth and mortality estimation of Indian mackerel (*Rastrelliger kanagurta)* in the Malacca Strait, Indonesia. *FAO Fish. Rep.*, No. 389, p. 372-384.

Growth and mortality of Indian mackerel *(Rastrelliger kanagurta)* were studied using the length-frequency data from Banda Aceh during the period of 1984-'86. The data were collected from the purse seine catches in Malacca Strait, Indonesia. The estimation of growth parameters was carried out using the length-frequency analysis, i.e., the ELEFAN program and the Wetherall method. Using Pauly's empirical equation to estimate M, fishing mortality and the exploitation rate were derived.

440. THAM A KOW 1950. The food and feeding relationships of the fishes of Singapore Strait. *Fishery Publications.* Colonial Office, London, **1** (1).

Coscinodiscus, copepods,*Squilla* larvae, Brachiuran zoea are mainly identified as food of *Rastrelliger kanagurta*. Occasionally their stomachs may be packed with *Stolephorus*.

441. THIRUMILU P, MAHADEVAN PILLAI P K, POOVANNAN P 1991. Scientific, popular and local names of common marine living resources along the Coromandal coast with special reference to finfishes and shellfishes. *Mar. Fish. Infor. Serv., T & E Ser.*, No. III, 16 pp.

Scientific, common and local names of Indian mackerel is given on p. 8.

442. THURSTON E 1900. Sea fisheries of Malabar and South Kanara. *Madras Govt. Mus. Bull.*, 3 (2): 138-165.

Some statistics along the coast, far back as 1893-'94 to 1898-'99 are given.

443. UDUPA K S 1986. Statistical method of estimating the size at first maturity in fishes. *Fish Byte*, 4 (2): 8-10.

A statistical method is described for the estimation of size at maturity with confidence limits. Length frequency data for male *Rastrelliger kanagurta* are applied to the equations given.

444. UDUPA K S, KRISHNA BHAT C H 1983. Length-weight relationship of Indian mackerel caught off Mangalore, Gangolli and Karwar by purse-seiners. *Indian J. Fish.*, 30 (1) : 155-157.

Length-weight relationships derived for 3 centres are compared for homogeneity, using analysis of covariance. Comparison of condition factors with those obtained in earlier studies is claimed to have shown little difference in the allometric growth of the fish.

445. UDUPA K S, KRISHNA BHAT C H 1984. Age and growth equation of the Indian mackerel from purse-seine catches off Karnataka coast. *Indian J. Fish.*, 31 (1) : 61-66.

Applying Bhattacharya method on monthly samples from Mangalore, Gangolli and Karwar in 1980-'81, it is claimed, three broods were observed in the purse seine catches, of 1, 2 and 3 years old respectively with mean total lengths 19.45 cm, 23.45 cm and 25.20 cm with the two-year olds dominating. The von-Bertalanffy growth equation is also derived for the data.

446. UDUPA K S, KRISHNA BHAT C H 1986. On the eye diameter - total length relationship of the Indian mackerel, *Rastrelliger kanagurta* (Cuvier). *Fishery Technology*, 23 (1) : 61-62.

Seven hundred and ninety one mackerel caught off Karnataka coast during 1979-'80 season were studied. Eye diameter of 0.5-0.9 cm range belong to 1 year old, 1.0-1.2 cm to 2 year old and 1.3-1.5 cm to 3 year olds. Eye diameter seems to have no significance in taxonomical work.

447. VARUGHESE PHILIPOSE, SCARIAH K S, VENKATARAMAN G, SUBBARAMAN G 1987. An appraisal of the marine fisheries of West Bengal. *CMFRI Special Publication* No. 31, 32 pp.

Quarterwise landings of Indian mackerel during the period 1975-'84, and gearwise contribution by mechanised and non-mechanised units during 1980-'84 are presented along with others in tables in appendix.

448. VARGHESE T J 1974. On the occurrence of mature mackerels off Bombay coast with notes on the fecundity of the species. *Mysore J. agric. Sci.*, 8 (4) : 618-624.

Capture of a few mature mackerel by trawlers at depth 19-23 ftm off Bombay is recorded. The observed lengths of fish, ova-diameter frequencies and estimated fecundity are presented.

449. VEDAVYASA RAO P 1963. On the line fishery for *Rastrelliger kanagurta* (Cuvier), along the North Kanara coast.*J. mar. biol. Ass. India*, 5 (2): 320-321.

A hook-and-line fishery for mackerel observed at Bhatkal in the North Kanara coast in Feb 1959 is recorded. Hooks baited with small pieces of cephalopods, clam or sardine, and sometimes even peices of mackerel, were used in the fishery. The fishery is deemed to have pointed to the possibility of the fish turning occasionally carnivorous.

450. VEERA BOONRAGSA 1987. Preliminary analysis of the mackerel (*Rastrelliger* and *Decapterus* spp.) resources on the west coast of Thailand. *BOBP/REP/39*. Annexure 1: 32-47.

Production of *R. kanagurta* along with that of *R. brachysoma* and *Decapterus* spp. from 1972 to 1985 and their monthly catch in 1985 are given. The catch, effort and cpue during 1979-'85 are also tabled. Their portwise landings are also provided. Their smallest observed lengths, recruitment periods, dominant size ranges, peak seasons, growth parameters like K, $L\infty$ & Lc, mortality and exploitation rate are given in Tables. Areas of production of these resources are marked in a map. Length frequencies, restructured frequencies and growth curves, catch and cpue related to standardized effort are given in figures.

451. VENKETARAMAN G 1960. Studies on the food and feeding relationships of the inshore fishes off Calicut on the Malabar coast. *Indian J. Fish.*, 7 (2) : 275-306.

The mackerel of 132- 216 mm size are found to be a plankton feeder. The common items found in the stomachs were copepods, decapod larvae, cladocerans, larval bivalves, fish eggs and larvae, peridinians and diatoms.

452. VENKATARAMAN G 1967. The Indian mackerel.*Souvenir, 20th Anniversary, Central Marine Fisheries Research Institute*, Mandapam Camp, p. 44-47.

A status paper on the fishery and biology of Indian mackerel, the article briefly touched upon the area of fishing, fishing season, nets used for capture, size and age of fish caught, observed shoaling behaviour, etc. The highly fluctuating nature of the fishery from year to year is pointed out, showing the annual landings for 1958-'65.

453. VENKETARAMAN G 1970. The Indian mackerel — Bionomics and life history. *Bull. Centr. Mar. Fish. Res. Inst.*, No. 24: 17-40.

Sex, maturity, spawning, fecundity, structure of egg; age, rate of growth, longivity, greatest size, food and feeding, migration, shoaling, parasites and predators and abnormalities are reviewed.

454. VENKATARAMAN G, MUKUNDAN C 1970. A note on the food of young mackerel. *J. mar. biol. Ass India,* **12** (1&2) : 230-232.

The food constituents in stomachs are estimated in terms of percentage by volume and presented in a table. The stomachs are classified based on degree of distension; and about 96% of them are stated to bave contained fish or fish parts, showing that mackerel at this stage were carnivorous. From the absence of items of bottom origin in the stomach, they are inferred to be surface or below-surface feeders.

455. VENKATARAMAN G, NARAYANA RAO K V 1973. On the mackerel fishery of Calicut during the years 1959-'60 to 1967-'68. *Indian J. Fish.,* **20** (2) : 448-475.

Based on the data of mackerel fishery of Calicut area for 1959-'60 to 1967-'68, seasonal trends in the catch and effort are drawn and their relationship with certain meteorological and hydrological factors are suggested. The different types of gear employed in fishery are mentioned. The monthwise distributions of gearwise and standard efforts, catches and catch per effort are worked out. The catch trends are stated to have indicated an improvement in the fishery in the third year after its having been poor for two successive years. The relative efficiencies of the different types of gear are worked out, taking *Pattenkolli vala,* stated to be the versatile gear, as standard. Confirming earlier reports, the abundance of mackerel is stated to have been greater when the temperature was within 27.7° and 29.2° C, and salinity within 30.4‰ and 33.9‰

456. VENKATA SUBBA RAO K, RAMAMOHANA RAO V, MOJUMDAR P, APPA RAO T, REUBEN S, DAN S S, NARAYANA RAO B 1980. Pelagic fishery resources of Lawson's Bay, Waltair. *Indian J. Fish.,* 27 (1 & 2): 35-53.

The occurrence of mackerel during 1970-'74 is refered to, giving the catch statistics and gears used.

457. VIJAYAKUMARAN K, NAIR S K 1991. Demersal finfish resources of the inner-continental shelf of the EEZ. *Proc. Nat. Workshop Fish. Resour. Data Fish. Indus.,* 71-79.

Mackerel is shown as an item being caught both from 0-50 m and 51-100 m depth zones along the sea off Karanataka, Kerala, Tamil Nadu, Andhra Pradesh and Orissa and West Bengal. The catch from Andhra coast as shown in illustrations was good and almost equal form deeper areas and 0- 50 m zone. The catch rate from the 51-100 m deep waters in Orissa and West Bengal nevertheless, was very very high when compared to that from 0-50 m depth.

458. VIJAYARAGHAVAN P 1962. Some observations on the spawning behaviour of mackerel. *Indian J. Fish.,* **9A** (2) : 647-652.

Frequency polygons of ova in the ovaries of 20 fish in V-VI stages of maturity from Porto Novo are presented and discussed, drawing conclusions as to the number of batches of ova that might be involved in one spawning. It is also recorded that, day catches did not contain any fish with running ovary, whereas ova were oozing in specimens from the night catches and therefore the spawning is stated as a nocturnal activity.

459. VIRABHADRA RAO K 1962. Distribution of the young stages of the mackerel, *Rastrelliger kanagurta* (Cuvier) in the Indian inshore waters. *Proceedings of the Symposium on Scombroid Fishes*, Marine Biological Association of India, Mandapam Camp, 12-15 January 1962, Part I, p. 469-482.

Based on past reports on small juvenile mackerel from several places along the coasts of the Arabian Sea, the Bay of Bengal and the Andaman Sea, a general pattern of its region-wise and length-wise distribution is made out, furnishing notes on some biological aspects of the species. From the length frequency distribution, two distinct groups of young ones are inferred to be entering in the inshore waters of west coast in different periods of a year. The spawning is inferred to commence from the end of March and to extend upto December. Good spawning grounds in the inshore waters of Vizhinjam on the west coast and off Madras on the east coast are suspected. The stomach contents of the juvenile mackerel observed at different coastal regions are stated to have been at variance, indicating a dissimilitude in the feeding habits. Figures and a table are included.

460. VIRABHADRA RAO K 1970. The Indian mackerel identity. *Bull. Centr. Mar. Fish. Res. Inst.*, No. 24: 3-14.

Taxonomy reviewed giving description, key to identification and general variability of *Rastrelliger kanagurta* and *R. brachysoma*. Validity of nomenclature, synonyms and common names are also given.

461. VIRABHADRA RAO K 1973. Distribution pattern of the major exploited marine fishery resources of India. *Proceedings of the Symposium on Living Resources of the Seas around India*, Central Marine Fisheries Research Institute, Cochin, India, December 1968, p. 44-45.

A general account on mackerel too is included, giving the fishing areas, the chief gears in operation, fishing season, growth rate, maturity, spawning season, feeding habits, method of preservation, etc.

462. VIRABHADRA RAO K, BASHEERUDDIN S 1953. Occurrence of young mackerel, *Rastrelliger kanagurta* (Cuvier) off Madras coast. *Curr. Sci.*, 22(6): 182-183.

Occurrence of *Rastrelliger kanagurta* in size range 4.9-10.3 cm in the inshore waters off Madras during March-April 1953 is recorded, compared with similar appearance on the west coast and its association with monsoon brought out.

463. VIVEKANANDAN E, GNANAMUTTU J C, SRINIVASARENGAN S, DEVADOSS P, KUTHALINGAM M D K, BALAKUMAR S K, CHANDRASEKAR S, MOHAN S 1991. Exploited marine fishery resources of Madras. *J. mar. biol. Ass. India*, 33 (1 & 2) : 40-48.

Data on the exploited marine fishery resources related to 3 major landing centres in Madras have been analysed for 1980-'86 with reference to important pelagic and demersal resources including mackerel. The catch and effort data of mechanised and indigenous gears for the period is analysed in detail.

464. WHITLEY G P 1944. *Austr. Zool.*, 10: 268.

The species *canagurta* in Queensland has been recorded caught from February to July in various gears down to Yeppoon.

465. WHITLEY G P 1947. *Austr. Zool.*, 11: 138.

Recorded the mackerel in the stomach of a trevally off Cape Baskerville, Western Australia.

466. WHITLEY G P 1962. Scombroid Fishes of Australia and New Zealand. *Proc. Symp. on Scombroid Fishes.* Mandapam 12-15, 1962. Marine Biological Association of India, Part I, p. 221-253.

Indian mackerel not recorded from Australian seas until 1879 is reported to have scattered occurrence in the seas of north western Australia, Northern Territory and Queensland. Description is given. The species is commonly called here as Rake-gilled mackerel also.

467. YOHANNAN T M 1977. Studies on the mackerel fishery of Mangalore area during 1969-'73. *Indian J. Fish.*, 24 (1 & 2) : 113-123.

The fishery from July 1969 to June 1973 at Ullal and Baikampady, employing gill-net (*patta bala*) and shore-seine (*rampani*) respectively, form the theme of the paper. The study is stated to have shown that the mackerel fishery was a success in 1970-'71, but failure in 1972-'73. The availability of juveniles and the trend in the monsoon intensity are suspected to have been factors that determined the fishery. Spawning appeared to be intense around July and January. Based on monthly modes, the sizes 14-16 cm and 20-22 cm are regarded respectively as one-year and two-year olds. The length-weight relationships are worked out. Tables and figures are furnished.

468. YOHANNAN T M 1979. The growth pattern of Indian mackerel. *Indian J. Fish.*, 26 (1 & 2) : 207-216.

The length-frequency distributions of the fish in the catches of non-selective gears at Mangalore during 1970-'74 are presented. The modal values are said to indicate the mackerel to grow to about 21 cm by the end of 8 months and about 22 cm by the completion of the first year. It

is also claimed that the growth equations derived for 12 months and 24 months data did not explain the growth pattern satisfactorily, whereas separate growth equations derived for the premature and mature phases fit well with the observed values.

469. YOHANNAN T M 1982. Population dynamics of Indian mackerel based on data from Mangalore during 1967-1975. *Indian J. Fish.*, 29 (1 & 2) : 50-62.

The total mortality rate (Z) worked out on the data collected at Mangalore during 1967-'75 is given as ranging between 2.54 and 6.21. Maintaining that the total mortality had no regression on fishing intensity, the natural mortality rate (M) is calculated as 1.5 from the effective life span of mackerel. K, t_o and W ∞ values are estimated based on the growth in weight. The studies claim to indicate that mackerel could withstand heavy fishing mortalities and the value of F that gives the maximum yield is calculated to be 6.00. An increase in the age at entry into the exploited phase (tp') to 8 months from the present 6 is suggested, with a belief that increasing the F value thus to 6.00 and tp to 8 the average annual catch could be raised to 198,870 tonnes from the present 96,451 tonnes. Supporting tables and figures are included.

470. YOHANNAN T M, BALASUBRAMANIAN K K 1988. Fluctuations in the mackerel fishery of the Calicut area during the seasons from 1980-'86. *Symposium on Tropical Marine Living Resources*, Marine Biological Association of India, Cochin, 12-16 January 1988, *Abstracts*, No. 34.

The general trends of the fishery for the 7 years are briefly reviewed, looking for probable causes of fluctuation. The size composition is mentioned and the probable spawning and recruiting periods and the relation of the fishery with the physical environment are suggested.

471. YOHANNAN T M, BALASUBRAMANIAN K K 1991. Mackerel fishery of the Calicut area and its fluctuations during the seasons from 1980-'81 to 1985-'86. *J. mar. biol. Ass. India*, 33 (1 & 2): 246- 254.

The results of a prelimanry study of the pattern of fluctuations in the mackerel fishery based on the catch, effort and length frequency data collected from Vellayil, Calicut regularly during 1980-'81 to 1985-'86 are presented. The mackerel fishery touched the lowest figure in 1983-'84, after a relatively good fishery in 1980-'81. Improvement was noticed subsequently. Recruitment to the fishery is almost completed by September. Mainstay of recruitement at Calicut is from the products of spawning in June and August. A good annual rainfall is found to be beneficial to the fishery, but the rainfall and catch in September is found to have an inverse relation. Catch in 1970-'71 is found to be well above equilibrium level. The magnitude of spawning stock in April-June period is found to have direct relation to the total catch of that season. In general, mackerel fishery is on the decline at Calicut. There are indications that the current fishing pressure on the population is more than optimum.

II. PROCESSING

472. ABDULLAH M I, YU S Y 1985. Quality changes in fish caught off the coast of peninsular Malaysia: Frozen storage of chub mackerel (*Rastrelliger kanagurta*), yellow banded trevally (*Selaroides leptolepis*) and thread fin bream (*Nemipterus tolu*). *FAO Fish. Rep.*, No. 317-Suppl., p. 162-176.

Proximate analysis, and organoleptic tests performed on gutted and ungutted Malaysian chub mackerel which were fast and slow frozen and stored and glazed at -20° C for 16 to 24 weeks are reported. The data observed on lipid oxidation, protein denaturation and pH changes are related to textural, flavour, odour and general acceptablility. The observed chemical composition, pH changes and the effects of cold storage on the odour, texture, flavour and acceptability are shown in tables. The effect of storage at -20° C on the amount of protein soluble in 5% NaCl on the thiobarbituric acid (TBA) values are shown in figures.

473. ABDULLAH M I, YU S Y 1985. Quality of frozen chub mackerel (*Rastrelliger kanagurta* Cuvier) after canning. *FAO Fish. Rep.*, No. 317-Suppl., p. 177-181.

The quality changes of the canned fresh and frozen chub mackerel, which had higher initial TBA values that were increasing with time of storage are stated to have become detectible only after one month. It is claimed that fish which had been frozen for 2-3 months before canning were acceptable after 3 months storage in cans, and that the acceptability decreased with increase in time of frozen storage before canning. The effect of storage at ambient temperature on the soluble protein nitrogen (SPN) in 5% NaCl on TBA values, pH changes and general acceptability scores in canned samples are shown in figures.

474. ABDULLAH M I, YU S Y 1985. The effect of freezing and frozen storage on the quality of chub mackerel (*R. kanagurta*). *FAO Fish. Rep.*, No. 317 -Suppl., p. 230-234.

Fast and slow-frozen gutted mackerel stored at -20° C for 4 months, both in glazed and in unglazed conditions are stated to have indicated that the TBA values had increased with frozen storage, especially in the unglazed samples. It is concluded that the solubility of the muscle proteins in an aqueous solution of 5% NaCl as well as the pH values decreased with storage and that the quality deterioration in terms of fat oxidation and protein denaturation was more pronounced in unglazed samples. The proximate composition is shown in a table and the malonaldehyde values, protein solubility and pH changes are shown in figures.

475. AL-ALAWI Z S 1981. Quality changes in *Trachiurus indicus* and *Rastrelliger kanagurta* during iced storage. *Tech. Circ. Dir. Fish.* (Bahrain), No. 7: 11 pp.

Brief mention on results of visual and olfactory trials and GR Torry merer readings on the quality changes the two species had undergone in storage

is made. Visual and olfactory changes indicate that *kanagurta* stored in ice has a shelf life of 8 days or even more.

476. ALUR M D, VENUGOPAL V, NERKAR D P 1989. Spoilage potential of some contaminant bacteria isolated from Indian mackerel (*Rastrelliger kanagurta*). *J. Food Sci.*, **54** (5): 1111- 1115.

Pseudomonas marinoglutinosa, Aeromonas hydrophila isolated from unirradiated spoiling Indian mackerel (*Rastrelliger kanagurta*) and *Bacillus megaterium, Micrococcus colpogenus* isolated from gamma-irradiated mackerel were examined for their spoilage potential in fish homogenate and fish muscle sarcoplasmic and myofibrillar protein fractions. Growth of *M. colpogenes* was not accompanied by putrefaction of the fish media as assessed by sensory and chemical criteria, suggesting contribution of varying spoilage potentials of the bacterial isolates in the overall spoilage of the fish.

477. ALUR M D, VENUGOPAL V, NERKAR D P, NAIR P M 1991. Bacterial spoilage profiles to identify irradiated fish. *J. Food Sci.*, 56 (2) : 332-334.

Effects of low dose r - irradiation of fish product on spoilage potentials of bacteria (*Aeromonas hydrophila, Salmonella typhimurium, Bacillus megaterium* and *Pseudomonas marinoglutinosa*) and mixed flora were examined for ability to proliferate in radurized fish and produce volatile acids (TVA) and bases (TVBN). Bacteria proliferated well in unirradiated and irradiated fish, but formation of VA and VB were lower in irradiated than unirradiated counterparts. This was found in Indian mackerel and four other fishes gamma-irradiated at 0 to 5 KGY under ice. TVA and TVBN produced by the organisms or mixed flora from fish were only 30-50% those of controls. A method for identifying radiation-processed fish could evolve based on lower susceptibility of irradiated fish to bacterial spoilage.

478. AMES G R, POULTER R G 1985. Frozen storage life of tropical fish species. *FAO. Fish. Rep.*, No. 317-Suppl., p. 155-161.

The paper reviews literature on longevity of mackerel and other tropical species stored in temperatures —0.5 to —30° C without changes and loss of quality.

479. AMES G R, POULTER R G 1987. Frozen storage life of tropical fish species. *Infofish International*, (6) : 40.

A review of past works on storage life of frozen mackerel is given. The shelf life and causes for quality deterioration of fatty as well as low-fat fish are presented. It is supported that the use of antioxidants might extend the storage life of fatty fish.

480. AMMU K, JOSE STEPHEN, DEVADASAN K 1989. Influence of dietary proteins on cholesterol levels in albino rats. *Fish. Technol.*, **26** (2) : 125-130.

The protein sources used in the study were fat free casein, defatted groundnut cake, and defatted fish powders from *Rastrelliger kanagurta* and 2 other fishes and marine prawns. An attempt is made to correlate the behaviour of the proteins with their respective amino acid compositions.

481. ANON 1967. *Indian Standard Specification for Mackerel (Rastrelliger* sp.)*Canned in Brine.* IS: 3849-1966. Indian Standard Institution, New Delhi : 8 pp.

The quality requirements and the methods of test for mackerel canned in brine free from artificial colouring matter and firming agents except edible common salt in hygienic conditions, methods of packing the material in internally lacquered cans hermatically sealed, processing requirements for the finished product, method of labelling of the cans with information regarding the manufacture and ISI certification mark and of sampling and tests are described.

482. ANON 1971. *Indian Standard Specification for Mackerel (Rastrelliger* sp.) *Canned inOil.* IS: 2420-1971. Indian Standard Institution, New Delhi : 8 pp.

Prescribing the quality requirements and the methods of test for mackerel canned in oil, the standard stresses the need for good quality mackerel, refined pure deodorized edible vegetable oil and salt of edible quality for best product. Artificial colouring matter, firming agents and other additives are prohibited. Methods of packing in hermatically sealed cans and requirements for the finished product are described. The need to limit heavy metals and microbiological contents within the permissible limit is emphasized, besides the necessity to show the ISI marking, etc. on the container. The methods of sampling the material and the tests are prescribed.

483. ANON 1971. *Indian Standard Specification for Mackerel, Fresh.* IS : 6032-1971. Indian Standard Institution, New Delhi : 8 pp.

The requirements and methods of sampling and test for fresh large (> 85 g) and small (85 g and below) mackerel (*Rastrelliger* sp.) are given. The preparation of material, requirements for fresh mackerel and in cooked state and micro-biological limits for fresh mackerel are described. Necessary remarks to be printed on the containers are indicated. Methods of sampling and tests are given.

484. ANON 1971. *Indian Standard Specification for Mackerel, Frozen.* IS: 6033-1971. Indian Standard Institution, New Delhi : 10 pp.

The Standard prescribes the quality requirements and the methods of sampling and testing of frozen mackerel (*Rastrelliger* sp.), such as grades, types, microbiological limits etc. The methods of packing of the frozen material in containers and labelling with necessary remarks and ISI certification mark are given as well as describing how the samplings and tests are to be carried out.

485. BALACHANDRAN K K, MURALEEDHARAN V 1975. Studies on Colombo-curing of mackerel (*Rastrelliger kanagurta*). *Fish. Technol.*, **12** (2): 145-150.

Optimum quantities of salt and *goruka puli* (Malabar tamarind : *Garcinia cambozea*) to be used in the pickle to give a product of acceptable organoleptic and chemical characteristics are worked out. The advantages of using sodium benzoate as a preservative is also examined. Tables are given showing the results of the different analyses.

486. BALACHANDRAN K K, VIJAYAN P K 1976. Processing aspects of Indian mackerel — A review. *Fish. Technol.*, **13** (2):81-87.

The methods of catching mackerel, seasonal variations in the landings and utilisation, and the different curing processes are mentioned. The possibility of preservation by canning and freezing is discussed. Tables given show the proximate composition and export of canned mackerel.

487. BANIK A K, CHOUDHURI D R, BOSE A N 1976. The effect of gamma irradiation on microbial load and sensory evaluation of white pomfret and Indian mackerel fishes. *J. Food Sci. Technol.*, **13** (2) : 67-69.

Results of an experimental irradiation carried out on eviscerated, whole-packed mackerel in polyethylene pouches, held at 0.2° C are reported. The extend of storage life was determined by sensory evaluation and total bacterial counts. The irradiated fish in ice is said to have remained in good condition for 15-20 days. The suitability of drip for determining total bacterial count and for assessing the keeping quality in these fishes are also discussed.

488. CHAKRABORTI R 1991. Histamine content in dried fish products from Kakinada coast. *Fish. Technol.*, 28 (1): 59-62.

The content of histamine, total volatile base nitrogen and salt were determined in 31 varieties of dried samples including mackerel from Kakinada. Histamine content in ungutted salted and dried fish was more than that in gutted, salted and dried fish. In whole dried mackerel it was 80.6 ± 48.22 mg %. TVBN values did not show any correlation with the histamine content of fish samples. Tables are given.

489. CYRIAC MATHEN 1974. Quality control in the Indian fish processing industry. *Fish. Technol.*, **11** (1) : 1-16.

The objectives of quality control, the specifications prescribed for fish and fishery products and processes, the salient features of the national standards, the common quality defects in fishery products, their causes and rectification, the methods of inspection of fish and fishery products, the international standards for fish and fishery products, the quality control research in the fish processing industry, the training of personnel, etc. are all reviewed. The Indian standard specifications prescribed for

fresh, frozen, canned and dried mackerel, the microbiological requirements for fresh and frozen mackerel, the quality requirements of canned product and requirements for dried fish are given in tables.

490. DEVADASAN K, MURALEEDHARAN V, GEORGE JOSEPH K 1975. Studies on smoke curing of tropical fishes. *Fish. Technol.*, **12** (1) : 77-80.

A new method of curing mackerel is suggested, wherein the gutted fresh fish are smoked for about 5 hrs and the product subjected to subsequent drying and treatment with turmeric, etc. for flavour.

491. DEVADASAN K, RAJENDRANATHAN NAIR M 1977. Further studies on changes in protein fractions of fish muscle during storage in ice. *Fish. Technol.*, **14** (2) : 127-130.

The changes in the major protein nitrogen fractions of mackerel during storage in ice are reported. Also it is compared with changes reported in some prawns and oil sardine.

492. DEVARAJU A N, SETTY T M R 1985. Comparative study of fish bacteria from tropical and cold/temperate marine waters. Spoilage of tropical fish and product development. *FAO Fish. Rep.*, No. 317-Suppl., p. 97-108.

The bacteria found in mackerel and 3 other freshly caught fishes from Mangalore are listed in the order of predominance and are compared with their cold/temperate counterparts with regard to growth and biochemical activities. Of the bacteria said to be common to both regions, *Moraxella* and *Corynebacterium* groups are stated to be able to grow well even at 37° and 42° C. The total aerobic plate counts and percentage generic distribution/composition are presented in tables. The growth of bacterial isolates (from tropical and cold water marine fish at 8° C, 29° C) at different temperatures are shown in figures.

493. DHANANJAYA S, HIREMATH G G 1988. Effect of cold-storage- temperature fluctuation on the keeping quality of frozen mackerel, *Rastrelliger kanagurta*. *The First Indian Fisheries Forum, Proceedings. Asian Fisheries Society, Indian Branch, Mangalore*, p. 413-414.

A marginal improvement in frozen storage stability is shown to be possible by antioxidants treatment by an experiment in which frozen-mackerel samples were stored at two temperatures and periodically tested. Tables showing the biochemical and organoleptic findings in the frozen mackerel stored at both the temperatures are given comparatively.

494. DORA K C, HIREMATH G.G 1991. Surimi : A new scope for diversification of seafood exports. *Seafood Export Journal*, **23** (3) : 11-13.

The article describes that mackerel can be used as a raw material for production of Surimi, which is widely used as an intermediate product for a variety of fabricated seafoods and other forms of highly appetising

products. The production process of frozen surimi is explained. Annual mackerel landings in India during 1986, 1987 and 1988 are given in Table.

495. GHADI S V, LEWIS N F 1979. Textural stability of radurized Indian mackerel (*Rastrelliger kanagurta*). *J. Food. Sci. Technol.*, **16** (6) : 226-228.

Fresh mackerel were subjected to 150 krad gamma irradiation, stored at 0° - 2° C and examined at regular intervals for changes in shear force (SF), water-holding capacity (WHC) and plasticity index (PI) alongside a control sample. The SF of both control and radurized samples decreased during storage; but the radurized samples taking a longer period. The WHC reduced and the pH increased in both and the drip loss was similar. Sensory ratings indicated that irradiated samples were acceptable for 20 days, whereas control were acceptable only for 10 days.

496. GOPAKUMAR K, RAJENDRANATHAN NAIR M 1971. Phospholipids of five Indian food fishes. *Fish. Technol.*, **8** (2) : 171-173.

Quantitative fractionation of lipids of 5 Indian food fishes including mackerel, using cloumn and thin-layer chromatographic techniques, are reported to show Phosphatidyl Choline and Phosphatidyl Ethanolamine as two principal components. The Phospholipids of mackerel are stated to have contained Lysophosphatidyl Ethanolamine to the extent of 3.5%. The higher amount of PE and PC, which were prone to hydrolysis, is suspected to be the factor contributing to the formation of larger quantities of free fatty acids (FFA) in the fish during frozen storage.

497. GOVINDAN T K 1969. Studies on salting and drying of fish with special reference to changes in nitrogenous constituents. *Indian Fd. Packer*, **23** (4): 18-22.

Changes occurring in the moisture, NaCl, salt extractable nitrogen, nonprotein nitrogen and free amino acid nitrogen in dressed sardines and mackerel during heavy salting for short and prolonged periods and subsequent drying, as well as pickling, in saturated brine are reported. The weight loss due to loss of water (Ca 27.5 ml/100 g of dressed fish) during heavy salting was made good to the extent of Ca 50% by the absorption of salt by the muscle. A certain amount of proteolysis was also indicated as shown by the higher NPN and free amino N values. During pickling of heavily salted mackerel in saturated brine, moisture content of the muscle attained a steady value of 60% and drastic loss in salt extractibility of proteins took place in pickle, SEN reaching a minimum value of Ca 2% in 9 days which was maintained through-out the rest of the storage period.

498. GOVINDAN T K 1972. A highly relished food fish of India. *Seafood Export Journal*, **4** (11) : 27-32.

A treatise on mackerel, the paper gives the chemical composition of the muscles, transportation, preservation, curing methods, canning, etc. of the fish.

499. GOVINDAN T K 1985. *Fish Processing Technology.* Oxford & IBH Publishing Co., New Delhi, 252 pp.

The occurrence, biology with a figure of mackerel are presented in the monograph. The different methods of freezing the fish as suggested by different authors are discussed. The changes occurring in the chemical constituents during frozen storage are shown. The method employed and the suitability of iced mackerel for canning, the Indian Standards requirements for canned mackerel, etc. are briefly described.

500. GOVINDAN T K, SIBSANKAR GUPTA, CHATTOPADHYAY P 1977. Investigations on long distance transportation of fish. 1. Transportation of frozen fish from Cochin to Calcutta. *Fish. Technol.*, **14** (2) : 109-115.

The findings on an experimental consignment despatched to Calcutta containing 5 species of fishes including mackerel frozen in glazed as well as unglazed blocks, packed in expanded polystyrene (EPS) insulated plywood boxes with and without additional ice, in uninsulated parcel vans of trains are reported. The consignments reached the destination in excellent condition and readily disposed off. The variety of fish used, weight of fish in the block, size of container, amount of glaze used, etc; results of chemical and bacteriological analyses before despatch and after arrival at Calcutta are all presented in tables.

501. HANUMANTHAPPA B 1983. Studies on the preparation and keeping quality of hot smoked mackerel (*Rastrelliger kanagurta*). M.F.Sc. Thesis, 107 pp. In: *Catalogue of Theses (1976-1985)*, University of Agricultural Sciences, Mangalore, Abstract No. 43.

A method for preparation of hot smoked mackerel with observation of its keeping quality at different storage temperatures form the theme of the theses.

502. HANUMANTHAPPA B, CHANDRASEKHAR T C 1987. Preparation and keeping quality of hot smoked mackerel. *Fish. Technol.*, **24** (2) : 112-115.

A method for the production of smoke cured mackerel by dry-salting with salt to fish ratio 1:8, followed by smoking in a traditional smoke chamber at 70° ± 5° C for 5 hrs is described. Tables are given comparing the proximate compositions of fresh and smoke-cured mackerel, and the effects of different concentrations and durations of salting and showing the chemical and other changes undergone in the process.

503. HIREMATH G G, FRANS TEUTSCHER, ANDERS NORDHEIM 1982. Experiments on storage of fish in chilled sea water. *Mysore. J. agric. Sci.*, **16** (3) : 329-337.

Mackerel chilled in sea water immediately after catch and stored at 0° - 5° C could be rated 'good' for 3 days, 'fair' for 6 days and 'acceptable' for 8 days. Changes in panel scores during chilled storage and analysis of variance for mean panel scores are tabulated, and the observed changes

in the organoleptic quality and TVB-N value of mackerel during chilled storage are shown in graphs.

504. HUSSAIN A M, CHAUDRY M A, HAQ I 1985. Effect of low doses of ionizing radiation on shelf-life of mackerel (*Rastrelliger kanagurta*). *Lebensm-Wiss. Technol.*, **18** (5) : 273-276.

Salient findings on the effect of low doses (0-3KGY) of ionizing radiation on the extension of shelf-life of mackerel experimentally stored at 1° - 3° C are reported. Total bacterial count in unirradiated fish is stated to have increased to 3.2 x 10^7/g, from an initial of 1 x 10^5/g, after 7 days storage. In 1.5 KGy- treated samples the total count reached 2.5 x 10^7/ g after one month of storage. Other findings reported are that in the unirradiated samples *Pseudomonas* and *Proteus* predominated during storage, whereas in irradiated samples *Achromobacter* and *Flavobacterium* were dominant besides the presence of *Bacillus* and *Micrococcus*. Moisture and protein content decreased and drip loss increased significantly during the storage of fish. Dipping of fish fillets in 10% sodium polyphosphate for 10 minutes prior to irradiation minimized the drip loss significantly.

505. IYENGAR J R, SEN D P 1970. The equilibrium relative humidity relationship of salted fish (*Barbus carnaticus* and *Rastrelliger canagurta*) : the effect of calcium and magnesium as impurities in common salt used for curing. *J. Food Sci. Technol.*, 7 (1) : 17-19.

Calcium and Magnesium contents were found decreasing the equilibrium moisture contents of mackerel when salted. Results of analyses of the different samples with respect to moisture, fat, ash and sodium chloride contents are given in a table. ERH relationship of salted mackerel, equilibrium moisture contents of sodium chloride used in the experiments corresponding to different relative humidities, equilibrium moisture content of salted mackerel corresponding to 70% R.H. are also given in tables.

506. JADHAV M G, MAGAR N G 1970. Preservation of fish by freezing and glazing : I. Bacteriology of fresh, frozen and glazed fish. *Fish. Technol.*, 7 (1) : 86-90.

The results of a microbiological investigation on 3 fresh-and-frozen fish species including mackerel carried out under various conditions of preservation such as glazing, block-freezing and preservation in gunny bag are reported. Determination of the bacterial load, and isolation, identification and classification of the resistant bacteria are also attempted. Spore-formers of *Subtilis mesentericus* group are recorded as having been found resistant to freezing as well as glazing by ascorbic acid, citric acid and sodium nitrite except a mixture of sodium chloride and glucose. Bacterial load was reduced to a good extent and maintained low till the end of frozen storage period. Effect of freezing and frozen storage on total plate counts of mackerel are shown in a table.

507. JADHAV M G, MAGAR N G 1970. Preservation of fish by freezing and glazing : II. Keeping quality of fish with particular reference to yellow discolouration and other allied organoleptic changes on prolonged storage. *Fish. Technol.*, 7 (2) : 146-157.

Organoleptic observations are recorded of mackerel in quick, slow and block-frozen, glazed, and stored conditions wherein glazing was renewed at intervals of 4 weeks. Keeping quality of glazed fish is reported as having been better than the unglazed fish, giving a storage life of 6 months. The results of the organoleptic examination for external appearance of body, gills and eyes, texture and odour at intervals of 4 weeks after thawing are listed in a table.

508. JADHAV M G, MAGAR N G 1970. Preservation of fish by freezing and glazing : III. Effect of freezing, glazing and frozen storage on the B-vitamins and essential minerals present in the fish flesh. *Indian J. Fish.*, 7 (2) : 158-163.

The changes in moisture, thiamin, riboflavin, niacin, phosphorus, iron, and calcium occurring in mackerel glazed with ascorbic acid, citric acid, sodium chloride and glucose and sodium nitrite, and kept under frozen storage upto 6 months are studied. Analysis of mackerel on frozen storage, and the percentage retention of the nutrients on frozen storage are given in tables.

509. KAMASASTRI P V, RAMANANDA RAO D 1962. Studies on Indian fish meals. Part I. Chemical composition and storage characteristics of fish meals prepared from different types of fishes. *Indian J. Fish.*, 9 (2B) : 108-117.

The chemical compositions of fishmeals prepared from different fish species including mackerel are reported, presenting the observed changes in nitrogen and fat during storage. The moisture and TVN as well as the acid value increased during storage, while the extractibility of fat and iodine value decreased.

510. KANDORAN M K, SURYANARAYANA RAO S V, VALSAN A P 1964. Studies on the effect of impurities on the penetration of salt in the curing of fish. *Indian J. Fish.*, **11** (1) B : 1-8.

The effects of 0.25% to 0.75% of calcium and magnesium in sodium chloride in curing is studied. The result is stated to have shown that the rate of penetration of salt had no relationship to the calcium and magnesium contents even at the level of 0.75%. Further, the presence of calcium and magnesium had not enhanced spoilage.

511. KANDORAN M K, VALSAN A P 1974. Packing of cured fish in India : Existing methods and suggestions for improvement. *Seafood Export Journal*, **6** (5) : 27-31.

The merits and demerits of the prevalant packing materials are discussed

and the various materials are listed in the order of efficiency, giving top rank to deal-wood or plywood boxes. It is suggested that the loss and deterioration due to dehydration or rehydration could be controlled by giving the packaging material an internal lining of polythene. Analytical values of dry-salted mackerel after 3 months of storage are compared with the initial values.

512. KRISHNAMURTHY B V, PRABHU R M, SHAMASUNDER B A, HANUMANTHAPPA B, CHANDRASEKHAR T C 1988. Cold smoking of the Indian mackerel, *Rastrelliger kanagurta*. *The first Indian Fisheries Forum, Proceedings*. Asian Fisheries Society, Indian Branch, Mangalore, p. 395-397.

A method evolved for cold smoking of mackerel in which dressed fish is dry salted (salt to fish 1:8) for 2 hrs and rinsed, predried and smoked at 30 ± 2° C for 24 hrs in smoke generated by smouldring a mixture of coconut husk and sawdust at 1:3 ratio till golden yellow in colour and packed in polythene bags is given. The product stored at room (30 ± 2° C) refrigerated (10 ± 2° C) and cooler (2 to 5° C) temperature on chemical, microbiological and organoleptic tests showed a shelf life of 2, 14 and 35 days respectively.

513. KRISHNOJI RAO B Y, BANDYOPADHYAY C 1983. Lipid composition of salted sun-dried Indian mackerel (*Rastrelliger kanagurta*). *J. Food Sci. Technol.*, **20** (2) : 62-64.

In salted and sun-dried mackerel, as compared to fresh ones, considerable reduction in glyceride and iodine with concomitant increase in free fatty acid and peroxide of muscle lipids are reported to have been observed. The fatty acid composition as determined by gas liquid chromatography is stated to have indicated that salting and sun-drying caused considerable loss in higher polyunsaturated fatty acids, attributable to lipid oxidation. The physico-chemical characteristics and the fatty-acid composition of muscle lipids of fresh and commercial salted and sun-dried mackerel are presented.

514. LAHIRY N L, SEN D P, VISWESWARIAH K 1961. Studies on dry-salting and sun-drying of mackerel (*Rastrelliger canagurta* Cuv.). Effect of varying proportions of salt to fish on the quality of sun-dried mackerel. *Fd. Sci.*, **10** (5) : 139-143.

One portion of salt to 7 or 8 portions of dressed fish is reported to have been found sufficient to check putrefaction and worm infestation during the first 24 hrs. When dried to about 40% level, the sodium chloride content would be more or less sufficient to saturate its moisture content, giving the product a better appearance.

515. LAHIRY N L, SEN D P, VISWESWARIAH K 1961. Studies on dry-salting and sun-drying of mackerel *Rastrelliger canagurta* (Cuv.). Effect of

incorporation of different chemicals into curing salt on the texture and cooking quality of the product. *Fd. Sci.*, **10** (5) : 144-148.

To render the sun-dried salted mackerel on cooking, experiments with various chemicals such as citric acid, tartaric acid, acetic acid, sodium citrate, sodium bicarbonate, sodium carbonate and sodium hexametaphosphate were tried with little success. However, additions of 2.5-5.0% of sodium bicarbonate and sodium carbonate and 2% of sodium hexametaphosphate to common curing salt and not dried to a moisture level of 35% or below, the softness on cooking improved.

516. MADHAVAN P, BALACHANDRAN K K, CHOUDHURI D R 1970. Suitability of ice stored mackerel and sardine for canning. *Fish. Technol.*, 7 (1) : 67 - 72.

The changes in the physical and chemical characteristics of the fish during ice storage were determined with reference to the quality of the product. Organoleptic analysis attempted is claimed to have indicated that mackerel stored in ice upto 3 days could be used for commercial canning. Longer storage caused poor appearance, increase in spoilage and poor organoleptic characteristics.

517. MARY P P, CHANDRAMOHAN D, NATARAJAN R 1975. The gut microflora of some commercially important fishes from Porto Novo waters. *Bull. Dep. Mar. Sci. Univ. Cochin*, 7 (1) : 185-199.

Comparative estimation of aerobic bacteria in the oesophagus, stomach and intestine of mackerel and 3 estuarine fishes is attempted giving their morphological and biochemical characteristics based on cultures. The isolates are nutritionally classified into 7 groups. *Bacillus, Vibrio, Corynebacterium, Achromobacter* and *Pseudomonas* are claimed to be the common forms. The probable role of bacteria in the digestion is discussed.

518. MOORJANI M N, VASANTHA M 1972. Hot smoking of oil sardines and mackerels — A short communication. *Seafood Export Journal*, 4 (3) : 25 - 27.

Processing of mackerel involving salting, boiling and smoking is described with the aid of a table and figures, commenting on the quality of the finished product, and recommending the method for short-term preservation under tropical condition.

519. MUKUNDAN M K, RADHAKRISHNAN A G, JAMES M A, NAIR M R 1981. Comparative study of the nutrient content of fish and shellfish. *Fish. Technol.*, 18 (2) : 129-132.

The amino acid, mineral and proximate composition of mackerel, another fish and 2 shell fishes are compared. The amino acid composition is also studied for the adequacy recommended by the FAO/WHO. Results of analyses of the major constituents are shown in table along with the

computed calorific value. The mineral composition, the amino acid composition and the FAO/WHO recommended requirements of essential amino acids are also shown in tables.

520. MURALEEDHARAN V, UNNITHAN G R, GEORGE JOSEPH K, UNNIKRISHNAN NAIR T S 1989. Quality of cured fish on the west-coast Comparative study with the IS specifications. *Fish. Technol.*, **26** (1): 30-32.

Moisture and salt content in cured fish products collected for 319 samples including mackerel from various centres on the west coast of India are compared and statistically tested. The moisture contents varied in samples from different centres, whereas the salt content remained more or less uniform. The deviations from the IS specifications were highly significant in both cases. The high mean moisture values and low salt values with respect to accepted standards are indicative of the improper drying and poor salting. Tables are given.

521. NAGENDRA T A, KARUNASAGAR I, KARUNASAGAR I 1990. Levels of histamine in some of the commercially important fish and fishery products in India. *FAO Fish. Rep.*, No. 401, p. 112-120.

Levels of histamine in a number of raw and processed fish samples were examined in view of concern for public health. Among raw fish, mackerel (*R. kanagurta*) had levels ranging from 26.55 to 59.85 mg %. Among processed fish, salted and dried mackerels had high levels (13.3-58.5 mg%) but canned ones had levels less than 20 mg %. The levels of histamine in raw fish did not appear to correlate directly with the count of histamine decarboxylating bacteria suggesting that all of them are capable of forming histamine in fish. A study of the microbiological profile of mackerels at various stages of salting and drying did not indicate that histamine formers would proliferate in fish during the initial stages of drying at ambient temperature.

522. NARAYANAN NAMBIAR V, MAHADEVA IYER K 1990. Microbial quality of fish in retail trade in Cochin. *Fish. Techol.*, **27** (1) : 51-59.

The load of different bacteria and the incidence of faecal indicator and pathogenic organisms in fresh and frozen fish available including mackerel in the retail markets in Cochin is assessed and presented. Total plate counts of fresh and frozen fish, distribution of *Escherichia coli*, distribution of faecal *Streptococci* and occurrence of *Salmonella* in fresh and frozen fish are shown in tables.

523. PERIGREEN P A, AYYAPPAN PILLAI S, SURENDRAN P K, GOVINDAN T K 1975. Studies on preservation of fish in refrigerated sea water. *Fish. Technol.*, **12** (2) : 105-111.

From the storage characteristics studies on 3 fishes including mackerel in refrigerated seawater (RSW) and crushed ice, RSW is recommended as

advantageous for mackerel as the fish would remain in acceptable condition for 4 to 6 days.

524. PEROVIC V, SAMUEL G E 1978. The canning of the Indian pelagic fish in a Yugoslavian canning plant. *Indo-Pacific Fishery Commission Proceedings. 18th session, Section III. Symposium on Fish Utilisation Technology and Marketing in the IPFC Region*, p. 272-287.

The paper reports on some experiments made in 1977 on canning mackerel and 3 other Indian fishes in a Yugoslavian canning plant to examine if the modern methods developed by that country for the Meditarranean fishes were suitable for the Indian species. Eleven different products were experimentally packed in 3 different types of steel and aluminium containers. The results are stated to have been promising, and if small changes in the canning lines and technological processes were adopted it would be possible to produce canned fish of standards acceptable in the world markets. Data on availability of raw material in Indian waters, the existing status of the fish canning industry in India and details of technological processes and packing materials are given. Technological scheme for mackerel canning is shown in flowsheet 2, and product details and yields in table 2. Appendices are given showing chemical analysis of raw material and panel assessment of the quality of canned fish.

525. PRABHU P V, RADHAKRISHNAN A G, ARUL JAMES M 1975. Bevarage preparation from fish hydrolysates. *Fish. Technol.*, **12** (2) : 127-130.

A method for the preparation of what is claimed to be an energy food, incorporating fish hydrolysates, sugar, cocoa, malt extract, etc. from different species of fish including mackerel is described. The preparation is reported palatabile when taken mixed with hot or cold milk. The analytical values of the hydrolysates of the different species of fish are given.

526. PRABHU R M 1979. Studies on the canning of smoked mackerels. MFSc. Thesis, 108 pp. In : *Catalogue of Thesis* (1976 - 1985), University of Agricultural Sciences, Mangalore, Abstract, No. 57.

An attempt made to develop new or modified products by standardising the procedures for canning of smoked mackerel in different packing media is reported.

527. PRABHU R M, SARALAYA K V 1984. Canning of smoked, mackerels : III. Effect of preprocess operations on the microbial load of fish during canning. *Mysore J. agric. Sci.*, **18** (4) : 308-310.

By reporting and comparing the changes in the microbial load due to brining, smoking and precooking of mackerel prior to canning, it is concluded that brining had the least-of-all effect on micro organisms. Effects of 3 preprocess operations on different microbial counts are given comparatively in a table.

528. PRABHU R M, SARALAYA K V, NAGARAJ A S 1981. Canning of smoked mackerels : I. Standardisation of canning methods. *Mysore J. agric. Sci.*, **15** (1) : 113-119.

Brief mention on the canning of smoked mackerel in cans of 3 different sizes and the standardization of brining, smoking, precooking, etc. are available. The evaluation of products is stated to have been based on physical and chemical characteristics and on tastepanel tests.

529. PRABHU R M, SARALAYA K V, NAGARAJ A S 1984. Canning of smoked mackerels : II. Quality evaluation and storage studies. *Mysore J. agric. Sci.*, **18** : 146-152.

Report on an experimental canning of smoked mackerel in 3 forms, namely wholes, halves and fillets, in 4 different media and containers is made. An evaluation of the product based on physical, chemical and organoleptic qualities at monthly intervals for a period of 6 months, states all the products acceptable and stable but the smoked mackerel canned in refined vegetable oil in sulphur-resistant lacquered cans were considerably good. Thermal processes used for different forms of pack, results of organoleptic evaluation, cut out characteristics and chemical composition and pH values of the canned products are shown.

530. PRATAPACHANDRA T N 1983. Bacterial extracellular proteases useful in fermentation of fish. M.Sc. Thesis, 119 pp. *Catalogue of Theses* (1976-1985), University of Agricultural Sciences, Mangalore, Abstracts, No. 70.

Isolation of bacteria from mackerel and standardisation of the cultural conditions for maximum production of proteases by these isolates are attempted, as well as investigating means to purify the proteases.

531. PRATHAPACHANDRA T N, NASSER M M, BHANDARY M H 1988. Effect of freezing on acid proteinase activities in different organs of the Indian mackerel *Rastrelliger kanagurta* (Cuvier). *The First Indian Fisheries Forum, Proceedings. Asian Fisheries Society, Indian Branch, Mangalore*, p. 351-354.

Freezing is claimed in this article to cause reduction in acid proteinase activity in muscle, gonads, liver, heart, and spleen of mackerel, with the activity being least in muscle. On partial purification by ammonium sulphate fractionation and DEAE cellulose ion exchange chromatography, 2 peaks of proteinase (Proteinase 1 and 2) are claimed to separate in fresh muscle extract. Freezing considerably reduces Proteinase-2, the purification levels obtained being 1000 fold in fresh fish. The proteinase activities of different organs, and the characteristics of partially purified crude muscle proteinase of fresh and frozen mackerel are given in tables. Figures are given to show the acid proteinase activity levels of crude extracts from the muscle and the different organs, and the chromatography of proteases from fresh and frozen mackerel on DEAE cellulose column.

532. RADHAKRISHNAN A G, ANTONY P D, NAIR M R 1985. Changes in major protein fractions of oil sardine (*Sardinella longiceps*) and mackerel (*Rastrelliger kanagurta*) during frozen storage. *Harvest and Post-harvest Technology of Fish*. Society of Fisheries Technologists (India) Cochin, p. 433-435.

Mackerel frozen-stored for 6 months at — 18° C is stated to have had the myofibrillar fraction decreasing with rise in the denatured fraction as the storage period increased. The sarcoplasmic protein fraction decreased, while the nonprotein fractions increased with increase in the storage period. The changes of the protein nitrogen fractions observed during the storage are given.

533. RAI B S, SARALAYA K V, PARASHURAM P 1970. Some observations on the canning of Indian mackerel. *Seafood Export Journal*, **2** (8) : 34-43.

The method of canning is outlined, and information on the fish landings, material characteristics, suitable styles of pack, packing media and product requirements are furnished. Some problems related to canning of mackerel are also discussed. Tables are given for ready reference.

534. RAVINDRANATHAN NAIR P, CHINNAMMA GEORGE, NIRMALA THAMPURAN, PERIGREEN P A, GOPAKUMAR K 1987. Studies on frozen storage characteristics of individually quick frozen and block frozen mackerel. *Fish. Technol.*, **24** (2) : 103-108.

Experiments on mackerel of medium (4%) and high (11%) lipid contents, quick-frozen individually (IQF) and as blocks (BF) and stored at —23° C are reported to have demonstrated the superiority of block-freezing for longer shelf-life. Changes in moisture (%), changes in non-protein nitrogen, microbiological characteristics and changes in organoleptic characteristics are given. Changes in PV, FFA and TBA value of IQF and BF mackerel are shown in figures.

535. RAVINDRANATHAN NAIR P, GEORGE JOSEPH K, UNNIKRISHNAN NAIR T S, CYRIAC MATHEN 1990. A preservation process for ready to cook fish portions at room temperature. *Seafood Export Journal*, **22** (7-8) : 45-47.

A formulation for preservation of ready to cook fish portions at room temperature and the results of storage studies of the treated samples are reported. It is stated that portions from mackerel and seven other fishes treated with the preservative mixture containing calcium propionate, citric acid, sodium chloride, turmeric powder and chilly powder could be stored in edible condition from one to four days at room temperature depending upon freshness. Tables are given.

536. SARALAYA K V, NAGARAJ A S 1986. Influence of physical characteristics and chemical composition on the canning yield of mackerels and sardines. *Mysore J. agric. Sci.*, **20** (3) : 216- 224.

Different sizes of mackerel are studied for physical characteristics, weight composition and major chemical components. The net yields of fish packed in commonly used cans are determined and on its basis charts are presented to help canners to improve the yields. The influence of chemical composition of fish on canning yield is also discussed.

537. SARALAYA K V, PARASHURAM P, RAI B S 1975. Studies on canning of mackerel fillets in oil. *Fish. Technol.*, **12** (2) : 120-126.

Canning in the form of skinless and boneless mackerel fillets in oil is studied. The technique of lye peeling is recommended for skin removal. The storage life of the final product, tested over a period of one year, is stated to have been found comparable with other fish products. The influence of fish size on fillet length and canning yield, the effect of lye treatments, the influence of washing on lye-peeled fish, the microbial fluctuations in canning of fillets, the thermal processes used or recommended, and the results of product examination by 'cut-out' and 'panel' tests are presented.

538. SEN D P, ANANDASWAMY B, IYENGAR N V R, LAHIRY N L 1961. Studies on the storage characteristics and packing of sun-dried salted mackerel (*Rastrelliger canagurta* Cuv.). *Fd. Sci.*, **10** (5) : 148-156.

Some studies made to find out packaging material suitable for storage of sun-dried salted mackerel for consumer use are reported. The storage characteristics of the commercial product and a product experimentally prepared under controlled conditions are given.

539. SEN D P, SRIPATHY N V 1967. Improved method for salt- curing and sun-drying of mackerel. *Indian Sea Foods*, **5** (1) : 12.

The paper describes the development of a curing mixture and procedure for curing and sundrying of mackerel.

540. SEN D P, VISWESWARIAH K, LAHIRY N L 1961. Studies on dry- salting and sun-drying of mackerel (*Rastrelliger canagurta* Cuv.). Different conditions of drying and their effect on the quality of dry-cured product. *Fd. Sci.*, **10** (5) : 123-131.

A salt : fish ratio of 1 : 5 appear to cause maximum loss of water in 24-26 hrs in gutted fish and in 18 hrs in split-open fish. Hanging and drying is recommended since dehydration takes place at a lower temperature and the product seem to be better although drying rate is low.

541. SEN D P, VISWESWARIAH K, LAHIRY N L 1961. Studies on dry-salting and sun-drying of mackerel (*Rastrelliger canagurta* Cuv.) effect of chlortetracycline, sorbic acid, sodium propionate, sodium benzoate and sodium acid phosphate on the keeping quality of sun-dried salted mackerel. *Fd. Sci.*, **10** (5) : 132-138.

The deteriorative changes observed on storing sun-dried salted mackerel

available as such and effects of certain bacteriostatic and fungicidal substances such as CTC sorbic acid, sodium propionate and sodium benzoate on keeping quality of the product are presented.

542. SUBRATA BASU, IMAM KHASIM D, GUPTA S S, PANDURANGA RAO C C 1989. Quality of dry fish from markets in Andhra Pradesh. *Fish. Technol.*, **26** (2) : 114-118.

Dry fish samples including mackerel were procured from different fish markets and subjected to biochemical and bacteriological evaluation for assessing quality. The quality of market samples was compared with the samples dried in laboratory and in the mechanical drier.

543. SURENDRAN P K, GOPAKUMAR K 1981. Selection of bacterial flora in the chlortetracycline treated oil sardine (*Sardinella longiceps*), Indian mackerel (*Rastrelliger kanagurta*) and prawn (*Metapenaeus dobsoni*) during ice storage. *Fish. Technol.*, **18** (2) : 133-141.

Pseudomonas, Moraxella, Acinetobacter and *Vibrio* that underwent significant changes during ice storage was influenced by chlortetracycline (CTC) treatment during storage. Though *Pseudomonas* initially reduced considerably, it subsequently constituted the bulk in the spoilage flora.

544. SURENDRAN P K, GOPAKUMAR K 1982. Bacterial flora of EDTA treated oil sardine (*Sardinella longiceps*). Indian mackerel (*Rastrelliger kanagurta*) and prawn (*Metapenaeus dobsoni*) in ice storage. *Fish. Technol.*, **19** (1) : 33-39.

The native flora of fresh mackerel consisted mainly of species of *Pseudomonas, Moraxella, Acinetobacter* and *Vibrio*. But during spoilage in ice, nearly 75% of the bacterial flora is reported to belong to *Pseudomonas* spp alone. But Na_2 EDTA treatment considerably reduced it. The pattern of change in bacteria both in untreated and in EDTA-treated mackerel is shown.

545. SURENDRAN P K, GOPAKUMAR K 1982. The bacteriology of oil sardine (*Sardinella longiceps*) and mackerel (*Rastrelliger kanagurta*) caught from tropical waters off Cochin. 1 - Quantitative aspects. *Fish. Technol.*, **19** (2): 89-96.

The total aerobic viable plate counts (TPCS) of skin, gills and intestine of newly caught mackerel at temperatures 36 ± 1° C, 28 ± 2° C (RT), 8 ± 1° C and 1 ± 1° C are reported. The plate counts of the skin, gills and intestine are given. The influence of the incubation temperatures on TPCS are discussed.

546. SURENDRAN P K, GOPAKUMAR K 1983. The bacteriology of oil sardine (*Sardinella longiceps*) and mackerel (*Rastrelliger kanagurta*) from tropical waters off Cochin. II - Qualitative aspects. *Fish. Technol.*, **20** (1) : 45-52.

The qualitative aspects observed of the bacteria are presented and

discussed with reference to seasons, claiming significant changes in the distribution of different genera. Distributions of bacteria on the skin, in the gills and in the intestines of newly caught mackerel and the seasonal variations in their distribution are given.

547. SURENDRAN P K, JOSEPH J, SHENDY A V, PERIGREEN P A, MAHADEVA IYER K, GOPAKUMAR K 1989. Studies on spoilage of commercially important tropical fishes under iced storage. *Fish. Res.*, 7 : 1-9.

Ice-stored mackerel is reported to have had an acceptable shelf life of about a week. It is also reported that during storage when incipient spoilage was noticed, one or two forms constitute the bulk of the bacteria, *Pseudomonas* being the chief one. Changes in flora during the storage and changes in the sensory scores are given.

548. SURENDRAN P K, MAHADEVA IYER K 1976. Bacterial flora of fresh and iced Indian mackerel (*Rastrelliger kanagurta*) and its response to chlortetracycline (CTC) treatment. *Fish. Technol.*, 13 (2) : 139-145.

Qualitative and quantitative estimates of the bacteria of fresh mackerel are presented and discussed. The total native as well as 5 ppm CTC insensitive flora of the fish are reported to show variations with season. About 90% of the fresh fish flora is claimed sensitive to 5 ppm CTC. *Vibrios, Pseudomonas, Achromobacter, Flavobacterium, Corynebacteria, Micrococci, Bacillus* and yeasts are recorded as the natural flora. At the time of spoilage, *Pseudomonas* is stated to dominate in fish stored in both types of ice.

549. SURENDRAN P K, MAHADEVA IYER K, GOPAKUMAR K 1985. Effectiveness of EDTA dips on the shelf life of oil sardine (*Sardinella longiceps*), mackerel (*Rastrelliger kanagurta*) and prawn (*Metapenaeus dobsoni*) in iced storage. *Fish. Technol.*, 22 (1) : 28-34.

Dipping fresh mackerel in 0.1 % and 1% solutions of Na_2EDTA is claimed to have controlled bacterial counts and reduced TMA and TVBN production while storing in ice, but without the desired effect of checking the rancidity-causing deterioration of fat. The observed bacteriological, chemical and organoleptic indices of the Na_2EDTA-treated mackerel held in ice are presented.

550. SURYANARAYANA RAO S V, KHABADE V S 1968. Studies on the artificial drying of salted mackerel. *J. Food Sci. Technol.*, 5 : 123-126.

Drying of mackerel in a tray drier with cross flow air current of temperature 45° C at a relative 50% humidity is recommended. Salting of the fish before drying is also suggested. Tables are given showing loss of moisture (Wo - Wt) as grams/100g of dry matter, drying rate and chemical changes during the drying of salted fish at 45° C and R.H. 50%. Drying rates of salted fish eviscerated and fully split, and eviscerated but not fully split are shown in figure.

551. SURYANARAYANA RAO S V, VALSAN A P 1962. Control of mould growth and reddening in salted and dried mackerel. *Res. & Ind.*, 7 (9) : 304-306.

The earliest symptom of microbial spoilage in salted and dried mackerel is stated to be mould growth, followed by reddening. The spoiled products showed total-volatile-nitrogen values above 100 mg. Based on laboratory experiments, treatment with 4% propionic acid is suggested as a remedy. By this method, it is claimed, the mould growth and reddening could be brought under control for 62 weeks.

552. SURYANARAYANA RAO S V, VALSAN A P 1962. Pickling of mackerel in tropical countries using propionic acid as preservative. *First International Congress on Fd. Sci. & Tech., London.*

Experimental pickling of mackerel in brines containing 0.5% and 1.0 % propionic acid is reported to have yielded favourable results in as much as the propionic acid protected the fish against the moulds, red halophiles and other spoilage symptoms common in traditional cures. The results of a laboratory investigation and a pilot-scale experiment are presented.

553. SURYANARAYANA RAO S V, VALSAN A P, KANDORAN M K, NAIR M R 1962. Storage behaviour of salted and dried fish in relation to humidity conditions. *Indian J. Fish.*, 9 (2) B : 156-161.

The keeping qualities of salted-and-dried mackerel stored under different humidities with particular reference to moulds and red halophiles are reported. An attempt is also made to determine the equilibrium moisture curve of the samples under these conditions comparing with that described by Canadian workers. The study is claimed to have indicated the need for a more intensive drying to prevent the mould growth if the latest packaging material was to be used without any antifungal agents. Effects of the different humidity levels on storage are comparatively shown.

554. SURYANARAYANA RAO S V, VALSAN A P, RAJENDRANATHAN NAIR M 1958. Studies on the preservation of fish by pickling. *Indian J. Fish.*, 5 (2) : 326-340.

Pickling mackerel with tamarind and salt, and by Ratnagiri method are compared chemically and discussed. It is concluded that pickled mackerel could be preserved upto 8 months, whereas the wet-salted products only less than 2 months.

555. SWAMY P K 1991. Present status and future prospects of seafood export from India. *Proc. Nat. Workshop Fish. Resour. Data Fish. Indus.*, p. 45-66.

In world exports and imports of selected fishery commodities during 1984-'86, the quantity and value of mackerels in fresh, chilled and frozen condition, and as canned products are also listed.

556. UNNIKRISHNAN NAIR T S, VALSAN A P 1971. Time lag between the catching and curing of fish and its influence on the finished product. 1. Mackerel. *Fish. Technol.*, **8** (1) : 12-18.

The maximum permissible time lags between catching and curing of mackerel under uniced and iced storage are studied. Based on the physical, chemical, and bacteriological qualities and taste panel findings, time lags of 8 hrs under uniced condition and 3 days under iced condition are recommended.

557. VALSAN A P 1963. A simplified method of pickling mackerel using propionic acid. *Indian J. Fish.*, **10** (1) B : 1-3.

A method of pickling split mackerel by directly dumping into saturated brine fortified with 0.25 and 0.5% propionic acid are described and its merits discussed in comparison with the traditional salt pickling and Colombo method of curing.

558. VALSAN A P 1975. A comparative yield and biochemical evaluation of the existing fish curing methods of India. *Fish Processing Industry in India. Symposium held at CFTRI, Mysore on 13 & 14 February 1975*, p. 77-79.

The article briefly and comparatively reviews the then existing methods of curing in India, evaluating the biochemical changes undergone in each case. The methods dealt with are sundrying, drycuring, mona curing, wet curing, pit curing, colombo curing and smoke curing.

559. VALSAN A P, RAJENDRANATHAN NAIR M, SURYANARAYANA RAO S V 1961. Propionic acid as a preservative for cured fish products. *J. Sci. & Ind. Res.*, **20D** (9): 351-354.

The advantages of using propionic acid, citric acid, boric acid, sodium benzoate and ethyl gallate as adjuncts to the conventional methods of preserving cured fish are examined. The shelf life of wet-salted mackerel treated with sodium nitrite, sodium benzoate and propionic acid, and the effect of sodium nitrite and propionic acid on pickled mackerel are also studied. Propionic acid is concluded to be the most promising for use in wet-salted and pickled fish, because it helped to supress the growth of moulds and red halophiles.

560. VARMA P R G, CHOUDHURI D R, PILLAI V K 1970. Effect of varying water contents in oil packed sardine and mackerel. *Fish. Technol.*, **7** (1): 95-96.

Water content is claimed to be proportionately affecting shelf life of canned fish, developing black stain on the can within 10-15 days.

561. VENKETARAMAN G, NARAYANA RAO K V 1970. The Indian mackerel — Technology and industry. *Bull. Cent. Mar. Fish. Res. Inst.*, No. 24 : 77-85.

Chemical composition of whole fish and fish meal is tabulated.

Preservation by curing, canning and spoilage are given. Fat content and other chemicals are dealt with. Utilisation in fresh, cured and canned conditions are given.

562. VENKATARAMAN R, CHARI S T 1951. Seasonal variation in the chemical composition of mackerel (*Rastrelliger kanagurta* Russell). *Proc. Indian Acad. Sci.*, 33 (b) : 126-134.

The observed chemical contents of the flesh of fresh mackerel over a period are presented in a table for the seasonal variation. Graphs showing the monthly protein relation, the ash variation, the fat variation and the constancy of the percentage of water for a period of 3 years are also given.

563. VENKATARAMAN R, CHARI S T 1953. Studies on mackerel fat variations: Correlation of plankton fat with fat of fish. *Proc. Indian Acad. Sci.*, 37 (B): 224-227.

The observed fat contents of dry plankton and of the flesh as well as whole of mackerel for an year are presented and their relation illustrated, drawing a positive relationship between the two. The fish is also recorded to have been most fatty in October-November and March-April.

564. VENKATARAMAN R, SREENIVASAN A 1953. Spoilage of mackerels preserved in oil. *Curr. Sci.*, 22 (10) : 309.

A spoilage claimed to be similar to the "sulfide stinker" is recorded as having been observed in mackerel preserved in oil. The bacteria involved in the spoilage is stated to be of the genus *Clostridium*, the source of which is suspected to be the gut.

565. VENUGOPAL V, GHADI S V, GHOSH S K, ALUR M D, DOKE S N, LEWIS N F 1982. Stability of radurized Indian mackerel (*Rastrelliger kanagurta*) as a function of temperature. *J. Food Prot.*, 45 (4) : 360-362.

The influence of 1.5 kGy of gamma irradiation on the stability of mackerel stored at temperatures of 0, 5, 10 and 15° C was examined. Using several indices for assessment of quality, it was found that the radiation treatment suppressed the rate of spoilage at the above temperatures. However, the relative spoilage rates of both unirradiated and irradiated mackerel were similar as a function of storage temperature. The storage-life of fish calculated on the basis of the Spencer and Baines equation for evaluation of spoilage compared favourably with scores obtained by organoleptic evaluation.

566. VENUGOPAL V, LEWIS N F 1985. The role of extracellular protease from a pseudomonad on spoilage of mackerel. *Harvest and Post-harvest Technology of Fish*. Society of Fisheries Technologists (India), Cochin, p. 424-425.

Pseudomonas marinoglutinosa isolated from mackerel is stated to have

produced appreciable amount of extracellular protease when grown in nutrient broth of semi-synthetic medium containing yeast extract as nitrogen source. The enzyme was isolated from the culture supernatant by lyophilisation, dialysis and affinity chromatography on bovine serum albumin bound CH-sepharose. The enzyme degraded several proteins including bovine serum albumin, lysozyme, haemoglobin and casein although it was most active against a preparation of of structural proteins from mackerel. Optimum temperature for the enzyme action was 50° C and pH range 7 to 9. Influence of the enzyme on the mackerel actomysin was examined. Incubation of the fish actomysin with the enzyme at 0-2° C for a period of 4 days is reported to have caused significant release of tyrosine from the protein. The treatment resulted in loss of about 60 % of Mg-dependent ATPase activity of the actomysin cohile Ca-dependent ATpase activity was not affected, with the loss of initial texture of the fish muscle attributable to the breakdown of actomyosin by the protease. The structural proteins are concluded to be susceptible to degradation by proteases released by psychrophilic micro organisms like *Pseudomonas marinoglutinosa*. Mg++ dependent ATPase activity of mackerel actomyosin treated with *P. marinoglutinosa* protease and release of tyrosine from mackerel actomyosin by *P. marinoglutinosa* protease at 0-2° C are shown.

567. VENUGOPAL V, LEWIS N F, NADKARNI G B 1981. Volatile acids content as a qualtiy index of Indian mackerel (*Rastrelliger kanagurta*). *Lebensm. Wiss Technol.*, **14** (1) : 39-42.

Volatile fatty acids (VA), mainly formic and acetic acids, were formed during storage of *Rastrelliger kanagurta*. At the terminal shelf life, content of VA was more in dark and light muscle as compared with the skin of the fish. The exposure of fish to 150 krad of gamma rays caused retardation in the VA formation during storage. Microflora from the irradiated fish had less potential to produce VA when allowed to grow in sterile mackerel homogenates. Loss in organoleptic acceptability could be correlated with the increase in VA both in the unirradiated as well as irradiated fish stored at temperatures ranging from 0 to 20° C, suggesting that VA value can be a useful parameter for the quality evaluation.

568. VENUGOPAL V, SAVAGAON K A 1975. Improvement in marketing quality of mackerel (*Rastrelliger kanagurta*) by radiation. *Fish Processing Industry in India. Symposium held at CFTRI, Mysore on 13 & 14 February 1975*, p. 145-146.

Irradiation of mackerel is reported to have resulted in the reduction of initial total bacterial counts and the dose required to effect one log cycle kill was 125 Krad-Irradiation of mackerel up to 150 Krad, scoring initially 6.6 - 7.0 for acceptability did not show detectable changes in odour and flavour. Storage in ice of mackerel upto 5 days prior to irradiation resulted in post irradiation shelf life close to that of freshly irradiated mackerel.

569. VENUGOPAL V, SAVAGAON K A, KUMTA U S, SREENIVASAN A 1973. Extension of shelf-life of Indian mackerel (*Rastrelliger kanagurta*) by irradiation. *J. Fish. Res. Board Canada*, 30 (2) : 305-309.

A dose of 150 krad is reported to have indicated as optimum for extending refrigerated (0 - 2° C) shelf-life of fresh mackerel. This dose extended the shelf life to 25 - 30 days from 10 - 12 days without inducing undesirable changes in the organoleptic qualities. Vacuum-packaging affected the appearance of the irradiated product by drawing out muscle fluids during storage. Samples irradiated aerobically did not become rancid and were acceptable to a taste panel. Storage of fish in ice beyond 5 days before irradiation reduced its post-irradiation shelf-life.

570. VIJAYAN P K, SURENDRAN P K, BALACHANDRAN K K 1985. Canning mackerel (*Rastrelliger kanagurta*) as fillets in oil. *Harvest and Post-harvest Technology of Fish*. Society of Fisheries Technologists (India), Cochin, p. 534-535.

A process of canning skinned and boneless mackerel fillets in oil is described. Effects of the various treatments attempted on skin peeling, bacteriological quality of fish at different stages of processing and results of the cut out test of canned mackerel fillet prepared are presented. It is inferred that the bacterial quality of the fish was not affected by the processes involved. The skin peeling method suggested is claimed to be simpler and more advantageous than other methods.

571. VIJAYAN P K, SURENDRAN P K, BALACHANDRAN K K 1989. Incidence of histamine in marine fishes sold in retail markets in relation to their content of histidine decarboxylating bacteria. *J. mar. biol. Ass. India*, 31 (1&2) : 202-204.

Histamine contents in 10 species of marine fish including Indian mackerel collected from retail markets in Cochin were estimated along with their bacterial profile in general and content of histidine decarboxylating bacteria in particular. Histamine was estimated by the method of Hardy and Smith (1976) using spectronic 21 spectrophotometer for measuring the absorbance. The study reveals that none of the fish samples surveyed contained histamine above 1.3 mg/100 g fish which is much below the recommended level as per USFDA specification, even though the histidine decarboxylating bacterial counts were of the order of 10 4 per g of fish muscle. Tables are given.

572. VISWANATHAN NAIR P G, GOPAKUMAR K, RAJENDRANATHAN NAIR M 1976. Lipid hydrolysis in mackerel (*Rastrelliger kanagurta*) during frozen storage. *Fish. Technol.*, 13 (2) : 111-114.

It is reported that during storage at — 18° C only the phosphorylated fraction underwent noticeable hydrolysis, and that the free fatty acid production was mainly associated with the phospholipid hydrolysis. There was no significant change in levels of the triglycerides and unsaponifiable matter.

III. ADDITIONS

573. SILAS E G 1962. Parasites of scombroid fishes. Part I. Monogenetic trematodes, digenetic trematodes, cestodes. *Proceedings of the Symposium on Scombroid Fishes*, Marine Biological Association of India, Mandapam Camp, 12-15 January 1962, Part III, p. 799-869.

Number of trematode parasites from *Rastrelliger kanagurta* are given.

574. SILAS E G, UMMERKUTTY A N P 1962. Parasites of scombroid fishes. Part II. Parasitic Copepoda. *Proceedings of the Symposium on Scombroid Fishes*, Marine Biological Association of India, Mandapam Camp, 12-15 January 1962, Part III, p. 876-993.

A few parasites are listed.

575. JAMES P S B R, KURUP K N, PILLAI N G K 1991. A review of present status of marine fisheries of Kerala. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 114 : 1-8.

Annual mackerel landings during 1985-'89 along with that of other fishes are given in a table. The catch in this 5 year period ranged between 10,068 and 85,272 tonnes. The average during the period was 35,855 tonnes forming 8.4 % in the marine fish catches of the state.

576. JAMES P S B R , RAJAGOPAL M S 1991. Marine fisheries management. In : Natarajan R, Dwivedi S N, Ramachandra S (Ed). *Coastal Zone Management*. Ocean Data Centre, Anna University, Madras, p. 172-177.

It is of interest to note that oil sardine and mackerel, mostly confined to the west coast, also occur in Tamil Nadu landings, the average catch being 2,625 and 9,026 tonnes respectively during 1984-'88 period.

577. RAO T S S 1951. Occurrence of *Lernaeenicus* sp. on *Scomber scomber*, Lawson's Bay, Waltair. *Curr. Sci.*, **21** (4) : 103-104.

The parasite recorded probably from *R. kanagurta* as *S.Scomber* is not an Indian species.

578. THIRUMILU P, MAHADEVAN PILLAI P K, KRISHNAN K S, POOVANNAN P 1991. The fishing gears used in the exploitation of marine and brackish water fishery resources along Tamil Nadu coast. *Mar. Fish. Infor. Serv., T & E Ser.*, No. 114 : 16 - 28.

Mackerel is reported to be caught by gears like drag net or shore seine *(Periya valai/ Karamadi valai/ Marukku valai/ Thalluvalai)*, drift gillnets *(Ara valai/ Pannu valai/ Thadachi valai, Kumla valai*, Gillnet *Pachi valai, Paru valai, Podi valai).*

IV. AUTHOR INDEX

PRICE LIST FOR

SPECIAL PUBLICATIONS AND BULLETINS PUBLISHED BY CMFRI

I. SPECIAL PUBLICATIONS

Spl. Pub. No.	Title	Year	Price	
			Indian Rs.	US $
1	2	3	4	5
No. 1	Pearl culture training : Long-term and short-term course	1977	5.00	2.00
No. 2	Mariculture research and developmental activities	1978		
No. 3	summer Institute in breeding and rearing of marine prawns	1978	20.00	5.00
No. 4	Economics of the indigenous fishing units at Cochin : A case study	1978	5.00	2.00
No. 5	Seminar on the role of small-scale fisheries and coastal aquaculture in integrated rural development, Madras, 6-9 December 1978. Abstracts	1978	10.00	5.00
No. 6	Proceedings of the first workshop on technology transfer in coastal aquaculture held at Cochin, 23-24 July, and Mandapam, 27-28 July 1979	1979	15.00	5.00
No. 7*	Manual of research methods for crustacean biochemistry and physiology	1981		
No. 8*	Manual of research methods for fish and shellfish nutrition	1982		
No. 9	Manual of research methods for marine invertebrate reproduction	1982	40.00	15.00

1	2	3	4	5
No. 10.	Analysis of marine fish landings in India : A new approach	1982	10.0	5.00
No. 11*	Approaches to finfish and shellfish pathology investigations	1983		
No. 12*	A code list of common marine living resources of the Indian seas	1983		
No. 13*	Application of genetics in aquaculture	1983		
No. 14*	Manual of research methods for invertebrate endocrinology	1983		
No. 15*	Production and use of *Artemia* in aquaculture	1984		
No. 16*	Manual on marine toxins in bivalve molluscs and general consideration of shellfish sanitation	1984		
No. 17*	Handbook of diagnosis and control of bacterial diseases in finfish and shellfish culture	1984		
No. 18	Proceedings of the workshop on sea turtle conservation	1984	25.00	10.00
No. 19*	Mariculture research under the Centre of Advanced Studies in Mariculture	1984		
No. 20*	Manual on pearl culture techniques	1984		
No. 21*	A guide to prawn farming in Kerala	1985		
No. 22*	Water quality management in aquaculture	1985		
No. 23	Hatchery production of penaeid prawn seed: *Penaeus indicus*	1985	10.00	5.00
No. 24	The present status of ribbon - fish fishery in India	1986	15.00	5.00

1	2	3	4	5
No. 25*	A practical manual for studies of environmental physiology and biochemistry of culturable marine organisms	1986	10.00	5.00
No. 26	Theorems in environmental adaptation	1986	15.00	5.00
No. 27	Bibliography of the publications by the staff of CMFRI 1948-'85	1986	40.00	5.00
No. 28	The present status of our knowledge on the lesser sardines of Indian waters	1986	10.00	5.00
No. 29	Exploitation of marine fishery resources and its contribution to Indian economy	1986	10.00	5.00
No. 30	Seminar on potential marine fishery resources, April 23, 1986	1987	30.00	10.00
No. 31	An appraisal of the marine fisheries of West Bengal	1987	10.00	5.00
No. 32	An appraisal of the marine fisheries of Orissa	1987	10.00	5.00
No. 33	An appraisal of the marine fisheries of Andhra Pradesh	1987	15.00	5.00
No. 34	An appraisal of the marine fisheries of Tamil Nadu and Pondicherry	1987	15.00	5.00
No. 35	An appraisal of the marine fisheries of Kerala	1987	10.00	5.00
No. 36	An appraisal of the marine fisheries of Karnataka & Goa	1987	25.00	10.00
No. 37	An appraisal of the marine fisheries of Maharashtra	1987	15.00	5.00
No. 38	An appraisal of the marine fisheries of Maharashtra	1987	15.00	5.00
No. 39	An appraisal of the marine fisheries of Lakshadweep and Andaman & Nicobar Islands	1987	5.00	2.00

1	2	3	4	5
No. 40*	National symposium on research and development in marine fisheries, Mandapam Camp, 16-18 September 1987. (Abstracts)	1987		
No. 41	A manual for hormone isolation and assay	1987	10.00	5.00
No. 42	Manual of techniques for estimating bacterial growth rates, productivity and numbers in aquaculture ponds	1987	5.00	2.00
No. 43	Nutritional quality of live food organisms and their enrichment	1987	5.00	2.00
No. 44	An evaluation of fishermen economy in Maharashtra and Gujarat — A case study	1988	20.00	5.00
No. 45	Motorization of country crafts in Kerala — An impact study	1989	20.00	5.00
No. 46	Atlas of clam resources of Karnataka	1989	15.00	5.00
No. 47	Annotated bibliography of commercially important prawns and prawn fisheries of India	1989	90.00	30.00
No. 48	The Indian oil sardine — *Sardinella longiceps* Valenciennes — An annotated bibliography	1990	25.00	10.00
No. 49	Hatchery production of pearl oyster spat : *Pinctada fucata*	1991	10.00	5.00
No. 50	Annotated bibliography of the silverbellies (Pisces : Family leiognathidae)	1992	70.00	25.00
No. 51	Bibliography (Part - 2). The publications by the staff of CMFRI 1986-1990	1992	40.00	15.00

1	2	3	4	5
No. 12*	Explroatory fishing by R.V. *Varuna*	1969		
No. 13*	Marine fish production in India, 1950-1968	1969		
No. 14*	Prawn fisheries of India	1969		
No. 15*	Bibliography of the echinoderms of the Indian Ocean	1969		
No. 16*	The Indian oil sardine	1969		
No. 17*	Mackerel and oil sardine tagging programme (1966-'67 to 1968-'69)	1970		
No. 18*	The polynemid fishes of India	1970		
No. 19*	Bibliography of contributions from CMFRI	1970		
No. 20*	The economic seaweeds of India	1970		
No. 21*	The Bombay duck, *Harpodon nehereus* (Ham)	1970		
No. 22*	Primary productivity in the Indian seas	1970		
No. 23*	The tunas and tuna-like fishes of India	1970		
No. 24*	The Indian mackerel	1970		
No. 25*	The commercial molluscs of India	1974		
No. 26*	The dugong, *Dugong dugon*	1975		
No. 27*	Exploited marine fishery resources of India : A synoptic survey, with comments on potential resources	1976		
No. 28	Coastal aquaculture : Marine prawn culture ; Part I : Larval development of Indian penaeid prawns	1979	15.00	5.00

1	2	3	4	5
No. 29	Coastal aquaculture : Mussel farming — progress and prospects	1980	10.00	5.00
No. 30A	Proceedings of the seminar on the role of small-scale fisheries and coastal aquaculture in integrated rural development, 6-7 December 1978, Madras	1981	35.00	10.00
No. 30B	Present status of small-scale fisheries in India and a few neighouring countries	1981	15.00	5.00
No. 31	Coastal zone management : Mudbanks of Kerala coast	1984	15.00	5.00
No. 32	Resources of tunas and related species and their fisheries in the Indian Ocean	1982	35.00	10.00
No. 33	Fishery resources of the Exclusive Economic Zone of the northwest coast of India	1982	15.00	5.00
No. 34	Mariculture potential of Andaman and Nicobar islands : An indicative survey	1983	25.00	10.00
No. 35	Sea turtile research and conservation	1984	20.00	5.00
No. 36	Tuna fishery of the Exclusive Economic Zone of India	1985	50.00	15.00
No. 37	Cephalopod bionomics, fisheries and resources of the Exclusive Economic Zone of India	1986	50.00	15.00
No. 38	Oyster culture, status and prospects	1987	20.00	5.00
No. 39	Pearl culture	1987	35.00	10.00
No. 40	Marine catfish resources of India : Exploitation and prospects	1987	25.00	10.00
No. 41	Seaweed research and utilization in India	1987	30.00	10.00
No. 42 Part I	National seminar on shellfish resources and farming, Tuticorin, 19-21 January, 1987. Session-I	1988	60.00	20.00
No. 42 Part II	National seminar on shellfish resources and farming, Tuticorin, 19-21 January, 1987. Session-II-VI	1988	55.00	20.00

1	2	3	4	5
No. 43	Marine living resources of the Union Territory of Lakshadweep — An indicative survey with suggestions for development	1989	70.00	25.00
No. 44 Part I	Proceedings National symposium on research and development in marine fisheries, Mandapam Camp, 16-18 September, 1987: Papers presented, Sessions I & II	1989	80.00	25.00
No. 44 Part II	Proceedings National symposium on research and development in marine fisheries, Mandapam Camp, 16-18 September, 1987: Papers presented, Sessions III & IV	1990	50.00	15.00
No. 44 Part III	Proceedings National symposium on research and development in marine fisheries, Mandapam Camp, 16-18 September, 1987: Papers presented, Sessions V, VI & VII	1991	60.00	20.00
No. 45	Monsoon fisheries of the west coast of India : Prospects, problems and management	1992	95.00	30.00

Please make your orders to :-

The Director,
Central Marine Fisheries Research Institute,
P. B. No. 2704, Cochin - 682 031, (India)

Payment may be made in advance by Demand Draft in favour of "ICAR UNIT - CMFRI" payable at State Bank of India, Ernakulam

Bank Commission and Postage will be charged extra

* Out of stock. However, Xerox copies can be made available at actual cost plus postage.