STUDIES ON THE SYSTEMATICS AND BIOLOGY OF THE FISHES OF THE VEMBANAD LAKE

THESIS

SUBMITTED TO THE UNIVERSITY OF COCHIN

IN PARTIAL FULFILMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN

FISHERY SCIENCE

IN THE FACULTY OF MARINE SCIENCES

BY

B. MADHUSOODANA KURUP, M.Sc.

DEPARTMENT OF MARINE SCIENCES, UNIVERSITY OF COCHIN

COCHIN - 682 016

JULY, 1982

C E R T I F I C A T E

This is to certify that this Thesis is an authentic record of research work carried out by Mr. B. Madhusoodana Kurup, M.Sc., under my supervision and guidance in the Department of Marine Sciences for the Ph.D. Degree of the University of Cochin and no part of it has not previously formed the basis for the award of any other degree in any University.

Dr.C.T.Samuel
(Supervising Teacher)
Professor and Head
Dept. of Industrial Fisheries
University of Cochin

Cochin-682016,
July, 1982.

ACKNOWLEDGEMENTS

I wish to record my deep sense of gratitude to Professor Dr.C.T.Samuel, Dean, Faculty of Marine Sciences and Head of the Department of Industrial Fisheries, University of Cochin, for suggesting the problem, the valuable guidance, the constant encouragements and the critical scrutiny of the manuscript.

My thanks are also due to the authorities of Cochin University and to Dr.[illegible].S.Sharma, Head of the Department of Marine Sciences for providing me with the necessary facilities to carry out this work in the Department of Marine Sciences. I am grateful to the University Grants Commission, New Delhi, for awarding a Junior Research Fellowship, during the tenure of which the present study was carried out.

I am greatly indebted to the following persons for confirming the identification of the present collection of fishes: Dr.B.B. Collette, NMFS Systematics Laboratory, National Museum of Natural History, Washington D.C.; Dr.T.Wongratana, Department of Fisheries, Ministry of Agriculture and Co-operatives, Ragadamnern Avenue, Bangkok; Dr.P.J.P. Whitehead, British Museum (Natural History), Cromwell Road, London SW7, 5 BD; Dr.K.C.Jayaram, Deputy Director, Z.S.I. (Fish Division) Calcutta; Dr.P.K. Talwar, Superintendenting Zoologist, Z.S.I. (Fish Division), Calcutta; Dr.G.Luther, Scientist, C.M.F.R.Institute, Vizhingam; Dr.R.S. Lalmohan, Scientist, C.M.F.R.Institute, Calicut and Dr.T.K. Chatterjee, Z.S.I. Calcutta. I am also grateful to Dr.W. Fischer, Convener, FAO Fisheries Department, Via della Terme Caracalla, Rome, Italy for permitting me to consult with the participants of the FAO/DANIDA expert consultation on field identification of commercial aquatic organisms in the Western Indian Ocean, which was held at C.M.F.R.Institute, Cochin from 21 January to 15 February 1980. I am specially thankful to Dr.K.C.Jayaram and Dr.P.K. Talwar, Z.S.I., Calcutta, who made the necessary arrangements for examining the type specimens and other representative materials of the collection of fishes in the Zoological Survey of India (Fish Division), Calcutta.

The statistical analyses of the data were assisted by Shri M. Krishna Iyer, Scientist, C.I.F.T., Cochin and Dr.M.V.Mohan, Fresh water Biologist, Kerala State Fisheries Department, Malampuzha. I also wish to thank

Mr.V.N.Balan, Artist-cum-Photographer, Department of Marine Sciences for the preparation of the illustrations.

PREFACE

The Vembanad lake is the largest brackish water lake system of the south west coast of India. This lake extends into the Alleppey, Kottayam, Ernakulam and Trichur districts of Kerala and serves as an extensive nursery ground for many marine animals. This lake is also a lucrative fishing ground and it also provides ample scope for undertaking large scale brackish water fish farming. The brackish water biotic niche is highly dynamic and productive and is always characterised by rich, varied and distinctive biological entities which can tolerate the extremely fluctuating physico-chemical parameters of this environment. Thus a characteristic type of fish population has developed in each brackish water lake on which the commercial fisheries are based.

Tropical brackish water fishes are of immense importance in providing protein food for humans, the demand for such protein is rising exponentially with the rapidly accelerating increase in human population. The ever increasing demand for fresh fish at the present day has made it imperative to exploit fully the resources of the estuaries and brackish water lakes of the country as well as to develop brackish water fish farming. Moreover, due to the inability of the capture fishery to cater to the needs of the export industry and the internal demand, brackish water fish farming had drawn the special attention of the fishery scientist during recent years. The developments of both capture and culture fisheries related to any brackish water system are dependent on the availability of scientific data on fish faunastic composition, various biological and physico-chemical factors in respect of the different species of fishes and the various zones of the environment. In addition to this, the perpetuation of the coastal fisheries resources may be also dependent on the brackish water ecosystem. Such studies would help to provide the needed perspective on the management of the resources.

In the past few years, the hydrography, primary production, plankton, benthos, crustacean and molluscan fisheries of Vembanad lake were subjected to intensive studies. But no effort has been made so far to bring out a comprehensive systematic account of the fish fauna of the Vembanad lake and also to study the various biological and physico-chemical factors in relation to the different fish species of the lake. The present effort is, therefore, to document a comprehensive systematic account of Vembanad lake fishes and to study the effect of physico-chemical parameters on the distribution and abundance of fishes in the lake. This study is expected to advance our knowledge on the biological aspects of two commercially important fishes of the lake which are very desirable for brackish water fish farming. Additionally, the results of the studies on the ecology as habitat, occurrence, season and abundance of all the recorded fishes of the lake and the commercially important fish species of the lake are also incorporated. A general appraisal on the detrimental factors which are adversely affecting the fisheries resources of the lake are presented and some measures of conservation are also suggested.

The results of the present study will be helpful in formulating suitable schemes for management of parts of the Vembanad lake for capture and culture fisheries.

LIST OF PUBLICATIONS

Appendix - I Madhusoodana Kurup, B. and C.T.Samuel 1979 Notes on a specimen of *Ambassis dayi* Bleeker with morphological abnormalities. *Matsya*, 5: 76-78.

II Madhusoodana Kurup, B. and C.T.Samuel 1980a Fishes of the subfamily Pollonulinae (Pisces: Clupeidae) from Vembanad lake, Kerala, South India. *Bull. Dept. Mar. Sci. Univ. Cochin*, 11(1): 85-98.

III Madhusoodana Kurup, B. and C.T.Samuel 1980b On the little known fish *Hyporhamphus* (*Hyporhamphus*) *xanthopterus* (Val.) from the Vembanad lake (Kerala) with a key for identification of half beaks (Pisces: Hemiramphidae) of the Vembanad lake. *Bull. Dept. Mar. Sci. Univ. Cochin*, 11(2): 1-9.

IV Madhusoodana Kurup, B. and C.T.Samuel 1981a On the occurrence of *Oxyurichthys nijsseni* Menon and Govindan (Pisces: Gobiidae) in Vembanad lake, Kerala *Matsya*, 7: 91-93 .

V Madhusoodana Kurup, B. and C.T.Samuel 1981b Sexual dimorphism in *Oxyurichthys nijsseni* Menon and Govindan *Curr. Sci.* 50(19): 873.

VI Madhusoodana Kurup, B. and C.T.Samuel 1981c Systematics and distribution of fishes of the family Leiognathidae (Pisces) of the Vembanad lake, Kerala (S.India). *Rec. Zool. Surv. India* (in press)

Appendix VII Madhusoodana Kurup, B. and C.T.Samuel 1981d On the occurrence of *Ilisha sirishai* Seshagiri Rao (Pisces: Clupeidae) in Vembanad lake, Kerala, South West coast of India. *J. Inland Fish. Soc. India* (in press)

VIII Madhusoodana Kurup, B. and C.T.Samuel 1981e A re-description of the little known rabbit fish *Siganus lineatus* Cuv. and Val. (Pisces: Siganidae) with notes on Siganid fishes of Vembanad lake, Southern India. *Nat. Acad. Sci.*, 51st Session, Biol. Sci., University of Cochin, Oct. 1981. Abstract No. 88: 30. (full paper communicated)

IX Madhusoodana Kurup, B. and C.T.Samuel 1981f Observation on the spawning biology and ecology of *Liza parsia* (Ham. Buch.) in a tropical estuary. Seminar on Estuaries, NIO, Goa. Dec. 1981. Abstract No. 73: 50. (full paper communicated).

X Shahul Hameed, M. and B.Madhusoodana Kurup 1981 Comparative studies on the populations of the Indian Sand Whiting *Sillago sihama* (Forsk.) (Pisces: Sillaginidae) from the East and West coasts of India. *J. Inland Fish. Soc. India* (in press).

Appendix XI Radhakrishnan, C.K., B. Madhusoodana Kurup and C.T.Samuel 1981 The occurrence of *Charybdis* (*C. lucifera* Fabr.) (Decapoda: Portunidae) in Vembanad lake. *Spl. Publ. Dept. Aquatic Biol. Fish. Univ. Kerala* (communicated).

XII Radhakrishnan, C.K., B. Madhusoodana Kurup and C.T.Samuel 1982 Distribution and ecology of the Crustacean population of the Vembanad lake (S. India) during the pre-monsoon periods (Dec. - May) *J. Inland Fish. Soc. India*. (communicated)

Abbreviations

A	: Anal
ASB	: Asiatic Society Bengal
C	: Caudal
Coll.	: Collection
D	: Dorsal
DW	: Disc Width
Dup. Cat.	: Duplicate Catalogue
GSI	: Gonado-Somatic Index
HL	: Head Length
lat.	: lateral
M	: Mean
micro. div.	: micrometer division
P	: Pectoral
SL	: Standard Length
TL	: Total Length
tr.	: transverse
V	: Ventral (Pelvic)
ZSI	: Zoological Survey of India (Calcutta)

CONTENTS

Page

...

GENERAL INTRODUCTION

1. GENERAL INTRODUCTION

In recent years, various aspects of brackish water fishes and fisheries resources have been the subject of considerable research owing to their importance in capture and culture fisheries development programmes. Many of the brackish waters are unified specialized dynamic ecosystems of high productivity which offer ideal biotic conditions to sustain a wide variety of aquatic populations. Surrounding these areas there is invariably a rich and diversified natural fishery which contributes to the natural economy. Besides such a lucrative fishery, enormous numbers of culturable fish seeds are also caught from these areas. Vulnerability to human influences is an advantageous characteristics of the brackish water lakes unlike the open sea. So control measures can be exercised over the factors governing fish production and parts of the lake can also be utilized for brackish water fish farming.

A detailed knowledge on fish species composition, interaction of environmental factors on the distribution and abundance of fishes and biological aspects of the economically important fishes of any brackish water lake are essential pre-requisites for a judicious exploitation of the resources and the development of the capture and culture fishery potential. The fish fauna of a brackish water system is generally composed of marine and fresh water fishes which are adapted to the waters of different varying salinities and truely 'residents' which are present throughout the year. The nature, distribution and abundance of fishes in a brackish water lake are predominently controlled by the master environmental factor viz., 'salinity'. The fish fauna of any of the brackish water lake of India has a direct relationship with the inshore fishes of the adjacent sea. So marine fishes predominates in these bodies and the fluctuation in their abundance could be related to movements or migration of the fish population.

1.1. Historical account on Brackish water Fishes and Fisheries of India:

The major source of brackish water fishes and fisheries resources for the country are from the brackish water lakes and estuaries located in the east and west coasts of India. Among the most important brackish water lakes, Chilka in Orissa, Pulicat in Andhra Pradesh and Tamil Nadu, Vembanad in Kerala and major estuaries - Hooghly - Matlah in West Bengal, Godavari in Andhra Pradesh and Mahanadi in Orissa produce appreciable quantities of fish. The estimated average production figures are: Chilka - 3600 tonnes, Pulicat - 1000 tonnes, Vembanad - more than 10000 tonnes, Hooghly - Matlah - 7500 tonnes, Godavari - 3919 tonnes and Mahanadi (marketable surplus only) - 650 tonnes (Jhingran and Gopalakrishnan, 1973).

Chilka lake is the largest brackish water lake of India, of which the scientific data on systematics and fisheries resources are available. The systematic treatment of the icthyo-fauna of this lake has been done by Chaudhuri (1916a, 1916b, 1917, 1923) and Hora (1923) under the auspices of Zoological Survey of India. These studies revealed 118 species of fishes of which 6 species were considered synonyms by Jones and Sujansingani (1954). To this list Koumans (1941) added one new Goby, Jones and Sujansingani (1954) 25 species of fishes and Roy and Sahoo (1957) a further 14 species of fishes. Therefore the total recorded species is 152. The biology and fisheries resources of the economically important fishes of this lake has been studied in detail (Jones and

Sujansinghani, 1954; Devasundaram, 1954; Jhingran and Natarajan 1969; Natarajan and Patnaik, 1971).

Pulicat lake is the second largest brackish water lake of the east coast of India. Contribution to our knowledge on the fish systematic account of this lake is by Chacko et al. (1953), who recorded 65 species of fishes. Selvanathan and Kaliyamurthy (1969) reported some new records of fishes from Pulicat lake. Various aspects of fisheries resources of the Pulicat lake have been worked out by Prabhakara Rao (1970a, 1970b, 1971) and Ramamohana Rao and Janardhana Rao (1971). The very few available papers on the fish and Fisheries of Vembanad lake are reviewed under the literature review of the study area.

Among the open estuaries, the largest and most extensive is the Hooghly-Matlah estuarine system. The icthyo-fauna of this estuarine system has been studied by many workers (Hamilton-Buchanan, 1822; Hora, 1934; David, 1954). Gopalakrishnan (1971) listed 131 species of fishes from the Hooghly-Matlah estuarine system. According to the most recent report, there is the occurrence of 172 species of fishes in this estuary

(Jhingran, 1982). The next largest system both by extend and production is the Godavari estuarine system. A total number of 224 species of fishes were reported from this estuary, of which 33 are clupeoids (Babu Rao, 1976) and 191 species are non clupeoids (Visweswara Rao, 1976). The systematic account of fishes of Mahanadi estuary is hitherto unknown.

1.2. Physiography of Vembanad lake:

The Vembanad lake is the largest brackish water lake system of south west coast of India, situated between latitudes 9°28' and 10°10'N and longitudes 76°13' and 76°31'E (Plate 1). It has a length of about 90 km and extends from Alleppey in the south to Thuruthippuram (east to Azheekode) in the north. The total area is about 256 sq.km. (Shetty, 1965). The depth at the Cochin navigation channel varies from 8-12 m and the depth of other parts of the lake is 1-5m. The width of the lake varies from a few 100 m to about 8 km. On the northern part of the lake, there are two permanent openings to the Arabian Sea, one at Cochin, a 450 m wide channel which forms the main entrance to the Cochin harbour and the other at Azheekode. The entire lake system is subjected to regular tidal influences and it has all the characteristics of a tropical estuary (Qasim *et al.*, 1969). Tides of this area are of mixed semidiurnal type with substantial differences in range and time. The main source of fresh water for the lake is two large rivers, Periyar in the north and Pamba in the south. Four other small rivers viz., Achancoil, Manimala, Meenachil and Moovattupuzha also empty into the lake. During the south west monsoon, the lake receives an average rainfall of 3300 mm and is virtually converted into a fresh water basin (Pillai, 1978).

A 1447 m long bund was constructed across the lake at Thannirmukkom during 1975 for preventing the penetration of salt water into the upper Kuttanad areas so as to enhance paddy cultivation. The water flow through the bund is regulated by spill ways and the bund is kept open during June to December and will be closed during the rest of the periods.

The physiography of Vembanad lake does not agree with Forel's (1892) definition of 'lake' as a body of standing water occupying a basin and lacking continuity with sea. The lake was part of the Arabian Sea until the uplift of part of the Alleppey and

Ernakulam districts in 1341 (Menon, 1913). Conversion of the original marine environment into brackish water is shown by the change in molluscan fauna (Ramaiam and Sebastian, 1976). The fresh water discharge from the rivers make the lake a typical estuary as per Pritchard's classification (Pritchard, 1967). The run off plus precipitation exceeds evaporation and it is a positive type of estuary (Balakrishnan, 1957).

1.3. Review on previous literature:

A review on the literature shows that various disciplines such as hydrography, nutrients, primary productivity, plankton, bottom fauna, crustacean and molluscan fisheries resources of the lake have been subjected to detailed studies. The present discussion on previous literature is limited to the studies on the hydrobiological and fisheries aspects of Vembanad lake. The hydrography of this lake has been investigated by several workers (Balakrishnan, 1957; Ramamritham and Jayaraman, 1963; George and Kartha, 1963; Cheriyan, 1967; Josanto, 1972; Shynamma and Balakrishnan, 1973; Balakrishnan and Shynamma, 1976). The pioneering attempt of making a qualitative and quantitative study of the plankton of this area was done by George (1958).

The species composition, distribution and abundance of phytoplankton in the lake was studied by Gopinathan (1972), Joseph and Kunjukrishna Pillai (1975) and Kumaran and Rao (1975). More recently, a few reports were published depicting the amplitude of seasonal and spatial change of zooplankton of Vembanad lake (Nair and Tranter, 1972; Menon et al., 1972; Haridas et al., 1973). Variation in the relative proportions of specific groups such as copepods, chaetognaths, hydromedusae, siphonophores, decapod larvae and cladocerans have also been studied by various authors (Wellershaus, 1969; Pillai, 1972; Pillai et al., 1973; Nair, 1972; Madhupratap, 1980; Rao et al., 1975). A compendious picture of the dynamism of the zooplankton of Vembanad lake was presented by Silas and Parameswaran Pillai (1975). Desai and Krishnan Kutty (1967) and Pillai (1977, 1978) studied the bottom fauna of the Vembanad lake.

The lake also serves as a ground which has been providing a sustainable yield of crustacean fisheries resources. Considerable work has been done on the biology and fisheries of prawns and crabs of this lake. Among them, the most important investigations are those of Menon and Raman (1961), George (1962), Kuttyamma and Antony (1975), Kathirvel *et al.* (1976) and Radhakrishnan *et al.* (1982, in press). The lake also serves as a major source of lime-shell to the state and to the factories situated in the proximate areas. A systematic survey of lime-shell deposits and clam resources of the lake has been conducted by Rasalam and Sebastian (1976). The only available literature on the fish and fisheries of Vembanad lake is confined to Shetty's (1965) preliminary survey report. Other sporadic reports on the occurrence of fishes in the lake are those of Pillay (1960), George (1965), Reghu (1973) and Noble (1974). From the above account, it is clear that an integral comprehensive study on various aspects of fishes of the lake is needed. Part of the results of this study has been published (Kurup and Samuel, 1979, 1980a, 1980b, 1981a, 1981b, 1981c, 1981d, 1981e, 1981f).

1.4. Objectives of the present study:

The main objectives of the present study are the following:

i) to project a comprehensive systematic account of fishes of Vembanad lake

ii) to present complete descriptions of all fish species of the lake with proper illustrations and to provide keys for identification for all genera and species (except monogeneric groups and monotypic species)

iii) to bring out new species or new records, if any , from the lake and to delineate the morphological differences in those species which are inhabiting different ecological conditions in the lake

iv) to understand the effect of physico-chemical conditions viz., Temperature, Salinity and Dissolved Oxygen on the distribution and abundance of fishes in the lake

v) to classify the gears and fishing methods of the lake and to incorporate details regarding catch composition, time and season of operation and fishing methods in the different sectors of the lake

vi) to elucidate the habitat, occurrence, season and abundance of all the recorded fishes of the lake

vii) to recognize the commercially important fishes of the lake

viii) to present a general appraisal of the detrimental factors which are adversely affecting the fishery resources and to suggest some measures of conservation

and ix) to study the biological aspects of selected species of economically important fishes of the lake.

It is claimed that this is the first attempt to study the above mentioned aspects of the fish fauna in any of the Indian brackish water lakes and one of the few works on ecological aspects of brackish water fishes.

The results of the present study on fishes of Vembanad lake are presented in four sections.

The first section deals with the general introduction. The second section embodies the taxonomic list of Vembanad lake fishes and their systematic descriptions based mainly on morphometry, meristics and morphology. The fishes were classified according to the latest and most widely accepted classification (Compagno, 1973; Greenwood, 1975). Of the 150 species of fishes recorded from the lake, 9 species belonging to 3 genera under the family Leiognathidae and 2 species of 2 genera under the sub-family Pellonulinae (Family: Clupeidae) were already described by the author (Kurup and Samuel, 1980a, 1981c - Appendix 2 and 6), so the descriptions of the above species are not incorporated in this account. 139 species of fishes belonging to 95 genera under 55 families are fully described and illustrated. Identification keys are provided for all the genera and species (except monogeneric and monotypic species of the Indo-Pacific area). The descriptions of family and species are modelled according to a uniform plan. The characters of taxonomic value of each family is briefly presented. The species are illustrated either as photographs or as drawings.

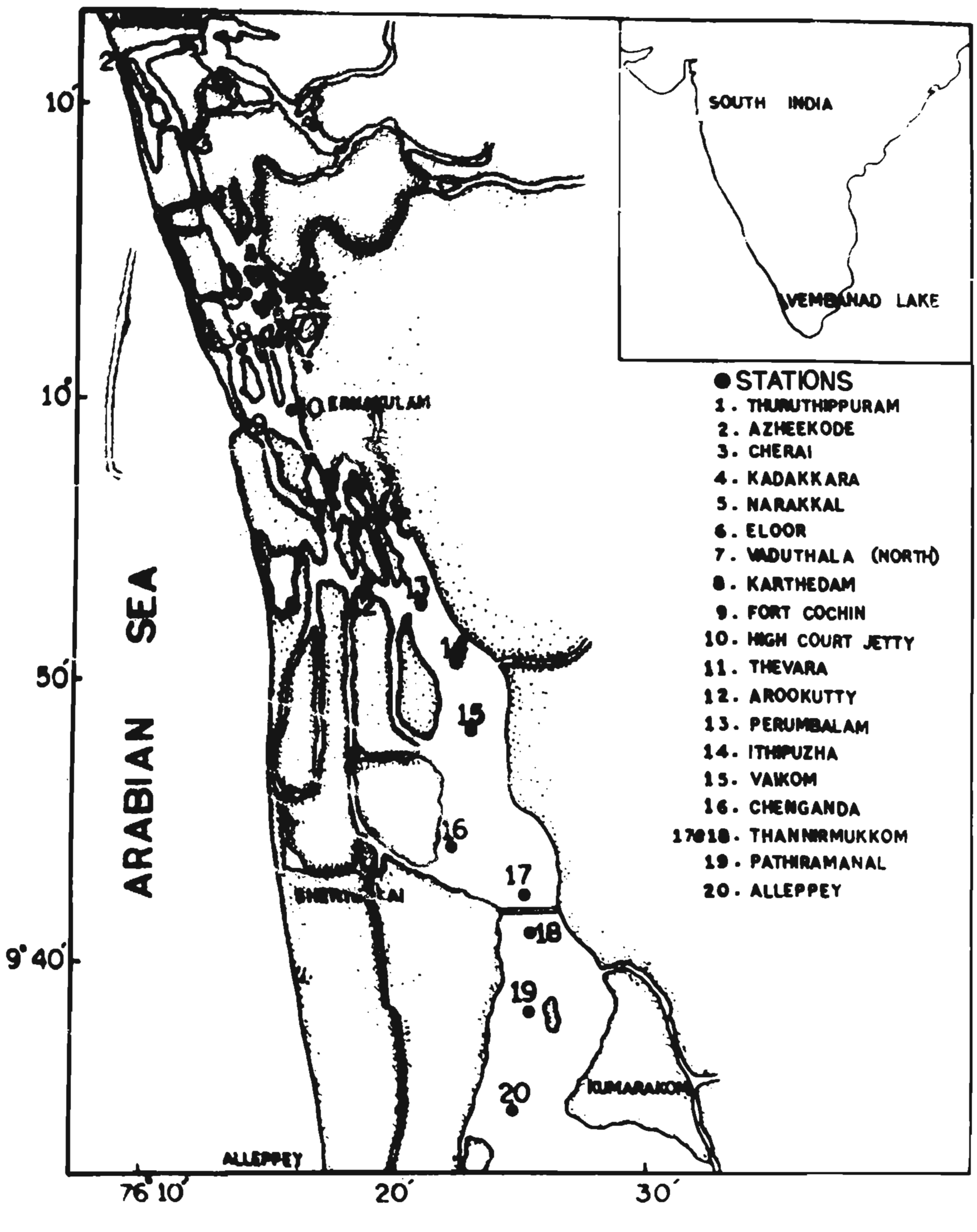
The third section deals with the hydrography and the fish distribution. Temperature, Salinity and Dissolved Oxygen values of 20 fixed stations in the lake are presented for the two year period of investigation (1978-1980). The fishing gears and methods employed in the lake are classified under 3 major heads and the details regarding the catch composition and fishing methods of different sectors of the lake are presented. The occurrence, season and abundance of 139 species in the lake are given. The fishes of the lake are classified into three broad categories viz., Oligohaline, True Estuarine and Marine. The effect of physico-chemical parameters on the distribution and abundance of fishes in different sectors of the lake during different seasons are discussed. The fishes which contribute to the commercial fisheries of the lake are delineated. A general appraisal on the detrimental factors on the fish fauna and fisheries resources of the lake are discussed.

The fourth section deals with the biology of two commercially important fish species of Vembanad lake viz., *Dayscieena albida* (Cuvier) and *Gerres filamentosus* Cuvier. The detailed biological aspects include studies on food and feeding habits, length-weight relationships, relative condition factor and breeding biology of the above mentioned two species.

A summary of the present study, references cited and published papers are presented in the subsequent sections.

Plate 1. Map of the Vembanad lake showing the location of stations with insert of Peninsular India

PLATE 1


SOUTH INDIA
VEMBANAD LAKE
● STATIONS
1. THURUTHIPPURAM
2. AZHEEKODE
3. CHERAI
4. KADAKKARA
5. NARAKKAL
6. ELOOR
7. VADUTHALA (NORTH)
8. KARTHEDAM
9. FORT COCHIN
10. HIGH COURT JETTY
11. THEVARA
12. AROOKUTTY
13. PERUMBALAM
14. ITHIPUZHA
15. VAIKOM
16. CHENGANDA
17&18. THANNIRMUKKOM
19. PATHIRAMANAL
20. ALLEPPEY
ARABIAN SEA
ERNAKULAM
KUMARAKOM
ALLEPPEY
10°
10'
50'
9°40'
76°10'
20'
30'

SYSTEMATIC STUDIES

2. SYSTEMATIC STUDIES

2.1. INTRODUCTION

The correct identification of a species is a necessary precedent to the investigation on any aspect of the biology and distribution of any animal. No attempt has been made so far to conduct a comprehensive integral study on the systematics of brackish water fishes of India, eventhough the fish fauna of the brackish water lakes and estuaries of India were taxonomically listed by several authors. The Vembanad lake is the largest brackish water lake along the South West coast of India and it supports an abundant and diversified group of fishes. Investigations on the systematics of the fish fauna of this brackish water lake is essentially needed for the following reasons:

i) to ascertain whether there exists any unidentified species of fishes or new distributional records

ii) to know about the endemic species of the lake

iii) to ascertain whether there is any remarkable difference in the morphological characters in the species in comparison to those species occurring elsewhere.

Panikkar (1952) stressed the necessity for intensive taxonomic work in the tropical areas because the rate of speciation is very rapid. Menon (1967) stated that the rivers of South India constitute one of the most fertile fields for ichthyological discoveries and so any intensive investigation on fishes could help to locate new species or to find out new facts regarding the status or distribution of species already described.

The most comprehensive studies on the classification of fishes of the Indo-Pacific area are those of Hamilton-Buchanan (1822), Day (1865, 1878), Gunther (1859-1870), Weber and de Beaufort (1911-1951), Koumans (1941), Smith (1949), Munro (1955), Fischer and Whitehead (1974) and Jones and Kumaran (1980). Our knowledge on the fishes of Malabar-Cochin area dates from Day (1865) who described several species of fishes from the above area. A review of the literature shows that ever since Day's monumental work (1865), no subsequent effort was made to conduct another comprehensive taxonomic study on the fishes of Kerala, especially on fresh water and estuarine fishes. So most of the fresh water and estuarine fishes of Kerala do require a taxonomic re-description in the light of recent trends used in fish systematics.

The taxonomic listing of the fish fauna of various brackish water lakes and estuaries of India were done by a series of workers (Chaudhuri, 1916a, 1916b, 1917, 1923; Chacko et al., 1953; Devasundaram, 1954; Jones and Sujansingani, 1954; Roy and Sahoo, 1957; Menon, 1961; Pillay, 1967; Gopalakrishnan, 1971; Babu Rao, 1976; Visweswara Rao, 1976). But our knowledge on the fishes of Vembanad lake is strictly confined to Shetty's (1965) preliminary taxonomic list. So a comprehensive systematic study on Vembanad lake fishes was undertaken and a series of papers of taxonomic interest were published [Kurup and Samuel, 1979, 1980a, 1980b, 1981c (in press)] from the results of the present investigation.

2.2. MATERIAL AND METHODS

The materials for the present study were collected from all categories of fishing gears and fishing devices employed in Vembanad lake during the period from October, 1973 to October, 1980. The details of fish sampling surveys, cruise reports and fishing gears and methods are described under section 3.5. The collected fishes were preserved in the field in 10% formalin and brought to the laboratory for further systematic studies. Details of the colouration in the fresh specimens were noted.

The collected fishes were identified upto the species level with the help of best and recently available identification keys. The characters generally used for identification were morphology, morphometry, meristic counts and dentition patterns, which are of utmost systematic importance and widely employed in fish taxonomy (Munehico Iwata, 1975; Collette and Chao, 1975). Moreover, the structure of the gas bladder, presence or absence of barbels and its relative length, fleshy cirri on the tip of snout, if any, structure of nasal papillae, size and shape of the upper jaw etc. were also used for the identification of species of certain specific groups.

Measurements and counts were made on preserved fishes. Meristic counts were made on Alizarin stained materials. Morphometric measurement and meristic counts were taken according to the recent methods adopted in very recent revisions or descriptions available (Table 1). Except for total length, all measurements were taken from point to point (straight line) on the left side of the fish (mouth closed). A draftsman dividers and Vernier Calipers were employed for taking measurements and the readings were rounded off to the nearest millimeter. All proportions are in percent of standard length except snout length, orbit diameter and inter-orbital width, which are in percent of head length. The number of morphometric characters studied varied from family to family since there existed many morphological differences among them. The definition of the different morphometric characters like total length, standard length etc. are omitted here since the definitions employed by the different authors listed under table 1 are not uniform.

List of morphometric measurements taken:

1. Total length
2. Standard length
3. Greatest body depth
4. Head length
5. Snout to dorsal fin origin
6. Snout to anal fin origin
7. Snout to pectoral fin origin
8. Snout to pelvic fin origin
9. Dorsal fin base length
10. Anal fin base length
11. Pectoral fin length
12. Pelvic fin length

13. Longest dorsal spine length

14. Longest anal spine length

15. Least depth of caudal peduncle

16. Length of straight part of lateral line (Carangidae)

17. Length of curved part of lateral line (Carangidae)

18. Barbel length

19. Snout length

20. Orbit diameter

21. Least width of inter orbital space

The number of specimens used for various morphometric measurements and meristic counts ranged from 1-25, depending on the availability of the fish in the lake. The number of specimens observed and its size ranges measured in standard length and total length, and the range and mean of each morphometric character in percent of standard length are incorporated in the systematic description of each species. Females and males were not treated separately for taking the measurements unless it exhibits any sexual dimorphism. In sexually dimorphic forms, the character which shows differences between the sexes were treated separately. Synonyms were strictly limited to a few monumental works. The availabl type specimens and other representative materials of the presently listed fishes

Table 1. Methods of morphometric measurements and meristic counts adopted for the present study.

Sl. No.	Groups/Family/Order	Author(s) and year
1.	Dasyatidae	Misra (1969)
2.	Elopiformes, Clupeiformes and Gonorhynchiformes	Wongratana (1980)
3.	Cypriniformes	Sobhana (1976)
4.	Hemiramphidae and Belonidae	Collette (1974)
5.	Centropomidae and Cichlidae	Lowe-McConnell (1978)
6.	Sillaginidae	Shahulhameed and Kurup (1981, in press)
7.	Carangidae	Williams and Venkataramani (1978)
8.	Sciaenidae	Trewavas (1977)
9.	Other percoid groups	Kurup and Samuel (1981c, in press)
10.	Mugilidae	Reddy (1977)
11.	Gobiidae	Chatterjee (1978)
12.	Siganidae	Jawel and Woodland (1974)
13.	Pleuronectiformes	Ramanathan and Natarajan (1980)
14.	All other groups	Holden and Raitt (1974)

of Vembanad lake were examined from the collection of the Zoological Survey of India, Calcutta and the details are incorporated under each species.

The gill raker counts were taken from the first gill arch on the left side of the fish. The number of gill rakers on the dorsal and ventral arches are separately given in paranthesis. Scale counts of lateral line rows and longitudinal rows are between the corner of the operculam and the level of the posterior edge of hypural plate. The transverse rows, are taken from the origin of the spinous dorsal fin, vertically downwards.

2.3. TAXONOMIC LIST OF VEMBANAD LAKE FISHES

The classification of fishes adopted here for Chondrichthyes is after Compagno (1973) and for Osteichthyes is after Greenwood (1975).

Class	: Chondrichthyes
Sub class	: Elasmobranchii
Cohort	: Euselachi
Super order	: Batoidea
Order	: Myliobatidae
Super family	: Dasyatoidea
Family	: Dasyatidae
	1. *Dasyatis* (*Himantura*) *uarnak*
	2. *Dasyatis* (*Pastinachus*) *sephen*
Class	: Osteichthyes
Sub class	: Teleostomi
Cohort	: Taeniopaedia
Super order	: Elopomorpha
Order	: Elopiformes
Sub order	: Elopoidei
Family	: Elopidae
	3. *Elops machnata*
Family	: Megalopidae
	4. *Megalops cyprinoides*
Order	: Anguilliformes
Sub Order	: Anguilloidei

Family	: Anguillidae
	5. *Anguilla bicolor bicolor*
Family	: Muraenidae
	6. *Thyrsoidea macrurus*
Family	: Muraenesocidae
	7. *Muraenesox bagio*
Family	: Ophichthidae
	8. *Pisodonophis boro*
Cohort	: Clupeocephala
Super order	: Clupeomorpha
Order	: Clupeiformes
Sub order	: Clupeoidei
Family	: Clupeidae
Sub family	: Dussumieriinae
	9. *Dussumieria acuta*
Sub family	: Clupeinae
	10. *Sardinella* (*Sardinella*) longiceps
	11. *Sardinella* (*Clupeonia*) *gibbosa*
	12. *Escualosa thoracata*
Sub family	: Pellonulinae
	13. *Dayella malabarica*
	14. *Ehirava fluviatilis*
Sub family	: Dorosomatinae
	15. *Nematalosa nasus*
	16. *Anodontostoma chacunda*

Sub family	: Pristigasterinae
	17. *Ilisha sirishai*
	18. *Ilisha melastoma*
Family	: Engraulidae
Sub family	: Engraulinae
	19. *Stolephorus indicus*
	20. *Stolephorus commersonii*
	21. *Stolephorus waitei*
	22. *Stolephorus insularis*
	23. *Thryssa setirostris*
	24. *Thryssa mystax*
	25. *Thryssa purava*
	26. *Thryssa kammalensis*
Cohort	: Euteleostei
Super order	: Ostariophysi
Series	: Anotophysi
Order	: Gonorhynchiformes
Sub order.	: Chanoidei
Family	: Chanidae
	27. *Chanos chanos*
Series	: Otophysi
Order	: Cypriniformes
Sub order	: Cyprinoidei
Family	: Cyprinidae

Sub family	: Cyprininae
	28. *Amblypharyngodon mola*
	29. *Puntius filamentosus*
	30. *Puntius amphibius*
	31. *Puntius sarana*
	32. *Labeo dussumieri*
Order	: Siluriformes
Family	: Bagridae
	33. *Mystus (Mystus) gulio*
	34. *Mystus (Mystus) malabaricus*
	35. *Mystus (Mystus) oculatus*
	36. *Horabagrus brachysoma*
Family	: Siluridae
	37. *Wallago attu*
	38. *Ompok bimaculatus*
Family	: Heteropneustidae
	39. *Heteropneustes fossilis*
Family	: Ariidae
	40. *Tachysaurus maculatus*
	41. *Tachysaurus subrostratus*
Super order	: Scopelomorpha
Order	: Myctophiformes
Sub order	: Myctophoidei
Family	: Synodontidae
	42. *Saurida undosquamis*

Super order	: Paracanthopterygii
Series	: Salmopercomorpha
Order	: Batrachoidiformes
Family	: Batrachoididae
	43. <u>Austrobatrachus dussumieri</u>
Super order	: Acanthopterygii
Series	: Atherinomorpha
Order	: Atheriniformes
Sub order	: Exocoetoidei
Family	: Hemiramphidae
	44. <u>Zenarchopterus dispar</u>
	45. <u>Rhynchorhamphus georgii</u>
	46. <u>Hyporhamphus</u> (<u>Hyporhamphus</u>) <u>xanthopterus</u>
	47. <u>Hyporhamphus</u> (<u>H.porhamphus</u>) <u>limbatus</u>
Family	: Belonidae
	48. <u>Strongylura strongylura</u>
	49. <u>Strongylura leiura leiura</u>
	50. <u>Tylosurus crocodilus crocodilus</u>
	51. <u>Xenentodon cancila</u>
Sub order	: Cyprinodontoidei
Family	: Poeciliidae
	52. <u>Gambusia affinis patruelis</u>

Sub order : Atherinoidei

Family : Atherinidae

53. *Atherina duodecimalis*

Series : Percomorpha

Order : Scorpaeniformes

Sub order : Platycephaloidei

Family : Platycephalidae

54. *Platycephalus indicus*

55. *Platycephalus crocodilus*

Order : Perciformes

Sub order : Percoidei

Family : Centropomidae

56. *Lates calcarifer*

57. *Ambassis dayi*

58. *Ambassis thomassi*

59. *Ambassis commersoni*

60. *Ambassis gymnocephalus*

Family : Serranidae

61. *Epinephelus tauvina*

Family : Theraponidae

62. *Therapon jarbua*

Family : Sillaginidae

63. *Sillago vincenti*

64. *Sillago sihama*

Family : Carangidae

65. *Megalaspis cordyla*

66. *Alectis indicus*

67. *Alepes djeddaba*

68. *Carangoides praeustus*

69. *Caranx sexfasciatus*

70. *Scomberoides tala*

71. *Scomberoides tol*

72. *Trachinotus blochii*

Family : Leiognathidae

73. *Leiognathus splendens*

74. *Leiognathus equulus*

75. *Leiognathus bindus*

76. *Leiognathus daura*

77. *Leiognathus berbis*

78. *Leiognathus brevirostris*

79. *Secutor insidiator*

80. *Secutor ruconius*

81. *Gazza minuta*

Family : Lutjanidae

82. *Lutianus johni*

83. *Lutianus argentimaculatus*

84. *Lutianus fulviflamma*

85. *Lutianus russelli*

86. *Lutianus rivulatus*

Family : Gerridae

87. *Gerres filamentosus*

88. *Gerres abbreviatus*

89. *Gerres setifer*

Family : Pomadasyidae

90. *Pomadasys hasta*

91. *Plectorhynchus nigrus*

Family : Lethrinidae

92. *Lethrinus microdon*

Family : Sparidae

93. *Mylio berda*

Family : Sciaenidae

94. *Protonibea diacanthus*

95. *Dendrophysa russelli*

96. *Daysciaena albida*

97. *Johnius (Johnius) belangerii*

Family : Mullidae

98. *Upeneus (Upeneus) sulphureus*

99. *Upeneus (Upeneus) vittatus*

100. *Parupeneus indicus*

Family : Drepanidae

101. *Drepane punctata*

Family : Scatophagidae

102. *Scatophagus argus*

Family : Gandidae

103. *Gandus marmoratus*

Family : Cichlidae

104. _Sarotherodon mossambicus_

105. _Etroplus suratensis_

106. _Etroplus maculatus_

Sub order : Mugiloidei

Family : Mugilidae

107. _Mugil cephalus_

108. _Valamugil seheli_

109. _Valamugil cunnesius_

110. _Valamugil speigleri_

111. _Liza macrolepis_

112. _Liza parsia_

113. _Liza subviridis_

Sub order : Sphyraenoidei

Family : Sphyraenidae

114. _Sphyraena jello_

Sub order : Polynemoidei

Family : Polynemidae

115. _Eleutheronema tetradactylum_

Sub order : Gobioidei

Family : Gobiidae

116. _Eleotris fusca_

117. _Butis butis_

118. _Bunaka gyrinoides_

119. *Stenogobius malabaricus*

120. *Oxyurichthys tentacularis*

121. *Oxyurichthys microlepis*

122. *Oxyurichthys nilsseni*

123. *Awaous stamineus*

124. *Glossogobius biocellatus*

125. *Glossogobius giuris*

126. *Gobiopsis macrostomus*

127. *Acentrogobius viridipunctatus*

128. *Acentrogobius caninus*

Family : Gobioididae

129. *Taenioides buchanani*

130. *Taenioides cirratus*

Family : Trypauchenidae

131. *Trypauchen vagina*

Sub order : Acanthuroidei

Family : Acanthuridae

132. *Acanthurus metoides*

Family : Siganidae

133. *Siganus lineatus*

134. *Siganus javus*

135. *Siganus canaliculatus*

Sub order : Channoidei

Family : Channidae

136. *Channa striata*

Sub order	: Anabantoidei
Family	: Anabantidae
	137. Anabas testudineus
Sub order	: Mastacembeloidei
Family	: Mastacembelidae
	138. Mastacembelus guentheri
	139. Mastacembelus armatus
Order	: Synbranchiformes
Sub order	: Synbranchedoi
Family	: Synbranchidae
	140. Synbranchus bengalensis
Order	: Pleuronectiformes
Sub order	: Pleuronectoidei
Family	: Bothidae
	141. Pseudorhombus arsius
Sub order	: Soleoidei
Family	: Soleidae
	142. Solea ovata
	143. Synaptura commersoniana
	144. Brachirus orientalis
Family	: Cynoglossidae
	145. Cynoglossus bilineatus
	146. Cynoglossus puncticeps

Order : Tetraodontiformes

Sub order : Balistoidei

Family : Triacanthidae

147. *Triacanthus brevirostris*

Sub order : Tetraodontoidei

Family : Tetraodontidae

148. *Chelonodon patoca*

149. *Tetraodon fluviatilis*

150. *Tetraodon leopardus*

2.4. SYSTEMATIC DESCRIPTIONS

CLASS	: CHONDRICHTHYES
SUB CLASS	: ELASMOBRANCHII
COHORT	: EUSELACHI
SUPER ORDER	: BATOIDEA
ORDER	: MYLIOBATIDAE
SUPER FAMILY	: DASYATOIDEA

2.4.1. FAMILY: DASYATIDAE

Characters of taxonomic value: Disc flattened, well depressed, oval or rhomboid and united with pectorals anteriorly. Tail long, whiplike with a serrated pungent spine. Eye on top of head. Spiracles large, close behind eye. Teeth small in the form of pavement. Five pairs of ventral gill openings. Dorsal fin absent. Pelvic fin small.

The first detailed study on sting rays of Indian waters was by Day (1878) who described 9 species under the genus Trygon. Annandale (1908) described a new species of sting ray from Bay of Bengal. Misra (1949, 1952) proposed a key for the sting rays of Indian waters and also described (1969) 15 species based on the preserved collections of Zoological Survey of India. 12 species are reported from Sri Lanka waters (Munro, 1955). Misra and Menon (1958) correlated the distribution of sting rays with the mean annual isotherms in Indian Ocean. Recently, Jones and Kumaran (1980) reported 4 species from Laccadive Archipelago.

Key to genera

Disc quadrangular, nearly as broad as long; body not completely covered with osseus tubercles or spines; tail much longer than length of disc; serrated caudal spine present .... Dasyatis Rafinesque.

Dasyatis Rafinesque, 1810

Dasyatis Rafinesque, 1810: 16.
Uroxis Rafinesque, 1810: 48.
Trygon (Adanson) Cuvier, 1817: 136.
Trygonobatis Blainville, 1825: 35.
Pastinachus Ruppell, 1828: 82.
Himantura Muller and Henle, 1837: 3.

Key to sub-genera

Cutaneous fold absent on tail .... Himantura Muller and Henle.

Cutaneous fold present on ventral side of the tail .... _Pastinachus_ Ruppell.

Sub-genus: _Himantura_ Muller and Henle

Key to species

Snout nearly pointed; tail 277.0–281.51% in disc length; body uniformly brown or spotted ....
.... _Dasyatis_ (_Himantura_) _uarnak_ (Forsskal)

Dasyatis (_Himantura_) _uarnak_ (Forsskal, 1775)
Plate 2.1

Raia uarnak Forskal, 1775: 18.
Trygon undulata Bleeker, 1852: 70.
Trygon uarnak Gunther, 1870: 473; Day, 1878: 737.
Dasyatis uarnak Fowler, 1928: 101; Smith, 1949: 79.
Dasyatis (_Himantura_) _uarnak_ Misra, 1949: 33, 1969: 166.
Himantura uarnak Munro, 1955: 14.

Description: Based on 2 specimens, 238.0 and 283.0 mm disc length.

Body measurements in percent of disc length: disc width 100.00–104.94 (M = 102.47); snout length 22.05–19.08 (M = 20.56); Orbit diameter 4.59–4.62

(M = 4.60); interorbital width 14.84-15.12 (M = 14.98); snout tip to hind border of spiracle 31.44-32.35 (M = 31.88); tail length 277.00-281.51 (M = 279.25); origin of caudal spine 36.97-37.45 (M = 37.21).

Disc rhomboid, width slightly greater than length. Snout pointed 4 skinny flaps on floor of the mouth, dental laminae undulating. Interorbital space flat. Spiracle longer than eye. Pelvic fin triangular, obtusely pointed. Dorsal surface of the body with tubercles in the median line. Tail whip-like, long without cutaneous fold, with a serrated spine.

Colour :

Dorsal surface of disc uniformly brownish-black or with small round brown spots. Tail brown or with black rings. Ventral side dull white.

Distribution :

Red sea, Zanzibar, Seychelles, Madagascar, Natal, Cape of Good Hope, South Africa, Arabia, Penang, Polynesia, Sri Lanka, Burma, Pakistan and Coasts of India including Laccadives.

Other material examined: ZSI No. F 5102/2 (115.0 mm DW) Chilka, Orissa, H.C. Ray Coll.

Sub-genus: *Pastinachus* Ruppell

Key to species

Cuteneous fold on tail very broad and well developed, 4 times the length of caudal spine .... *Dasyatis* (*Pastinachus*) *sephen* (Forsskal)

Dasyatis (*Pastinachus*) *sephen* (Forsskal, 1775)
Plate 2.2

Raia sephen Forskal, 1775: 17.
Raia fluviatilis Hamilton, 1822: 1.
Hypolophus sephen Bleeker, 1852: 77.
Trygon sephen Gunther, 1870: 482; Day, 1878: 740.
Dasyatis sephen Fowler, 1928: 102.
Dasyatis (*Pastinachus*) *sephen* Misra, 1949: 34; 1969: 173.
Pastinachus sephen Munro, 1955: 13.

Description: Based on a single specimen, 281.0 mm disc length.

Body measurements in percent of disc length: disc width 103.55; snout length 20.28; orbit diameter 2.84; interorbital width 13.32; snout tip to hind border of spiracle 31.67; tail length 234.00; origin of caudal spine 70.46.

Disc nearly quadrangular, broader than long. Snout obtusely pointed. 5 skinny flaps on floor of mouth, dental laminae undulating. Interorbital space nearly flat. Spiracle longer than eye. Pelvic fin short and obtusely pointed. Dorsal surface granular with two distinct central tubercles in a row. Tail long, depressed anteriorly with a ventral broad cutaneous fold which begins very close to the serrated caudal spine and ending below posterior third of tail.

Colour:

Brownish-black on dorsal surface of the disc, dull white ventrally. Cutaneous fold black.

Distribution:

Red sea, Arabia to Seychelles, Thailand, Indonesia, Malaysia, Philippines, Australia, Sri Lanka, Burma, Pakistan and Coasts of India including Laccadives.

Other material examined: ZSI Reg. F. 1240 (137.0 mm DW) River Ganges, K.S. Misra Coll.

CLASS	: OSTEICHTHYES
SUB CLASS	: TELEOSTOMI
COHORT	: TAENIOPAEDIA
SUPER ORDER	: ELOPOMORPHA

ORDER : ELOPIFORMES

SUB ORDER : ELOPOIDEI

2.4.2. <u>FAMILY: ELOPIDAE</u>

<u>Characters of taxonomic value</u>: Body elongate and cylindrical. Cleft of the mouth oblique. Lateral line present. Scales small, cycloid, absent on head. Single dorsal fin. Belly smooth. Gular plate and pseudobranch present.

Family Elopidae consists of a single genus *Elops* with a single valid species in the Indo-Pacific region. This genus was described under various names by different taxonomists (Day, 1878; Weber and de Beaufort, 1913; Munro, 1955; Misra, 1976). A brief review of the elopoid fishes of the Red Sea were presented by Whitehead (1965).

<u>*Elops* Linnaeus, 1766</u>

Elops Linnaeus, 1766: 518.
Mugilomorus Lacepede, 1803: 397.
Trichonotus Rafinesque, 1815: 88.

<u>*Elops machnata* (Forsskal, 1775)</u>
<u>Plate 3.1</u>

Argentina machnata Forsskal, 1775: 68.

Elops indicus Swainson, 1839: 292; Chaudhuri, 1915: 413.

Elops saurus (misidentifications) Day, 1878: 649;
Hornell, 1917: 93; Misra, 1976: 9.

Elops machnata Schlegel, 1850: 241; Weber and
de Beaufort, 1913: 4; Fowler, 1938: 21;
Munro, 1955: 21; Fischer and Whitehead, 1974.

Elops hawaiensis Weber and de Beaufort, 1913: 3.

Description: Based on 6 specimens ranging in size 158.0–176.0 mm SL (1941.0–215.0 mm TL).

Fin formula: D. 21–22; A. 16–17; P. 17; V. 14; C. 28.

Body measurements expressed in percent of standard length: greatest body depth 16.87–17.08 (M = 17.01); head length 25.15–27.21 (M = 26.49); snout to D fin origin 51.87–53.69 (M = 52.48); snout to A fin origin 76.58–78.26 (M = 77.25); snout to pectoral fin origin 25.15–26.26 (M = 25.94); snout to pelvic fin origin 51.55–52.54 (M = 52.04); base D fin 13.66–15.93 (M = 15.24); base A fin 6.32–9.94 (M = 8.49); pectoral fin length 13.35–15.00 (M = 14.29); pelvic fin length 13.63–14.87 (M = 14.28); least depth of caudal peduncle 7.67–8.75 (M = 8.10).

In percent of head length: snout length 24.46-27.16 (M = 25.98); orbit diameter 19.14-23.25 (M = 21.61); least width of interorbital space 20.93-24.69 (M = 22.48).

Body elongate and cylindrical. Mouth terminal, cleft of mouth oblique. Snout pointed. Maxillae reaching to well behind the posterior margin of eyes, its lower border with fine denticulations. Interorbital space concave and broad. Adipose eyelid present. Gill rakers (7-8) + (13-14) = 20-22. Villiform teeth present in jaws, vomer and palatine. Lateral line straight, extends upto caudal fin base. Axillary scale present at pectoral and pelvic fins axis. Caudal fin deeply forked.

__Scales:__ Lateral line scale 84-98; in transverse series 19-22. Scales present all over the body including on the basal part of caudal fin. Scale sheaths are prominent at dorsal, anal, pectoral and pelvic fins base.

__Colour:__ Dorsal profile silvery with greenish tinge, ventral profile bright silvery. Scales of dorsal profile are mottled with minute black spots. Dorsal and caudal fins dusky black. Other fins slightly yellowish.

Distribution: East and South African coasts, Madagascar, Malay Peninsula, Philippines, Indonesia, China, Korea, Japan, New South Wales, Hawaii, Red Sea, Arabia, Cape of Good Hope, Australia, Sri Lanka, Pakistan and India: both east and west coasts.

Remarks: Day (1878), Weber and de Beaufort (1913), Smith (1949), Misra (1976) and Babu Rao (1976) described *E. saurus* Linnaeus from the Indo-Pacific region. But according to Fischer and Whitehead (1974), *E. saurus* is not found in the Indo-Pacific region and so the above descriptions may probably be due to misidentifications of *E. machnata*. It's distribution extends upto Hawaii where it was designated as *E. hawaiensis*.

2.4.3. FAMILY: MEGALOPIDAE

Megalops Lacepede

Megalops Lacepede, 1802: 289.

Brisbania Castelnau, 1878: 241.

Tarpon Jordan and Evermann, 1896: 409.

Megalops - monotypic

Megalops cyprinoides (Broussonet, 1782)

Plate 3.2

Clupea cyprinoides Broussonet, 1782: 296

Cyprinodon cundinga Hamilton, 1822: 254.

Megalops indicus Valenciennes, 1846: 388.

Megalops macrophthalmus Bleeker, 1850: 421.

Elops apalike Day, 1865: 228.

Megalops cyprinoides Gunther, 1868: 471; Day, 1878: 650;

Weber and de Beaufort, 1913: 5; Fowler, 1938: 21;

to D fin origin 49.60–53.51 (M = 51.42); snout to A fin origin 70.19–75.13 (M = 72.79); snout to pectoral fin origin 25.94–27.52 (M = 26.65); snout to pelvic fin origin 50.45–52.36 (M = 51.36); base D fin 12.16–12.99 (M = 12.69); base A fin 15.40–18.47 (M = 17.72); pectoral fin length 17.83–17.91 (M = 17.88); pelvic fin length 12.99–13.76 (M = 13.38); least depth of caudal peduncle 9.63–10.27 (M = 9.93).

In percent of head length: snout length 24.61–31.25 (M = 28.30); orbit diameter 25.00–27.69 (M = 26.43); least width of interorbital space 22.22–25.24 (M = 23.28).

Body elongated and slightly compressed. Mouth superior, cleft of mouth oblique and the lower jaw prominent. Maxilla reaching to behind posterior margin of eye. Interorbital space flat. Adipose eyelid confined to orbital margin. Belly smooth and unkeeled. Gill rakers on first arch (12–15) + (29–32) = 41–47. Villiform teeth in jaws, vomer, palatine, pterygoid and tongue. Last ray of the dorsal fin filamentous, reaching upto caudal peduncle. Axillary scale present at pectoral and pelvic fins axis. Lateral line ceases on caudal fin base. Caudal fin deeply forked.

<u>Scales</u>: Lateral line scales 33–38; in transverse series 10–11. Scales present all over the body including the

caudal base.

<u>Colour</u>: Dorsal profile dull green, ventral profile silvery bright. Interorbital space dark green. Snout tip black. Dorsal fin tip, caudal fin and distal half of pectoral fin dusky black. Other fins colourless.

<u>Distribution</u>: East and South African coasts, Natal, Zanzibar, Madagascar, Mauritius, Malay Peninsula, Penang, Singapore, Indonesia, Siam, Philippines, China, Formosa, Fusan, Port Darwin, Brisbane, Queensland, Melonesia, Micronesia, Polynesia, Sri Lanka, Australia, Pakistan and India: both east and west coasts.

<u>Other material examined</u>: ZSI No. 2671 (179.0 mm SL) history unknown, F. Day Coll.

ORDER : ANGUILLIFORMES

SUB ORDER : ANGUILLOIDEI

2.4.4. <u>FAMILY: ANGUILLIDAE</u>

<u>Characters of taxonomic value</u>: Body elongate and cylindrical, anteriorly depressed and posteriorly compressed. Mouth large, cleft of mouth slightly oblique. Jaws and vomer with small conical teeth in bands. Scales elongated, embedded in the skin. Lateral line distinct. Dorsal and anal fins confluent

with caudal fin. Pectoral fin well developed. Origin of dorsal before or somewhat behind anal origin. Pelvic fin absent.

Two species of this family are known from India (Day, 1878) and Sri Lanka (Munro, 1955). Weber and de Beaufort (1916) described 6 species from Indo-Australian Archipelago. There are 17 valid species of Anguilla distributed throughout the world (Mar. Fish Inform. Serv. Ser. No. 23, 1980).

Family Anguillidae is monogeneric.

Anguilla Shaw, 1803

Anguilla Shaw, 1803: 15.

Key to the species

Head shorter; snout broad; lower jaw not prominent; vomerine teeth reaching as far backwards as those on maxilla; dorsal fin commences above vent; dark olive dorsally and dull yellowish ventrally .... Anguilla bicolor bicolor McClelland.

Anguilla bicolor bicolor McClelland, 1845
Plate 4.1

Anguilla bicolor McClelland, 1845: 178; Day, 1878: 660; Jones and Kumaran, 1980: 83.

Anguilla bicolor bicolor Munro, 1955: 57.

Description: Based on 7 specimens ranging in size 247.0–616.0 mm SL (250.0–628.0 mm TL).

Fin formula: D. 217–232; A. 194–216; P. 16–18; C. 10.

Body measurements expressed in percent of standard length: greatest body depth 5.26–8.11 (M = 6.84); head length 13.12–15.66 (M = 14.51); snout to D fin origin 39.02–42.20 (M = 40.70); snout to A fin origin 42.10–44.64 (M = 43.22); snout to pectoral fin origin 12.55–15.75 (M = 14.27); pectoral fin length 3.23–5.84 (M = 4.20).

In percent of head length: snout length 18.49–20.28 (M = 19.58); orbit diameter 7.57–10.41 (M = 9.12); least width of interorbital space 18.13–22.89 (M = 20.68).

Body elongate and cylindrical. Mouth large. Hind tip of maxilla reaching to well beyond vertical below posterior margin of eye. Interorbital space flat. Two nostrils on each side, the anterior nostril tubular and near to anterior margin of snout, posterior nostril an oval slit and near to eye. Gill rakers absent. Maxillary and intermaxillary with very small teeth in bands, which are narrowing posteriorly. Mandible with teeth, tapering posteriorly. Lateral line distinct and complete.

Scales: Elongate scales embedded in the skin, present on head and body.

Colour: Dark olive above, dull white or yellowish below.

Distribution: East coast of Africa, Seychelles, Indonesia, Malaysia, Sri Lanka, Burma, and coasts of India including Laccadives and Andamans.

Other materials examined: ZSI No. 2187 (522.0 mm SL) Andamans, 2652 (305.0 mm SL) Bengal, 2711 (440.0 mm SL) Madras, F. Day Coll.

Remarks: Samuel (1962) reported *A. bicolor bicolor* from Kayamkulam and Veli lakes of Kerala.

2.4.5. FAMILY : MURAENIDAE

Characters of taxonomic value: Body elongated and compressed. Mouth large, cleft of mouth reaching behind eye. Anterior nostril tubular, near tip of snout. Teeth granular, conical, compressed, molar-like or fang-like and depressible in one or more rows in jaws, on inter maxillary and on vomer. Dorsal and anal fins confluent with caudal fin. Pectoral and pelvic fins absent.

Among the fishes of the family Muraenidae, a single genus is represented in the Vembanad lake and a single species is known under the genus *Thyrsoidea* (Weber and de Beaufort, 1916; Munro, 1955).

Key to genus

Head and trunk more than twice in tail; anterior nostril in a simple tube; barbel-like appendages absent; tail without bony subdermal scutes; lateral line present .... *Thyrsoidea* Kaup.

Thyrsoidea Kaup, 1856

Thyrsoidea Kaup, 1856: 271.

A single species is known.

Thyrsoidea macrurus (Bleeker, 1854)
Plate 4.2

Muraena macrurus Bleeker, 1854: 324; Gunther, 1870: 127.
Thyrsoidea macrurus Bleeker, 1864: 111; Weber and de Beaufort, 1916: 355.
Muraena macrura Day, 1878: 672.
Thyrsoidea macrura Munro, 1955: 60.

<u>Description</u>: Based on a single specimen, 2720.0 mm SL (2740.0 mm TL).

Body measurements expressed in percent of standard length: greatest body depth 2.94; head length 6.98; snout to D fin origin 3.89; snout to A fin origin 37.50.

In percent of head length: snout length 10.26; orbit diameter 2.89; least width of interorbital space 8.15.

Body elongated. Interorbital space flat. Anterior nostril tubular, situated at the top of snout, posterior nostril slit-like and situated above front margin of eye. Gill rakers absent. Teeth in two rows on intermaxillary, uniserial teeth on mandible and vomer. Lateral line reaching to caudal peduncle. Dorsal fin origin slightly in advance to vertical above gill opening. Anal fin origin from the vent. Dorsal and anal fins covered with thick skin, low and confluent with caudal fin.

<u>Scales</u>: Absent.

<u>Colour</u>: Brownish-black above, dull white below. Margin of dorsal and anal fins black.

Distribution: Formosa, Palew Islands, Australia, Sri Lanka and coasts of India including Andamans.

Other materials examined: ZSI Nos. 2761 (1670.0 mm SL) Andamans, 2768 (702.0 mm SL) Madras, F. Day Coll.

2.4.6. FAMILY : MURAENESOCIDAE

Characters of taxonomic value: Body very long, anteriorly cylindrical and posteriorly compressed. Mouth large, extending far behind eye. Fangs on vomer and anterior most region of lower jaw. Scales absent. Lateral line distinct. Dorsal and anal fins confluent with caudal fin. Pectoral fin present. Origin of dorsal from vertical above gill opening. Pelvic fin absent.

Of the two genera known under this family (Fischer and Whitehead, 1974) a single genus Muraenesox is represented in the Vembanad lake. 3 species under this genus were described from India (Day, 1878) and Indo-Australian Archipelago (Weber and de Beaufort, 1916). A single species is known from Sri Lanka (Munro, 1955). Fischer and Whitehead (1974) described 2 species from the Eastern Indian Ocean and Western Central Pacific.

Key to genus:

Distinct bulge at bases of canine teeth on middle part of vomer .... *Muraenesox* Mc Clelland.

Muraenesox Mc Clelland, 1843

Muraenesox Mc Clelland, 1843: 408.

Key to species

Lat. line pores 36–38 from head to above vent; canine teeth on vomer has wide interspace; posterior nostril slightly nearer to eye than to anterior nostril; orbit diameter 8.82–12.03% in HL .... *Muraenesox bagio* (Hamilton-Buchanan).

Muraenesox bagio (Hamilton-Buchanan, 1822)
Plate 5.1

Muraena bagio Hamilton-Buchanan, 1822: 364.
Muraenesox bagio Kaup, 1856: 116; Bleeker, 1864: 24; Fischer and Whitehead, 1974.

Description: Based on 6 specimens ranging in size 215.0–838.0 mm SL (220.0–844.0 mm TL).

Fin formula: D. 232–268; A. 187–210; P. 14; C. 10.

Body measurements expressed in percent of standard length: greatest body depth 4.41-6.74 (M = 6.37); head length 15.97-18.99 (M = 16.99); snout to D fin origin 14.16-16.81 (M = 15.32); snout to A fin origin 41.72-46.94 (M = 46.82); snout to pectoral fin origin 16.25-18.99 (M = 17.18); pectoral fin length 3.72-5.75 (M = 5.37).

In percent of head length: snout length 24.13-28.57 (M = 27.17); orbit diameter 8.82-12.63 (M = 10.35); least width of interorbital space 9.00-9.77 (M = 9.41).

Body elongated and compressed. Snout long. Mouth large. Cleft of mouth reaching to far behind the level of eye. Interorbital space nearly flat. Two nostrils on each side, anterior nostril tubular, posterior nostril as an oval slit, the latter near to eye than to anterior nostril. Gill rakers absent. Anterior most region of lower jaw and vomer with fang-like teeth, the latter with distinct basal lobes. Small pointed teeth in rows on both jaws. Dorsal fin origin above gill opening, dorsal and anal fins confluent with caudal fin. Lateral line reaching to caudal peduncle, 36-38 lateral pores from head to above vent.

<u>Scales</u>: Absent.

Colour: Greyish-brown above, dull white below. Dorsal, anal and caudal fins with black margin. Pectoral fin colourless.

Distribution: East Africa, Samoa, Australia and coasts of India.

Remarks: *M. bagio* was considered as a synonym of *M. cinereus* (Forsskal) (Weber and de Beaufort, 1916; Munro, 1955) but Fischer and Whitehead (1974) described them as two distinct species.

2.4.7. FAMILY : OPHICHTHIDAE

Characters of taxonomic value: Body elongate and vermiform. Mouth small, upper jaw projecting beyond the lower jaw. Teeth pointed, conical or granular in

9 genera were reported from Indo-Australian Archipelago (Weber and de Beaufort, 1916). Munro (1955) listed 12 species under 6 genera from Sri Lanka waters. Menon (1961) described another new species from Karaikkal, Madras and also provided a key to the 10 species of Indian Ophichthidae. Rahman (1979) reported two species from Bangladesh, of which one species is a new distributional record from that area. 7 species under 5 genera were represented in the Laccadive Archipelago (Jones and Kumaran, 1980).

Key to genus

Origin of dorsal behind gill opening; pectorals well developed; teeth granular in bands on jaws, teeth on vomer present; lips without barbels .... *Pisoodonophis* Kaup.

Pisoodonophis Kaup, 1856

Pisoodonophis Kaup, 1856: 15.

Key to species

Origin of dorsal behind end of pectoral; head 5.84% in SL; dorsal and anal very low .... *Pisoodonophis boro* (Hamilton-Buchanan, 1822).

<u>Pisoodonophis boro</u> (Hamilton-Buchanan, 1822)

Plate 5.2

<u>Ophiaurus boro</u> Hamilton-Buchanan, 1822: 20; Bleeker, 1853: 156.

<u>Ophiaurus harancha</u> Hamilton-Buchanan, 1822: 21.

<u>Pisoodonophis boro</u> Kaup, 1856: 17; Weber and de Beaufort, 1916: 297; Menon, 1961: 15.

<u>Ophichthys boro</u> Gunther, 1870: 77; Day, 1878: 664.

<u>Description</u>: Based on one specimen, 402.0 mm SL (=TL).

<u>Fin formula</u>: D. 342; A. 262; P. 13.

Body measurements in percent of standard length: greatest body depth 1.61; head length 5.84; snout to D fin origin 8.33; snout to A fin origin 11.69; snout to pectoral fin origin 5.84; pectoral fin length 1.36.

In percent of head length: snout length 12.76; orbit diameter 8.51; least width of interorbital space 10.61.

Body elongate and vermiform. Snout pointed, overhanging lower jaw. Cleft of mouth horizontal. Hind end of maxilla reaching to well beyond vertical below posterior margin of eye. A lateral groove in the interorbital space. A series of small pores on head. Anterior nostril tubular on the inner side of anterior most region of upper jaw. Gill rakers absent. Teeth granular, in patches on maxilla, premaxilla, mandible and vomer. Lateral line complete. Origin of dorsal fin well behind posterior tip of pectoral fin. Dorsal and anal fins not reaching to tip of tail, not confluent around tail, the latter projecting as a stiff point. Anal fin origin close to vent.

Scales: Absent.

Colour: Brownish-black above, yellowish-white below. Dorsal, anal and pelvic fins dull white.

Distribution: All the coastal regions of tropics between Africa and Tahiti.

Other materials examined: ZSI Nos. 2167 (540.0 mm SL) locality unknown, 2756 (300.0 mm SL) Madras, 2757 and 2758 (450.0 and 375.0 mm SL) Calcutta, F. Day Coll.

COHORT	: CLUPEOCEPHALA
SUPER ORDER	: CLUPEOMORPHA
ORDER	: CLUPEIFORMES
SUB ORDER	: CLUPEOIDEI

2.4.8. FAMILY : CLUPEIDAE

Characters of taxonomic value: Body elongate, cylindrical or compressed. Mouth more or less terminal, cleft of mouth not reaching behind eye. Gill membrane free from isthmus. Branchiostegal rays present. Lateral line absent. Scales cycloid, thin and deciduous; absent on head. Belly with keeled or unkeeled scutes, but lacking in some genera. Spines absent in fins. Single dorsal fin, located in the midpoint of the body. Caudal fin deeply forked.

Whitehead (1972) recognized 7 sub-families under the family Clupeidae from the seas around India, of which 5 sub-families were represented in the present collections.

Key to sub-families (modified from that of Whitehead, 1972)

1. Branchiostegal rays 14-19; belly devoid of scutes; pre-maxillae rectangular .... Dussumieriinae.

Branchiostegal rays 4-8; belly with scutes; pre-maxillae triangular .... 2.

2. Anal fin with less than 30 rays; pelvic fin with 7-9 rays ....3.

Anal fin with more than 30 rays; pelvic fin with 7 rays ....4.

3. Mouth terminal; lower jaw not flared outwards at corners; last ray normal ....3a.

Mouth inferior; lower jaw flared outwards at corners; last dorsal ray normal or filamentous ....3b.

3a. Upper jaw without median notch, two supra-maxillae; keeled scutes before and behind pelvic fin .... Clupeinae.

Upper jaw without median notch, a single supra-maxilla; unkeeled scutes before pelvic fin .... Pellonulinae.

3b. Stomach gizzard-like; a single supra-maxilla ... . Dorosomatinae.

4. Lower jaw strongly prognathous .... Pristigasterinae.

<u>Sub-family: Dussumieriinae</u>

Two genera are included (Whitehead, 1972; Fischer and Whitehead, 1974) under the sub-family Dussumieriinae. The genus <u>Dussumieria</u> alone was represented in the

Vembanad lake. Formerly two valid species reported under this genus (Day, 1878; Weber and de Beaufort, 1913; Munro, 1955; Misra, 1976). Whitehead (1963, 1972), Whitehead *et al.* (1966) and Fischer and Whitehead (1974) have included *Dussumieria hasseltii* Bleeker as conspecific with *D. acuta* Valenciennes.

Key to genus

Pelvic fins under dorsal fin base; 2 supramaxillae; isthumus pointed anteriorly; dorsal rays 14-19 .... *Dussumieria* Valenciennes.

Dussumieria Valenciennes, 1847

Dussumieria Valenciennes, 1847: 467.
Montalbania Fowler, 1934: 244.
Montalbiana Bertin, 1943: 7.

Dussumieria - monotypic (Fischer and Whitehead, 1974)
Dussumieria acuta Valenciennes, 1847
Plate 6.1

Dussumieria acuta Valenciennes, 1847: 467; Day, 1878: 647; Weber and de Beaufort, 1913: 21; Fowler, 1930: 598; Munro, 1955: 28; Whitehead, 1972: 170; Fischer and Whitehead, 1974; Misra, 1976: 21.

Dussumieria elopsoides Bleeker, 1849: 12.

Dussumieria hasselti Bleeker, 1850: 422; Day, 1878: 647; Weber and de Beaufort, 1913: 23; Fowler, 1924: 39; Munro, 1955: 29; Misra, 1976: 23.

Dussumieria productissima Chabanaud, 1933: 4.

Etrumeus (*Montalbania*) *albulina* Fowler, 1934: 244.

Description: Based on 15 specimens ranging in size 118.0–133.0 mm SL (137.0–160.0 mm TL).

Fin formula: D. 17–18; A. 16; P. 14; V. 8; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 19.40–24.40 (M = 22.16); head length 25.00–27.41 (M = 26.26); snout to D fin origin 51.69–56.72 (M = 54.92); snout to A fin origin 76.69–80.74 (M = 79.79); snout to pectoral fin origin 27.96–29.83 (M = 28.78); snout to pelvic fin origin 58.89–62.50 (M = 61.16); base D fin 14.40–15.20 (M = 14.81); base A fin 8.47–10.08 (M = 9.19); pectoral fin length 14.28–15.67 (M = 15.29); pelvic fin length 8.51–10.51 (M = 9.72); least depth of caudal peduncle 8.88–10.40 (M = 9.67).

In percent of head length: snout length 31.42–34.32 (M = 33.30); orbit diameter 26.15–29.85 (M = 27.72); least width of interorbital space 22.95–26.86 (M = 24.24).

Body elongate and cylindrical. Mouth terminal. Maxilla does not reach in front of eye, premaxilla rectangular. Interorbital space flat. Adipose eyelid partly covers the eye. Belly smooth and without scutes. Gill rakers on first arch (11-13) + (23-25) = 34-38. Jaws with distinct teeth, villiform teeth in palate, pterygoid and tongue. Pectoral and pelvic fins with axillary scales. Caudal fin deeply forked.

Scales: Scales in lateral series 46-49; in transverse series 11-12. Scale sheaths are visible at dorsal, anal, pectoral and pelvic fin bases. Head without scales.

Colour: Dorsal profile bluish green, ventral profile silvery bright. Opercle silvery with bluish tinge. Golden yellow lateral band from opercle to caudal peduncle. Exposed scale margins of the dorsal profile are black, thus imparting a blackish tinge. Forked margin of caudal fin very blackish. Other fins colourless.

Distribution: Madagascar, East African coasts, Eastern Mediterranean, Red Sea, Persian Gulf, Malay Peninsula, Hong Kong, Amoy, Foochow, Singapore, Australia, Sri Lanka, Pakistan and India: both east and west coasts.

Other materials examined: ZSI Nos. 2168 (111.0 SL) Bombay, 2639 (117.0 mm SL) Madras, F. Day Coll.

Sub-family: Clupeinae

Among the fishes of the sub-family Clupeinae, 14 genera were recognized of which 6 genera were reported from Indo-Pacific region (Whitehead, 1972). Of the 6 genera, fishes of the genera *Sardinella* and *Escualosa* were represented in the Vembanad lake. Chan (1965) revised the Indo-Pacific clupeid fishes of the Genus *Sardinella* and recognised two sub-genera. Following Chan's work, Whitehead (1972) recognized 3 sub-genera under this genus and reported 12 species from Indian waters. Nair (1973) in his synopsis of the Indian species, listed 9 species under the genus *Sardinella*. Fischer and Whitehead (1974) listed 14 species under this genus from the Eastern Indian Ocean and Western Central Pacific. Misra (1976) described 10 species under *Sardinella* from India and placed them under the sub-family Clupeini. The genus *Escualosa* is monotypic and is confined in the Indo-Pacific area (Whitehead, 1972; Nair, 1973; Fischer and Whitehead, 1974; Dutt, 1975; Misra, 1976).

Key to Genera

1. Opercle smooth; gill opening with two fleshy outgrowths; pelvic fin rays 8–9 ....2.

Opercle smooth; gill opening smoothly rounded; pelvic fin rays 7 ....3.

2. Upper and lower portion of the paddle shaped 2nd supramaxilla nearly equal; frontoparietal striae numerous (7–14) .... *Sardinella* Valenciennes.

3. 2nd supra-maxilla large and rectangular; upper jaw slightly notched; lateral silvery stripe along the mid-line of the body .... *Escualosa* Whitley.

Sardinella Valenciennes, 1847

Sardinella Valenciennes, 1847: 18.
Clupeonia Valenciennes, 1847: 345.
Kowala Valenciennes, 1847: 362.
Amblygaster Bleeker, 1849: 73.
Clupalosa Bleeker, 1849: 12.
Sardinia Poey, 1860: 311.
Paralosa Bleeker, 1868: 3[illegible].
Wilkesina Fowler and Bean, 1923: 3.

Key to sub-genera (Chan, 1965)

1. Pelvic fin rays 9; pseudobranch long and with distinct ventral ridge; epibranchial gill rakers curled upwards; lower gill rakers 145-258:.......... .... *Sardinella*.

Pelvic fin rays 8; pseudobranch short and flat; epibranchial gill rakers almost straight; lower gill rakers not more than 130 .... *Clupeonia*.

Key to species - *Sardinella* (*Sardinella*)

Body depth 19.52-21.87% in SL; head length 31.51-34.00% in SL; ventral scutes sharp and exposed; exposed portion of the interopercle almost semicircular; lower gill rakers 200-220; a black/golden yellow spot at the superior angle of opercle .... *Sardinella* (*Sardinella*) *longiceps* Valenciennes.

Sardinella (*Sardinella*) *longiceps* Valenciennes, 1847
Plate 6.2

Sardinella longiceps Valenciennes, 1847: 273; Fowler, 1924: 36; Munro, 1955: 25; Whitehead, 1972: 177; Nair, 1973: 4; Fischer and Whitehead, 1974; Misra, 1976: 45.

Alausa scombrina Valenciennes, 1847: 442.

Sardinella neohowii Day, 1865: 220.

Clupea longiceps Gunther, 1868: 448; Day, 1878: 161.

Clupea (*Harengula*) *longiceps* Weber and de Beaufort, 1913: 82.

Description: Based on 20 specimens ranging in size 81.0–165.0 mm SL (96.0–193.0 mm TL).

Fin formula: D. 16–17; A. 14–16; P. 15–16; V. 9; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 19.52–21.97 (M = 20.92); head length 31.51–34.00 (M = 32.95); snout to D fin origin 46.06–49.27 (M = 48.05); snout to A fin origin 77.77–80.50 (M = 79.16); snout to pectoral fin origin 30.30–32.35 (M = 31.49); snout to pelvic fin origin 56.96–58.85 (M = 57.79); base D fin 11.53–13.36 (M = 12.45); base A fin 11.50–13.06 (M = 12.50); pectoral fin length 15.45–17.32 (M = 17.03); pelvic fin length 8.78–10.09 (M = 9.55); least depth of caudal peduncle 7.21–8.85 (M = 7.97).

In percent of head length: snout length 26.47–30.00 (M = 28.13); orbit diameter 18.26–21.87 (M = 21.13); least width of interorbital space 20.19–22.22 (M = 21.77).

Body elongate. Mouth terminal, slightly oblique and the lower jaw slightly longer. Maxilla reaching to vertical below anterior margin of eye. Interorbital space flat, adipose eyelid broad. Belly with scutes, (18-20) + (13-15) = 31-35. Gill rakers on first arch (156-170) + (200-220) = 356-390. Teeth absent. Axillary scale present at pelvic fin axis. Caudal fin deeply forked.

Scales: Scales in lateral series 45-46; in transverse series 11-13. Scales present all over the body including dorsal, anal, caudal and pectoral fins base.

Colour: Dorsal profile bluish-green, ventral profile shining silvery. A lateral golden yellow stripe along the mid-line of the body. Opercle with a golden yellow/ black blotch. Dorsal and caudal fins dusky black. Other fins colourless.

Distribution: East African coasts and Seychelles, Gulf of Aden, Gulf of Oman, Red sea, Mombasa, Philippines, North Borneo, Iran, Pakistan, Sri Lanka and India: both east and west coasts.

Other material examined: ZSI No. 2616 (157.0 mm SL) Malabar, F. Day Coll.

Remarks: The racial investigation studies were conducted by subjecting morphometric characters of the population of *S.* (*S*). *longiceps* collected from Bombay-Karachi, Muscat, Aden and Karwar regions by Devanesan and Chidambaram (1943) and tentatively concluded that there is the existence of more than one race in oil sardine population. Devanesan (1943) proved that the population of *S.* (*S*). *longiceps* of Bombay-Karachi regions and Malabar regions differ in the number of pectoral rays and head length in total length ratios.

Key to species - *Sardinella* (*Clupeonia*)

Body depth 27.77-31.73% in SL; head length 25.00-26.52% in SL; ventral scutes sharp and exposed; lower gill rakers 56-62; post-pelvic scutes 15-16; caudal fin margin dusky black; black spot at the base of anterior dorsal rays .... *Sardinella* (*Clupeonia*) *gibbosa* (Bleeker).

Sardinella (*Clupeonia*) *gibbosa* (Bleeker, 1849)
Plate 7.1

Clupea gibbosa Bleeker, 1849: 72

Sardinella jussieu Lacepede, 1803: 469(*nomen dubium*); Fowler, 1929: 592; Munro, 1955: 26; Misra, 1976: 43.

<u>*Clupea*</u> (<u>*Harengula*</u>) <u>*fimbriata*</u> Weber and de Beaufort, 1913: 75.

<u>*Sardinella gibbosa*</u> Regan, 1917: 383; Whitehead, 1972: 185; Nair, 1973: 39; Fischer and Whitehead, 1974.

<u>Description</u>: Based on 2 specimens, 90.0 and 115.0 mm SL (108.0 and 141.0 mm TL).

<u>Fin formula</u>: D. 17; A. 17–18; P. 15; V. 8; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 27.77–31.73 (M = 29.75); head length 25.00–26.52 (M = 25.76); snout to D fin origin 43.33–43.91 (M = 43.62); snout to A fin origin 76.52–7[illegible].66 (M = 76.[illegible]2); snout to pectoral fin origin 26.66–27.52 (M = 27.09); snout to pelvic fin origin 52.22–53.04 (M = 52.63); base D fin 13.80–13.91 (M = 13.85); base A fin 15.55–16.08 (M = 15.81); pectoral fin length 16.52–16.66 (M = 16.59); pelvic fin length 1[illegible]; least depth of caudal peduncle 10.0%.

In percent of head length: snout length 24.59–31.11 (M = 27.96); orbit diameter 22.95–26.66 (M = 24.80); least width of interorbital space 22.95–28.88 (M = 25.91).

Body elongate and compressed. Mouth terminal, oblique and the lower jaw slightly longer. Maxillae reaching to vertical below anterior border of eyes. Interorbital space flat, adipose eyelid broad. Belly with prominent scutes, (17-19) + (15-16) = 32-35. Gill rakers on first arch (27-30) + 56-62 = 83-92. Teeth absent. Pelvic fin with axillary scale. Caudal fin deeply forked.

Scales: Scales in lateral series 44-45; in transverse series 11-12. Scales present all over the body including on dorsal, anal, caudal, pectoral and pelvic fins base.

Colour: Dorsal profile brownish-yellow, ventral profile shining silvery. Black spot at the bases of anterior dorsal rays. Dorsal and anal fins dusky black. Caudal fin tip blackish. Other fins colourless.

Distribution: East Africa, Red Sea, Gulfs of Aden and Oman, Malaya, Thailand, Philippines, Hong Kong, Taiwan, Northern Australia and India: both east and west coasts.

Escualosa Whitley, 1940

Leptogaster Bleeker, 1872: 262.

Kowala (non Valenciennes): Regan, 1922: 387.

Escualosa Whitley, 1940: 402.

Escualosa - monotypic

Escualosa thoracata (Valenciennes, 1847)

Plate 7.2

Kowala thoracata Valenciennes, 1847: 363.

Meletta lile Valenciennes, 1847: 378.

Rogenia argyrotaenia Bleeker, 1852: 457.

Clupea (*Clupeoides*) *argyrotaenia* Bleeker, 1872: 101.

Clupea lile Day, 1878: 638.

Clupeoides lile Weber and de Beaufort, 1913: 57; Fowler, 1928: 31.

Kowala coval Fowler, 1941: 100; Munro, 1955: 24; Nair, 1973: 74; Misra, 1976: 65.

Escualosa thoracata Whitehead, 1967: 70, 1972: 189; Fischer and Whitehead, 1974; Dutt, 1975: 234.

Description: Based on 25 specimens ranging in size 56.0-85.0 mm SL (68.0-103.0 mm SL).

Fin formula: D. 15-17; A. 17-19; P. 11-12; V. 7; C. 28.

Body measurements expressed in percent of standard length: greatest body depth 29.26-32.25 (M = 31.15); head length 24.24-28.57 (M = 26.20);

snout to D fin origin 45.21–48.78 (M = 47.09); snout to A fin origin 73.01–76.78 (M = 74.93); snout to pectoral fin origin 25.30–28.65 (M = 27.02); snout to pelvic fin origin 49.99–53.57 (M = 51.46); base D fin 13.25–15.15 (M = 14.47); base A fin 16.02–17.94 (M = 16.94); pectoral fin length 17.10–20.51 (M = 18.88); pelvic fin length 10.91–12.90 (M = 11.67); least depth of caudal peduncle 11.58–13.91 (M = 12.67).

In percent of head length: snout length 25.00–30.76 (M = 28.58); orbit diameter 27.27–34.88 (M = 32.70); least width of interorbital space 24.99–28.26 (M = 27.00).

Body oblong, deep and well compressed. Mouth superior, oblique and the lower jaw prominent. Maxillae reaching to well behind vertical below anterior margin of eyes. Two supramaxillae, the second one rectangular. Interorbital space concave, adipose eyelids partly covering the eyes. Belly strongly keeled, (15–17) + (10–11) = 25–28. Gill rakers on first arch (17–20) + (32–35) = 49–55. Teeth present on vomer, palatine, pterygoids and tongue. Caudal fin deeply forked.

__Scales__: Scales in lateral series 36–39; in transverse series 10–12. Scales present all over the body including on dorsal, anal, caudal and pectoral fins base.

<u>Colour</u>: Body silvery, dorsal profile with purple tinge. A lateral silvery stripe along the mid-line of the body. Snout tip black. Two rows of black dots along the back. Dorsal and anal fins dusky black.

<u>Distribution</u>: Indo-Malayan Archipelago, Papua, Townsville, Queensland, Pakistan, Sri Lanka and India: both east and west coasts.

<u>Other material examined</u>: ZSI No.2239 (82.0 mm SL) Bombay, F. Day Coll.

<u>Remarks</u>: The name *Kowala coval* (Cuvier) has been widely employed for this species by recent workers, following Fowler (1941). Whitehead (1967) resurrected the name *K. thoracata* for this species and also considered *Clupea coval* Cuvier (1829), based on *Kowal* of Russel (1803) as *nomen dubium*. Dutt (1971, 1975) proposed that the name *Kowala coval* as applied to the white sardine is incorrect and it is in fact *K. thoracata*.

Sub-family: Pellonulinae

Among the fishes of the sub-family Pellonulinae, two monotypic species viz. *Dayella malabarica* (Day) and

Ehirava fluviatilis Deraniyagala were recognized from Vembanad lake. These two species were re-discovered from India after Day's (1878) collection. So a redescription was very essential for its exact taxonomic identity. A brief review of literature on fishes of the sub-family Pellonulinae, key to fishes of the sub-family Pellonulinae of Vembanad lake, re-description of *D. malabarica* and *E. fluviatilis* with complete synonyms and geographical distribution of the two species are presented elsewhere (Kurup and Samuel, 1980a: included as appendix to the Thesis).

Sub-family: *Dorosomatinae*

Of the 6 known genera included in this sub-family, 3 genera are certainly represented in Indian waters, but the occurrence of other monotypic genera in India are doubtful (Whitehead, 1972). Misra (1976) reported 4 genera from India and the sub-family was designated as Dorosomatini. In earlier account, this sub-family have given the status of a family viz. Dorosomidae (Munro, 1955). A brief review of the Indo-Pacific gizzard shad genera *Nematalosa*, *Clupanodon* and *Konosirus* were done by Whitehead (1962). Among the genera of this sub-family Dorosomatinae, fishes of the genera *Nematalosa* and

Anodontostoma were represented in the study area. Of the 6 known species of the genus *Nematalosa*, a single species is represented in India. Two species are reported under the genus *Anodontostoma* from Indian waters (Whitehead, 1972). Misra's (1976) account is rather incomplete since he diagnosed only a single species of *Anodontostoma* from Indian waters.

Key to genera

1. Last dorsal ray filamentous ....2.

   Last dorsal ray not filamentous ....3.

2. Dentary edge strongly flared outwards in front of maxillary end; gill rakers of first arch less than half length of corresponding gill filament; paired predorsal scales overlapping in mid-line .... *Nematalosa* Regan.

3. Maxilla straight and thin, its tip tapering terminally; predorsal scales in median series .... *Anodontostoma* Bleeker.

Nematalosa Regan, 1917

Nematalosa Regan, 1917: 313.
Fluvialosa Whitley, 1943: 179.

Key to species

Body depth 34.92–37.63% in SL; 3rd infraorbital greatly expanded and its anterior margin rising almost vertically from above the lower jaw articulation .... *Nematalosa nasus* (Bloch).

Nematalosa nasus (Bloch, 1795)

Plate 3.1

Clupea nasus Bloch, 1795: 116; Schneider, 1801: 426.

Chatoessus attus Gray, 1834: 91; Day, 1865: 243;

Chatoessus nasus Valenciennes, 1848: 104; Gunther, 1868: 407; Day, 1878: 634.

Dorosoma nasus Weber and de Beaufort, 1913: 24.

Nematalosa nasus Regan, 1917: 313; Fowler, 1938: 25; Munro, 1955: 29; Whitehead, 1972: 204; Fischer and Whitehead, 1974; Misra, 1976: 99.

Description: Based on 4 specimens ranging in size 186.0–180.0 mm SL (222.0–240.0 mm TL).

Fin formula: D. 15–16; A. 20–23; P.15; V. 8; C. 26.

Body measurements expressed in percent of standard length: greatest body depth 34.92–37.63 (M = 36.27); head length 26.61–26.98 (M = 26.79); snout to D fin origin

46.77–48.14 (M = 47.45); snout to A fin origin 70.43–72.48 (M = 71.45); snout to pectoral fin origin 25.92–26.07 (M = 25.99); snout to pelvic fin origin 48.92–49.73 (M = 49.32); base D fin 14.81–16.12 (M = 15.46); base A fin 20.63–23.11 (M = 21.87); pectoral fin length 21.23–22.48 (M = 21.85); pelvic fin length 11.64–12.36 (M = 12.00); least depth of caudal peduncle 11.58–11.82 (M = 11.20).

In percent of head length: snout length 15.15–17.64 (M = 16.39); orbit diameter 31.31–31.37 (M = 31.34); least width of interorbital space 30.38–33.33 (M = 31.85).

Body oblong and slightly compressed. Snout obtusely pointed. Mouth inferior. Upper jaw prominent, lower jaw flared at corner. Interorbital space broad and convex. Adipose eyelid broad. Belly with very strong scutes, (15–16) + (10–11) = 25–27. Gill rakers on first arch 205–224. Teeth absent. Last ray of the dorsal fin filamentous. Pectoral and pelvic fins with axillary scale. Caudal fin well forked.

<u>Scales</u>: Scales in lateral series 45–48; in transverse series 17–18. Scales present all over the body including on caudal fin. Scale sheaths are visible at dorsal, anal, pectoral and pelvic fins base.

Colour: Dorsal profile greyish green. Ventral profile silvery. The first few rows of scales on dorsal profile are having a central black spot, thus appearing horizontal black lines. A black shoulder blotch behind the posterior superior angle of orbit. Dorsal and caudal fins tips dusky black. Other fins colourless.

Distribution: South Africa, Malaya, Thailand, Philippines, Gulf of Aden, Hong Kong, Persian Gulf, Indonesia, Sri Lanka, Pakistan and India: both east and west coasts.

Other materials examined: ZSI Nos. F. 1438/1 (109.0 mm SL) history unknown, I.H. Burkil Coll; 2208 (124.0 mm SL) Akyab, 2665 (82.0 mm SL) Madras, 2696 (122.0 mm SL) Bombay, F. Day Coll.

Anodontostoma Bleeker, 1849

Andontostoma Bleeker, 1849: 15.

Key to species

Snout well protruded; dorsal with 17-18 rays; lat. line scales 39-42; tr. scales 12-13 .... Anodontostoma chacunda (Hamilton-Buchanan).

Anodontostoma chacunda (Hamilton-Buchanan, 1822)

Plate 8.2

<u>Clupanodon chacunda</u> Hamilton-Buchanan, 1822: 246.

<u>Anodontostoma hasseltii</u> Bleeker, 1849: 15.

<u>Chatoessus chacunda</u> Day, 1865: 242; Gunther, 1868: 411.

<u>Dorosoma chacunda</u> Weber and de Beaufort, 1913: 25.

<u>Anodontostoma chacunda</u> Regan, 1917: 316; Fowler, 1928: 32; Munro, 1955: 3_; Whitehead, 1972: 207; Fischer and Whitehead, 1974; Mera, 1975: 101.

<u>Description</u>: Based on 25 specimens ranging in size 52.0–110.0 mm SL (64.0–140.0 mm TL).

<u>Fin formula</u>: D. 17–19; A. 19–21; P. 15; V. 8; C. 24–26.

Body measurements expressed in percent of standard length: greatest body depth 40.00–46.00 (M = 42.86); head length 28.04–32.65 (M = 30.27); snout to D fin origin 45.97–48.88 (M = 47.63); snout to A fin origin 73.32–78.16 (M = 76.38); snout to pectoral fin origin 26.36–29.99 (M = 28.26); snout to pelvic fin origin 53.26–55.97 (M = 54.26); base D fin 17.64–20.58 (M = 19.21); base A fin 17.68–20.00 (M = 18.92); pectoral fin length 21.00–24.03 (M = 22.89); pelvic fin length 12.50–14.73) (M = 13.85); least depth of caudal peduncle 12.22–14.36 (M = 13.82).

In percent of head length: snout length 20.79–24.99 (M = 23.72); orbit diameter 26.92–33.33 (M = 30.53); least width of interorbital space 30.76–35.71 (M = 33.61).

Body oval and compressed. Snout obtusely pointed. Mouth inferior, upper jaw prominent. Maxilla straight, thin, tapering terminally and reaching to vertical below anterior border of eyes. Interorbital space broad and convex. Adipose eyelids broad. Belly with strong scutes, (16–18) + (10–12) = 26–30. Gill rakers on first arch (75–82) + (78–84) = 153–166. Teeth absent. Axillary scale present at pelvic axis, absent at pectoral axis. Caudal fin deeply forked.

<u>Scales</u>: Scales in lateral series 39–42; in transverse series 11–13. Scales present all over the body including on caudal fin. Scale sheaths are present at dorsal, anal, pectoral and pelvic fin base.

<u>Colour</u>: Body silvery, dorsal profile slightly purple-blue. Golden yellow lateral reflections along the mid-line of the body. Occipital region yellowish. Opercle shining silvery. A black shoulder blotch behind the posterior superior angle of the orbit. Dorsal fin tip black. Inner margin of forked caudal fin slightly yellowish. Other fins colourless.

<u>Distribution</u>: Persian Gulf, Indo-Malayan Archipelago, Thailand, Philippines, Hainan, Indonesia, Australia,

Pakistan, Sri Lanka and India: both east and west coasts including Andamans.

Other materials examined: ZSI Nos. F. 1293/2 (140.0 mm SL) Sonnakkuppam, Cuddalore, A.G.K. Menon Coll; 2208 (186.0 mm SL) Andamans, F. Day Coll.

Sub-family: Pristigasterinae

Among the fishes of the sub-family Pristigasterinae, the genus *Ilisha* alone was represented in the Vembanad lake. All the species now placed in the genus *Ilisha* were included under *Pellona* by Day (1878). Norman (1923) revised the fishes of the genus *Ilisha* and Fowler (1941) listed and described the Indo-Pacific species. Dutt (1967) listed and described the species of *Ilisha* available at Visakhapatnam. Based on the presence or absence of toothed hypomaxilla, Whitehead (1970) differentiated the two genera *Ilisha* and *Pellona* of this sub-family. Talwar and Whitehead (1971) described many of the types of *Ilisha*. Whitehead (1972) has also given a synopsis to the Indian *Ilisha*. Seshagiri Rao (1972, 1973, 1975a, 1975b, 1976, 1981) re-described a number of little known *Ilisha* species from Indian waters, some of which were new distributional records from the Indian coasts. Fischer and Whitehead (1974) listed 6 species from Eastern Indian Ocean and Western Central Pacific. Seshagiri Rao (1975c) described a new species of _Ilisha_ from the coasts of Visakhapatnam and reported 9 species in his review (1976) of _Ilisha_ species from the Indo-Pacific area. Other notable taxonomic studies on fishes of the genus _Ilisha_ from Indian waters are those of Ramaiyan and Whitehead (1975) and Ramaiyan and Natarajan (1975). In a recent revision of _Ilisha_ fishes of India, Ramaiyan and Natarajan (1980) listed 8 species from Indian waters and also suggested that Seshagiri Rao's new species _I. whiteheadi_ appears to be _I. kampeni_ (Weber and de Beaufort).

Key to genus

No toothed hypo-maxilla; pelvic fins present .... _Ilisha_ Richardson.

Ilisha Richardson, 1846

Ilisha Richardson, 1846: 306.

Platygaster Swainson, 1838: 278.

Zunasia Jordon and Metz, 1913: 7.

Pseudochirocentrodon Miranda-Ribeiro, 1923: 8.

Euplatygaster Fowler, 1934: 246.

Key to species

Swimbladder without post-coelomic extensions; frontal ridges indica pattern; body depth 31.08-34.70% in SL; gill rakers 32-36; scutes 25-29 .... *Ilisha sirishai* Seshagiri Rao.

Swimbladder with bifid tubular post-coelomic extensions; frontal ridges indica pattern; body depth 37.73-39.83% in SL; gill rakers 32-35; scutes 24-30 .... *Ilisha melastoma* (Schneider).

Ilisha sirishai Seshagiri Rao, 1975
Plate 9.1

Ilisha sirishai Seshagiri Rao, 1975: 463; 1975: 526, 1976: 503; Ramaiyan and Whitehead, 1975: 188; Kurup and Samuel, 1981d.

Description: Based on 20 specimens ranging in size 49.0-79.0 mm SL (68.0-103.0 TL).

Fin formula: D. 15-17; A. 37-40; P. 14-16; V. 7; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 31.08-34.70 (M = 33.39); head length 27.70-30.61 (M = 28.91); snout to D fin origin 48.63-51.81 (M = 50.07); snout to A fin origin 62.02–65.58 (M = 63.99); snout to pectoral fin origin 27.70–30.54 (M = 29.27); snout to pelvic fin origin 45.45–49.31 (M = 47.43); base D fin 11.11–14.49 (M = 12.96); base A fin 31.46–34.86 (M = 33.42); pectoral fin length 14.49–16.90 (M = 15.62); pelvic fin length 5.26–7.23 (M = 6.39); least depth of caudal peduncle 9.70–10.61 (M = 10.26).

In percent of head length: snout length 25.64–31.81 (M = 28.63); orbit diameter 26.08–32.69 (M = 29.09); least width of interorbital space 17.07–20.58 (M = 18.78).

Body elongated and well compressed. Mouth superior, lower jaw projecting. Maxilla extending to vertical below anterior border of eye, lower border finely serrated. Frontals with two prominent ridges of 'indica pattern' (Seshagiri Rao, 1972). No hypo-maxilla, two supra-maxilla. Belly with scutes, (18–20) + (7–9) = 25–29. Gill rakers on first arch (11–12) + (21–24) = 32–36. Very small teeth in a single row in both jaws. Pectoral fin with axillary scale, pelvic without axillary scale. Caudal fin deeply forked.

<u>Scales</u>: Scales in lateral series 40–42; in transverse series 10–12. Deciduous scales, present on body including anal fin base. Scales absent on head.

Swimbladder: Swimbladder without post-coelomic extension.

Colour: Body silvery, scales of back are mottled with very minute black spots thus imparting a blackish tinge. Lower profile shining silvery. Tip of dorsal fin and caudal fin dusky black. Other fins colourless.

Distribution: Visakhapatnam on the east coast, Bombay and Cochin on the west coast of India.

Remarks: Kurup and Samuel (1981d, in press) reported *I. sirishai* from the Vembanad lake and observed some variations in the morphometric and meristic characters of this species from the original description (Seshagiri Rao, 1975c) and also discussed its seasonal distribution and abundance with the fluctuating hydrological conditions of the lake. Ramaiyan and Natarajan (1975) stated that Seshagiri Rao's *I. sirishai* may represent specimens of *I. melastoma* that lack post-coelomic extension of swimbladder, but Ramaiyan and Whitehead (1975) recognized *I. sirishai* when the key was revised by utilising the swimbladder as a major taxonomic character.

Ilisha melastoma (Schneider, 1801)

Plate 9.2

Clupea melastoma Schneider, 1801: 427.

Clupea motius Hamilton-Buchanan, 1822: 251.

Pellona micropus Valenciennes, 1847: 320.

Ilisha melastoma Whitehead, 1972: 212; Fischer and Whitehead, 1974; Ramaiyan and Whitehead, 1975: 189; Ramaiyan and Natarajan, 1975: 955.

Description: Based on 8 specimens ranging in size 61.0-104.0 mm SL (74.0-126.0 mm TL).

Fin formula: D. 15-16; A. 38-39; P. 15-16; V. 7; C. 26.

Body measurements expressed in percent of standard length: greatest body depth 37.73-39.83 (M = 38.62); head length 26.80-31.14 (M = 28.89); snout to D fin origin 46.96-49.29 (M = 47.99); snout to A fin origin 56.25-63.93 (M = 61.22); snout to pectoral fin origin 26.92-30.32 (M = 28.68); snout to pelvic fin origin 45.36-52.11 (M = 48.99); base D fin 10.82-14.39 (M = 12.73); base A fin 34.84-38.23 (M = 36.60); pectoral fin length 13.40-18.30 (M = 16.28); pelvic fin length 5.67-7.37 (M = 6.53); least depth of caudal peduncle 8.65-13.11 (M = 10.93).

In percent of head length: snout length 26.92–31.57 (M = 30.36); orbit diameter 28.94–34.61 (M = 30.48); least width of interorbital space 15.38–19.51 (M = 17.42).

Body elongated and well compressed. Mouth superior, lower jaw projecting. Maxilla extending to vertical below anterior margin of eye, lower margin serrated. Frontals with two prominent ridges of 'indica pattern' (Seshagiri Rao, 1972). No hypo-maxilla, two supra-maxilla. Belly with scutes, (17–22) + (7–8) = 24–30. Gill rakers on first arch (10–11) + (22–23) = 32–34. Single row of conical teeth on pre-maxilla, granular teeth in tongue. Pectoral fin with axillary scale, pelvic fin without. Caudal fin deeply forked.

Scales: Scales in lateral series 41–43; in transverse series 9–10. Deciduous scales present all over the body including anal fin base. Scales absent on head.

Swimbladder: Swimbladder with paired tubular post-coelomic extensions.

Colour: Body silvery. Scales of the back are mottled with very minute black dots thus imparting a blackish tinge. Dorsal fin tip and caudal fin dusky black. Other fins colourless.

Distribution: Persian Gulf to Kongkong, Penang, Batavia and India: east and west coasts.

2.4.9. FAMILY: ENGRAULIDAE

Characters of taxonomic value: Body elongate, subcylindrical or well compressed. Snout prominent, lower jaw underslung. Maxilla usually elongated. Gill membrane free from isthmus. Lateral line absent. Eyes covered with the membrane. Scales deciduous, cycloid, absent on head. Belly with keeled or needle-like scutes. Uniserial teeth present in palatine, vomer, pterygoid and tongue. Single dorsal fin. Caudal fin deeply forked.

Among the fishes of the family Engraulidae, 14 genera are recognized, of which 7 are known from the Indo-Pacific region under two subfamilies (Whitehead, 1972).

Key to sub-family (Whitehead, 1972)

Body normal; caudal fin bilobed; gill rakers present on posterior face of 3rd epibranchial .... Engraulinae.

Sub-family: Engraulinae

Of the 5 known genera of the sub-family Engraulinae from the Indian Ocean, fishes of two genera viz. *Stolephorus* and *Thryssa* were represented in the Vembanad lake. Day (1878) described the fishes of these two genera under a single genus *Engraulis* Cuvier and listed 14 species from India. Weber and de Beaufort (1913) recognized 5 species under the genus *Stolephorus* and 10 species under the genus *Thryssa* from the Indo-Australian Archipelago but the generic name *Engraulis* was used for the later. Hardenburg (1933) described 4 new species of *Stolephorus* and also recognized (1934) 9 species from the Indo-Australian Archipelago. It was Fowler (1941) who emended *Stolephorus* and created the new genus *Anchoviella*, which was widely employed by later workers. Munro (1955) listed 2 species under the genus *Anchoviella* and 6 species under the genus *Thrissocles* from Sri Lanka waters, and the later generic name was considered now as a junior synonym of *Thryssa*. George (1958) listed 7 species of *Stolephorus* from Indian waters of which two of them were new distributional records from this area. Based on the collection from International Indian Ocean Expedition, Whitehead (1968) in his synopsis listed 8 species of Stolephorus and 4 species of Thryssa from Indian Ocean. 10 species of Stolephorus and 8 species of Thryssa were recognized from the seas around India (Whitehead, 1972). Fischer and Whitehead (1974) listed 12 species under Stolephorus and 8 species under Thryssa from Eastern Indian Ocean and Western Central Pacific. Misra's (1976) account on this family of fishes from India is rather incomplete since he listed only 4 species under Anchoviella and the validity of the 13 species describdd under the genus Thrissocles are doubtful. Other important contribution to the systematics and distribution of fishes of these two genera from the Indian Ocean were those of Nair (1953), Varadarajan (1953), Dutt and Babu Rao (1959), Dutt (1961), Babu Rao (1966, 1971, 1973, 1976), Chandra (1966) and Talwar and Whitehead (1971).

Key to genera

1. Abdominal scutes present; posterior tip of maxilla usually projecting well beyond supra-maxilla; posterior frontal fontanelles triangular; caudal fin deeply forked, not confluent with anal fin ....2.

2. Scutes needle-like, restricted in between pectoral and pelvic fin bases; anal fin short, with

less than 25 fin rays .... *Stolephorus* Lacepede.

Scutes keeled and trenchant, present before pectoral fin base and behind pelvic fin base; anal fin long, with more than 25 fin rays ....3.

3. First pectoral ray normal, not elongated ... . *Thryssa* Cuvier.

Stolephorus Lacepede, 1803

Stolephorus Lacepede, 1803: 381.
Encrasicholina Fowler, 1938: 157.
Amentum Whitley, 1940: 402.
Anchoviella Fowler, 1941: 696.

Key to species

1. Anal origin under dorsal base; no spine on pelvic scute; predorsal spine may or may not be present ....2.

2. Maxilla tip reaching to anterior border of preopercle; posteroventral edge of preopercle evenly rounded ....3.

Maxilla tip reaching to well beyond posterior border of preopercle; posteroventral edge of preopercle evenly rounded or concave ....4.

3. Pelvic fin tip not reaching to below dorsal fin origin; lat. line scales 38-42; posterior frontal fontanelles narrow, lateral borders straight; lower gill rakers 20-24; pre-pelvic scutes 4-5; no pigment line on back .... Stolephorus indicus van Hasselt.

4. Posteroventral edge of preopercle evenly rounded; 3 branchiostegal rays on posterior ceratohyal; no predorsal spine ....5.

Posteroventral edge of preopercle concave; 2 branchiostegal rays on posterior ceratohyal; predorsal spine small or absent ....6.

5. Body cylindrical; pelvic fin tip reaching to nearly below 3rd dorsal ray; teeth on palate and pterygoids poorly developed; posterior frontal fontanelles broad, lateral borders sigmoid; lower gill rakers 20-25; pre-pelvic scutes 3-4; dusky patch behind occiput, continuing as two broad pigment lines upto dorsal fin origin .... Stolephorus commersonii Lacepede.

Body compressed; pelvic fin tip not reaching to below dorsal origin; teeth on palate and pterygoids well developed; posterior frontal fontanelles small and pointed anteriorly; lower gill rakers 19-23; pre-pelvic scutes 6-8; small black dots on snout and below eye .... <u>Stolephorus waitei</u> Jordan and Seale.

6. Body compressed; pelvic fin tip terminating just before dorsal origin; posterior frontal fontanelles narrow; lateral border straight; lower gill rakers 23-25; pre-pelvic scutes 6-7; double pigment lines along the midline of back behind dorsal; no dots on snout or under eye; caudal fin yellow with black margin .... <u>Stolephorus insularis</u> Hardenberg.

<u>Stolephorus indicus</u> (van Hasselt, 1823)
Plate No.1

<u>Engraulis indica</u> van Hasselt, 1823: 329.
<u>Engraulis balinensis</u> Bleeker, 1849: 11.
<u>Engraulis indicus</u> Day, 1878: 629.
<u>Stolephorus indicus</u> Weber and de Beaufort, 1913: 46.
<u>Stolephorus indicus nanus</u> Hardenberg, 1933: 263.
<u>Anchoviella indica</u> Fowler, 1941: 706; Munro, 1955: 31; Misra, 1976: 123.
<u>Stolephorus indicus</u> Whitehead, 1972: 225; Fischer and Whitehead, 1974.

<u>Description</u>: Based on 10 specimens ranging in size 71.0–126.0 mm SL (85.0–147.0 mm TL).

<u>Fin formula</u>: D. 16–17; A. 19–20; P. 15–16; V. 7; C. 24.

Body measurements expressed in percent of standard length: greatest body depth 16.80–18.64 (M = 17.72); head length 22.61–23.94 (M = 23.13); snout to D fin origin 52.81–54.66 (M = 53.46); snout to A fin origin 61.86–63.49 (M = 62.35); snout to pectoral fin origin 24.57–25.42 (M = 25.06); snout to pelvic fin origin 42.62–44.44 (M = 43.66); base D fin 13.49–14.08 (M = 13.72); base A fin 16.10–16.90 (M = 16.51); pectoral fin length 11.09–13.38 (M = 12.17); pelvic fin length 7.37–8.05 (M = 7.67); least depth of caudal peduncle 7.78–9.15 (M = 8.30).

In percent of head length: snout length 22.80–26.47 (M = 23.82); orbit diameter 25.92–28.07 (M = 27.45); least width of interorbital space 26.31–30.35 (M = 26.86).

Body elongate and nearly cylindrical. Snout pointed, upper jaw prominent. Posterior frontal fontanelles narrow, lateral borders straight. Maxilla reaching to anterior border or preopercle, its lower margin finely serrated. Posteroventral edge of preopercle rounded. Interorbital space flat. Prepelvic scutes 4-5. Gill rakers on first arch (16-19) + (20-24) = 36-43. Very minute teeth in jaws, palate and pterygoids. Anal origin below dorsal fin base. Pelvic fin tip terminating well before dorsal fin origin. Axillary scale present at the axis of pectoral and pelvic fins. Caudal fin forked.

Scales: Scales in lateral series 38-42; in transverse series 8-9. Scales present all over the body including at dorsal, anal, caudal pectoral and pelvic fins base.

Colour: Body dull white, a silvery lateral band along the midline of the body from opercle to the caudal peduncle. Opercle shining silvery with golden reflections. Occiput is having 9 black spots. Snout dusky black. Exposed margins of the scale on dorsal profile black. Caudal fin dusky black. Other fins colourless.

Distribution: Mozambique, East Africa, Red Sea, Persian Gulf, Indo-Malayan Archipelago, Philippines, Hongkong, Papua, Samoa, Australia, Sri Lanka, Pakistan and India: both east and west coasts.

Other materials examined: ZSI Nos. 2600 (60.0 mm SL) Chellumbrum, 2603 (59.0 mm SL) Madras, 2750 (75.0 mm SL) Orissa, F. Day Coll.

Stolephorus commersonii Lacepede, 1803

Plate 10.2

Stolephorus commersonii Lacepède, 1803: 381; Weber and de Beaufort, 1913: 45; Hardenberg, 1934: 323; Whitehead, 1972: 226; Fischer and Whitehead, 1974.

Engraulis commersonianus Gunther, 1868: 388; Day, 1878: 629.

Anchoviella commersonii Fowler, 1941: 703; Munro, 1955: 31; Misra, 1976: 120.

Description: Based on 25 specimens ranging in size 41.0–99.0 mm SL (49.0–121.0 mm TL).

Fin formula: D. 16–17; A. 19–21; P. 13–14; V. 7; C. 22–24.

Body measurements expressed in percent of standard length: greatest body depth 19.07–22.72 (M = 20.50); head length 23.19–26.19 (M = 24.70); snout to D fin origin 51.13–54.45 (M = 52.84); snout to A fin origin 60.86–64.83 (M = 62.64); snout to pectoral fin origin 24.60–25.57 (M = 25.40); snout to pelvic fin origin 42.68–46.52 (M = 44.92); base D fin 13.08–16.36 (M = 14.39); base A fin 17.80–20.70 (M = 17.48); pectoral fin length 13.79–16.66 (M = 15.03); pelvic fin length 9.42–10.90 (M = 10.09); least depth of caudal peduncle 9.42–11.11 (M = 10.47).

In percent of head length: snout length 20.00–25.33 (M = 21.96); orbit diameter 26.00–31.81 (M = 28.47); least width of interorbital space 26.00–30.55 (M = 28.51).

Body elongate and cylindrical. Mouth slightly horizontal. Snout pointed, upper jaw prominent. Posterior frontal fontanelles broad, lateral borders sigmoid. Maxilla reaching to well beyond posterior border of preopercle, its lower border serrated. Posteroventral edge of preopercle rounded. Interorbital space with faint median ridge. Pre-pelvic scutes 3–4. Gill rakers on first arch (16–19) + (22–25) = 38–44. Minute teeth in jaws, teeth in palate and pterygoids poorly developed. Anal fin origin below dorsal fin base. Pelvic fin tip terminating below the 3rd dorsal fin ray. Pectoral and pelvic fins with axillary scale. Caudal fin forked.

<u>Scales</u>: Scales in lateral series 35–37; in transverse series 8–9. Scales present all over the body including

at dorsal, anal, caudal, pectoral and pelvic fins base.

<u>Colour</u>: Body dull white, 3-4 rows of scales on dorsal profile have black margin at its exposed portion. Operele shining silvery with golden reflections. A shining silvery lateral band along the midline of the body, broadens posteriorly. Dusky patch behind occiput, continuing as two distinct broad pigment lines upto dorsal fin origin. Snout tip dusky black. Dorsal and caudal fins dusky black. Other fins colourless.

<u>Distribution</u>: Mauritius, Madagascar, Comoro Island, East Africa, Indo-Malayan Archipelago, Thailand, Philippines, Australia, Sri Lanka, Pakistan and India: both east and west coasts.

<u>Other material examined</u>: ZSI No. 2748 (99.0 mm SL) Madras, F. Day Coll.

<u>Stolephorus waitei</u> Jordan and Seale, 1926

<u>Plate 10.3</u>

<u>Stolephorus waitei</u> Jordan and Seale, 1926: 380.

<u>Stolephorus insularis</u> (part) Hardenberg, 1933: 260.

<u>Stolephorus insularis bataviensis</u> Hardenberg, 1933: 261.

__Description:__ Based on 17 specimens ranging in size 57.0–79.0 mm SL (70.0–95.5 mm TL).

__Fin formula:__ D. 15–16; A. 19–20; P. 15–16; V. 7; C. 24.

Body measurements expressed in percent of standard length: greatest body depth 16.66–20.72 (M = 19.38); head length 24.81–26.66 (M = 25.48); snout to D fin origin 51.33–55.71 (M = 53.88); snout to A fin origin 60.00–64.91 (M = 62.44); snout to pectoral fin origin 25.54–28.33 (M = 26.79); snout to pelvic fin origin 42.66–45.83 (M = 44.38); base D fin 13.29–16.66 (M = 14.78); base A fin 18.57–21.33 (M = 19.66); pectoral fin length 12.85–15.00 (M = 14.38); pelvic fin length 6.96–8.00 (M = 7.78); least depth of caudal peduncle 9.33–10.71 (M = 10.01).

In percent of head length: snout length 19.44–23.75 (M = 21.42); orbit diameter 25.33–30.00 (M = 28.38); least width of interorbital space 23.33–28.12 (M = 25.82).

Body elongate and compressed. Mouth slightly oblique. Snout rather rounded, upper jaw prominent. Posterior frontal fontanelles small, pointing anteriorly. Maxilla reaching to well behind posterior border of preopercle, its lower margin serrated. Posteroventral edge of preopercle rounded. Interorbital space flat with a faint median ridge. Pre-pelvic scutes 6-8. Gill rakers on first arch (16-17) + (19-23) = 35-40. Very small teeth present in jaws, teeth on palate and pterygoids well developed. Anal fin origin below dorsal fin base. Pelvic fin tip not reaching to below dorsal fin origin. Pectoral and pelvic fins with axillary scale. Caudal fin forked.

Scales: Scales in lateral series 32-34; in transverse series 8-9. Scales present all over the body including at dorsal, anal, caudal, pectoral and pelvic fins base.

Colour: Body dull white, dorsal profile mottled with very minute black dots, thus imparting black colouration. Opercle shining silvery. A shining silvery lateral band along the midline of the body. Snout and anterior half of the head spotted black, a very faint patch behind the occiput. Caudal fin pale, margin dusky black. Other fins colourless.

Distribution: South West Coast of India to South East Asia and to Queensland.

Stolephorus insularis Hardenberg, 1933

Plate 10.4

Stolephorus insularis Hardenberg, 1933: 260.

Stolephorus insularis baweanensis Hardenberg, 1933: 261.

Stolephorus insularis insularis Hardenberg, 1933: 261.

Stolephorus insularis oceanicus Hardenberg, 1933: 261.

Anchoviella bataviensis Fowler, 1941: 708.

Stolephorus bataviensis Whitehead, 1972: 226; Fischer and Whitehead, 1974.

Description: Based on 9 specimens ranging in size 55.0–66.0 mm SL (67.0–73.0 mm TL).

Fin formula: D. 16.17; A. 20–21; P. 13–14; V. 7; C. 26.

Body measurements expressed in percent of standard length: greatest body depth 20.00–21.81 (M = 20.91); head length 24.16–25.45 (M = 24.70); snout to D fin origin 53.33–55.55 (M = 54.71); snout to A fin origin 63.63–66.66 (M = 64.61); snout to pectoral fin origin 26.66–27.35 (M = 27.18); snout to pelvic fin origin 44.54–47.00 (M = 45.63); base D fin 13.63–17.09 (M = 15.20); base A fin 16.66–20.90 (M = 19.08); pectoral fin length 14.54–16.23 (M = 15.65); pelvic fin length 8.54–10.83 (M = 9.40); least depth of caudal peduncle 10.25–11.11 (M = 10.79).

In percent of head length: snout length 18.51-22.06 (M = 20.39); orbit diameter 27.14-31.03 (M = 28.59); least width of interorbital space 24.13-29.62 (M = 27.47).

Body elongated and compressed. Mouth slightly oblique. Snout rounded, upper jaw prominent. Posterior frontal fontanelles narrow and with straight borders. Maxilla reaching to well behind posterior border of opercle, its lower margin serrated. Posteroventral edge of preopercle concave. Interorbital space flat. Pre-pelvic scutes 6-7. Gill rakers on first arch (18-19) + (23-25) = 41-44. Very small teeth in jaws, palate and pterygoids. Pre-dorsal spine small or absent. Anal origin below dorsal fin base. Pelvic fin tip terminating just before dorsal fin origin. Pectoral and pelvic fins with axillary scales. Caudal fin deeply forked.

__Scales:__ Scales in lateral series 29-33; in transverse series 8. Scales present all over the body including at dorsal, anal, caudal, pectoral and pelvic fins base.

__Colour:__ Body dull white, back side greenish black. Opercle shining silvery. Silvery lateral band along the midline of the body, which broadens posteriorly. Greenish-black spot on occiput. Snout devoid of spots.

A double pigment line along the midline of back behind the dorsal fin. Caudal fin yellowish, its forked margin black.

Distribution: Indo-Malayan Archipelago, Thailand, Philippines, Hongkong, Taiwan and India: both east and west coasts.

Thryssa Cuvier, 1829

Thrissa Cuvier, 1816: 176.
Thryssa Cuvier, 1829: 323.
Thryssus Swainson, 1838: 279.
Trichosoma Swainson, 1839: 292.
Thrissocles Jordan and Evermann, 1917: 98.
Scutengraulis Jordan and Seale, 1925: 30.

Key to species

1. Lower jaw with high coronoid process; maxilla reaching to tip of pelvic fin; gill rakers 16-17 .... Thryssa setirostris (Broussonet).

Lower jaw slender; maxilla not reaching to pelvic fin origin; gill rakers more than 17 ....2.

2. Maxilla reaching to slightly behind pectoral fin origin; gill rakers 25-29; serrae of the gill rakers

not clumped but uneven ....3.

Maxilla not reaching to pectoral fin origin; gill rakers more than 29; serrae of the gill rakers not clumped ....4.

3. Mouth nearly horizontal; snout to dorsal fin origin 50.39–53.30% in SL; dorsal rays 14–15; anal rays 36–41; ventral scutes 16–20 + 8–12 .... _Thryssa mystax_ (Schneider).

Mouth strongly oblique; snout to dorsal fin origin 48.40–51.5%; in SL; dorsal rays 13–14; anal rays 43–45; ventral scutes 15–16 + 8–9 .... _Thryssa purava_ (Hamilton-Buchanan).

4. Maxilla nearly reaching to hind border of opercle; snout to dorsal fin origin 5...0–54.23% in SL; dorsal rays 13–14; anal rays 37–39; gill rakers 40–45; ventral scutes 13–16 + 8–9 .... _Thryssa kammalensis_ (Bleeker).

Thryssa setirostris (Broussonet, 1782)

Plate 11.1

Clupea setirostris Broussonet, 1782: Pl.2.

Engraulis setirostris Valenciennes, 1848: 69; Day, 1878: 626; Weber and de Beaufort, 1913: 40.

Thryssa macrognathos Bleeker, 1849: 13.

Thrissocles setirostris Fowler, 1941: 679; Munro, 1955: 32; Misra, 1976: 144.

Thryssa setirostris Whitehead, 1972: 230; Fischer and Whitehead, 1974.

Description: Based on 4 specimens ranging in size 77.0-103.0 mm SL (92.0-126.0 mm TL).

Fin formula: D. 14-15; A. 40; P.13; V. 7; C. 18.

Body measurements expressed in percent of standard length: greatest body depth 24.02-26.21 (M = 25.11); head length 19.90-23.37 (M = 21.63); snout to D fin origin 51.94-52.42 (M = 52.18); snout to A fin origin 61.68-62.13 (M = 61.90); snout to pectoral fin origin 21.35-24.67 (M = 23.01); snout to pelvic fin origin 40.77-42.85 (M = 41.81); base D fin 10.67-11.03 (M = 10.85); base A fin 30.58-33.11 (M = 31.84); pectoral fin length 18.83-19.41 (M = 19.21); pelvic fin length 12.98-13.59 (M = 13.28); least depth of caudal peduncle 10.38-11.03 (M = 10.85).

In percent of head length: snout length 22.22-24.39 (M = 23.30); orbit diameter 25.00-29.26 (M = 27.13); least width of interorbital space 27.77-29.26 (M = 28.51).

Body elongate and well compressed. Mouth slightly oblique. Upper jaw prominent, snout bluntly rounded. Maxilla reaching to pelvic fin tip, its lower margin well serrated. Median ridge in the interorbital space, eyes covered with adipose eyelid. Belly with keeled scutes, (17-18) + (9-10) = 26-28. Gill rakers on first arch 5 + (11-12) = 16-17. Very small uniserial teeth in jaws, vomer, palatines, pterygoids and tongue. A small spine before dorsal fin origin. Axillary scale present at pectoral and pelvic fins axis. Caudal fin deeply forked.

Scales: Scales in lateral series 42-43; in transverse series 10. Scales present all over the body including at dorsal, anal, caudal, pectoral and pelvic fins base.

Colour: 4-5 rows of scales on the back are greenish, rest of the body bright silvery. Opercle silvery. Black venule on shoulder region. Caudal fin dusky black. Other fins colourless.

Distribution: Durban, Mozambique, East Africa, Red Sea, Gulf of Aden, Indo-Malayan Archipelago, Papua, Thailand, Philippines, Amoy, Australia, Sri Lanka, Pakistan and India: both east and west coasts.

Other material examined: ZSI No. F 2575/1 (120.0 mm SL) Trivandrum. A. Annandale Coll.

Thryssa mystax (Schneider, 1801)

Plate 11.2

Clupea mystax Schneider, 1801: 426.

Thryssa mystax Richardson, 1846: 309; Whitehead, 1972: 231; Fischer and Whitehead, 1974.

Engraulis mystax Valenciennes, 1848: 67; Gunther, 1868: 397; Day, 1878: 625; Weber and de Beaufort, 1913: 38.

Stolephorus (*Thryssa*) *Valenciennesi* Bleeker, 1866: 306.

Thrissocles mystax Fowler, 1941: 675; Munro, 1955: 32; Misra, 1976: 140.

Description: Based on 25 specimens ranging in size 68.0–151.0 mm SL (81.0–181.0 mm TL).

Fin formula: D. 14–15; A. 36–41; P. 13; V. 7; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 23.13–25.39 (M = 24.21); head length 24.26–26.47 (M = 25.25); snout to D fin origin 50.39–53.88 (M = 52.09); snout to A fin origin 59.05–64.18 (M = 62.51); snout to pectoral fin origin 25.98–27.94 (M = 26.95); snout to pelvic fin origin 40.15–43.51 (M = 51.95); base D fin 9.57–12.16 (M = 10.54); base A fin 28.76–31.08 (M = 29.50); pectoral fin length 15.23–17.64 (M = 16.65); pelvic fin length 7.35–10.29 (M = 8.18); least depth of caudal peduncle 9.45–11.20 (M = 10.14).

In percent of head length: snout length 22.40–27.50 (M = 23.27); orbit diameter 21.87–25.00 (M = 23.55); least width of interorbital space 24.32–30.00 (M = 26.86).

Body elongate and compressed. Mouth nearly horizontal. Snout bluntly rounded. Upper jaw prominent. Maxilla reaching to slightly behind pectoral fin origin, its lower margin well serrated. Median ridge in interorbital space, eye covered with the membrane. Belly with keeled acutes, (16–20) + (8–12) = 24–32. Gill rakers not clumped, on first arch (11–12) + (15–17) = 26–29. Biserial teeth in jaws. A small spine before the dorsal fin origin. Axillary scale present at pectoral and pelvic fins axis. Caudal fin deeply forked.

<u>Scales</u>: Scales in lateral series 40–46; in transverse series 11–13. Scales present all over the body including

at dorsal, anal, caudal, pectoral and pelvic fins base.

Colour: 3-4 rows of scale on back deep blue, rest of the dorsal and ventral profiles silvery. Opercle silvery. Black venule on shoulder region. Caudal fin black tipped. Other fins slightly yellowish.

Distribution: Singapore, Thailand, Indonesia, New Guinea, Borneo, Taiwan, Amoy, Australia, Pakistan, Sri Lanka and India: both east and west coasts.

Other material examined: ZSI No. 2201 (124.0 mm SL) Bombay, F. Day Coll.

Thryssa purava (Hamilton-Buchanan, 1822)
Plate 12.1

Clupea purava Hamilton-Buchanan, 1822: 238.

Engraulis purava Valenciennes, 1848: 65; Gunther, 1868: 397; Day, 1878: 628; Weber and de Beaufort, 1913: 39; Fowler, 1924: 40.

Thrissocles purava Fowler, 1941: 677; Misra, 1976: 142.

Thryssa purava Whitehead, 1972: 231; Fischer and Whitehead, 1974.

Description: Based on 25 specimens ranging in size 95.0-155.0 mm SL (115.0-176.0 mm TL).

__Fin formula__: D. 13-14; A. 43-45; P. 14; V. 7; C. 22-24.

Body measurements expressed in percent of standard length: greatest body depth 25.42-28.09 (M = 26.62); head length 20.00-22.22 (M = 21.16); snout to D fin origin 48.40-51.57 (M = 49.48); snout to A fin origin 55.50-60.00 (M = 56.94); snout to pectoral fin origin 22.00-25.78 (M = 23.38); snout to pelvic fin origin 36.66-40.10 (M = 38.45); base D fin 8.12-10.00 (M = 8.85); base A fin 35.35-40.62 (M = 38.20); pectoral fin length 16.01-18.94 (M = 17.47); pelvic fin length 7.73-10.50 (M = 8.76); least depth of caudal peduncle 8.52-11.57 (M = 9.90).

In percent of head length: snout length 17.50-23.07 (M = 19.80); orbit diameter 20.00-26.92 (M = 23.10); least width of interorbital space 22.22-26.31 (M = 25.11).

Body elongate and strongly compressed. Head small, mouth strongly oblique. Upper jaw prominent, snout bluntly rounded. Maxilla reaching to slightly behind pectoral fin origin, its lower margin well serrated. Median ridge present in the interorbital space, eye covered with the membrane. Belly with keeled scutes, (15-16) + (8-9) = 23-25. Gill rakers not clumped, on first arch (12-14) + (13-15) = 25-28.

Very small uniserial teeth in jaws. A small spine before the dorsal fin origin. Axillary scale present at pectoral and pelvic fins axis. Caudal fin deeply forked.

Scales: Scales in lateral series 40-44; in transverse series 12-13. Scales present all over the body including at dorsal, anal, caudal, pectoral and pelvic fins base.

Colour: 3-4 scale rows on back deep blue, rest of the dorsal and ventral profiles bright silvery. Ventral profile is having a slight purple tinge. Opercle shining silvery. A black venule on shoulder region. Dorsal and caudal fins slightly yellowish, other fins colourless.

Distribution: Persian Gulf, Malayan Archipelago, West Pakistan, Eastern Indian Ocean and Western Central Pacific and India: both east and west coasts.

Other materials examined: ZSI Nos. F 7969 (135.0 mm SL) Calcutta, 2197 (138.0 mm SL) Bombay, 2198 (114.0 mm SL) Madras, 2200 (85.0 mm SL) Madras, F. Day Coll.

Thryssa kammalensis (Bleeker, 1849)

Plate 12.2

Engraulis kammalensis Bleeker, 1849: 13.

Engraulis kammalensis Day, 1878: 626; Weber and de Beaufort, 1913: 35.

Thrissocles kammalensis Fowler, 1941: 672; Munro, 1955: 32; Misra, 1976: 135.

Thryssa kammalensis Whitehead, 1972: 236; Fischer and Whitehead, 1974.

Description: Based on 25 specimens ranging in size 59.0–149.0 mm SL (72.0–170.0 mm TL).

Fin formula: D. 13–14; A. 37–39; P. 14; V. 7; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 27.81–31.54 (M = 28.93); head length 24.03–26.62 (M = 25.15); snout to D fin origin 50.00–54.23 (M = 51.97); snout to A fin origin 60.86–64.44 (M = 62.25); snout to pectoral fin origin 24.83–28.40 (M = 27.03); snout to pelvic fin origin 40.98–43.93 (M = 42.92); base D fin 9.61–11.85 (M = 10.22); base A fin 30.37–35.71 (M = 32.94); pectoral fin length 18.45–20.23 (M = 19.01); pelvic fin length 7.40–10.84 (M = 8.50); least depth of caudal peduncle 10.05–11.86 (M = 10.82).

In percent of head length: snout length 20.58–24.42 (M = 22.57); orbit diameter 23.33–27.27

(M = 25.94); least width of interorbital space 25.50–31.11 (M = 28.53).

Body elongate and compressed. Mouth slightly oblique. Upper jaw prominent, snout slightly pointed. Maxilla nearly reaching to hind border of opercle. Interorbital space with the median ridge, eye covered with the membrane. Belly with keeled scutes, (13–16) + (8–9) = 21–25. Gill rakers on first arch (18–21) + (22–24) = 40–45. Very small teeth in jaws, palatine, pterygoid, vomer and tongue. A very small spine before the dorsal fin origin. Axillary scale present at pectoral and pelvic fins axis. Caudal fin deeply forked.

Scales: Scales in lateral series 34–38; in transverse series 10–11. Scales present all over the body including at dorsal, anal, caudal, pectoral and pelvic fins base.

Colour: 4–5 rows of scales on back greyish-brown, other portion of the dorsal profile and ventral profile shining silvery. Black venule on shoulder region. Distal half of dorsal and caudal fins dusky black. Other fins colourless.

Distribution: Malaysia, Indonesia, Thailand, Papua, Malayan Archipelago, Philippines, Pakistan, Sri Lanka and India: both east and west coasts.

<u>Other materials examined</u>: ZSI Nos. 2203 (90.0 mm SL) Orissa, F 7951/1 (91.0 mm SL) Orissa, F. Day Coll.

COHORT	: EUTELEOSTEI
SUPER ORDER	: OSTARIOPHYSI
SERIES	: ANOTOPHYSI
ORDER	: GONORHYNCHIFORMES
SUB ORDER	: CHANOIDEI

2.4.10. <u>FAMILY</u> : <u>CHANIDAE</u>

<u>Characters of taxonomic value</u>: Body elongate and compressed. Mouth small, cleft of mouth transverse. Maxilla short, lower jaw short with symphysial tubercle. Gill membrane entirely united ventrally. Lateral line present. Scales small, cycloid and absent on head. Supra-maxillae, tooth and gular plate absent. Pseudobranch present. Belly smooth. Paired fins with prominent axillary scale.

Family Chanidae is represented by a single monotypic genus in the Indo-Pacific area (Day, 1878; Weber and de Beaufort, 1913; Munro, 1955; Fischer and Whitehead, 1974; Misra, 1976).

<u>Chanos</u> Lacepede, 1803

<u>Chanos</u> Lacepede, 1803: 395.

Lutodeira van Hasselt, 1823: 333.

Scoliostomus Ruppell, 1828: 17.

Ptycholepis Gray, 1842: 218.

Lutodira Agassiz, 1846: 217.

Chanos chanos (Forsskal, 1775)

Plate 13.1

Mugil chanos Forsskal, 1775: 74.

Mugil salmoneus Bloch and Schneider, 1801: 421.

Chanos pala Day, 1865: 224.

Chanos salmoneus Gunther, 1868: 473; Day, 1878: 651.

Chanos chanos Jordon and Snyder, 1901: 52; Weber and de Beaufort, 1913: 15; Munro, 1955: 34; Fischer and Whitehead, 1974; Misra, 1976: 186.

Description: Based on 8 specimens ranging in size 109.0–272.0 mm SL (143.0–345.0 mm TL).

Fin formula: D. 13–14; A. 9; P. 14–15; V. 11; C. 28.

Body measurements expressed in percent of standard length: greatest body depth 23.57–26.83 (M = 24.66); head length 25.73–27.98 (M = 26.93); snout to D fin origin 50.00–52.75 (M = 51.32); snout to A fin origin 79.55–82.56 (M = 81.04); snout to pectoral fin fin origin 25.00–28.89 (M = 27.20); snout to pelvic fin origin 54.77–60.09 (M = 57.19); base D fin 12.86–13.46

(M = 13.23); base A fin 5.55-6.91 (M = 6.15); pectoral fin length 14.66-15.59 (M = 14.98); pelvic fin length 12.44-14.67 (M = 13.62); least depth of caudal peduncle 8.88-10.09 (M = 9.58).

In percent of head length: snout length 25.35-29.41 (M = 27.56); orbit diameter 22.85-27.86 (M = 25.49); least width of interorbital space 33.80-39.28 (M = 36.10).

Body elongated and compressed. Mouth small, terminal and the upper jaw prominent. Maxillae do not extend upto anterior margin of eyes. Interorbital space flat and broad. Eyes completely covered with adipose eyelids. Gill rakers on first arch 180-221 + 212-260 = 392-481. Teeth absent. Lateral line straight, extends upto caudal fin base. Pectoral and pelvic fins with very prominent axillary scales. Caudal fin deeply forked.

Scales: Lateral line scales 73-78; in transverse series 20-25. Scales small, present all over the body including on caudal fin. Prominent scale sheaths are visible at dorsal, anal, pectoral and pelvic fins base.

Colour: Body shining silvery with greenish-blue tinge on back. Preopercle and opercle silvery. Interorbital space and dorsal profile of the head are dull green. Caudal peduncle silvery. Dorsal and caudal fins dusky black. Other fins colourless.

Distribution: Through out the Indo-Pacific region. India: both east and west coasts.

Other material examined: ZSI No. F 1268/2 (73.0 mm SL) Karraikkal, Madras, A.G.K. Menon Coll.

SERIES : OTOPHYSI

ORDER : CYPRINIFORMES

SUB ORDER : CYPRINOIDEI

2.4.11. FAMILY : CYPRINIDAE

Characters of taxonomic value: Body oblong and moderately compressed; snout blunt or pointed. Mouth superior, terminal or distinctly inferior, usually protrusible and always toothless. Barbels absent, one or two pairs present. Lower pharyngeal teeth large and in several rows. Lateral line present. Gill membrane united with isthmus. Head scaleless. Single dorsal fin. Caudal fin deeply forked.

3 sub-families were recognized from India (Jhingran, 1982) of which a single sub-family was represented in the collections.

Key to sub-family

Abdomen rounded; lat. line in middle of body and often present in tail .... Cyprininae.

Sub-family: Cyprininae

Three genera of the sub-family Cyprininae are represented in Vembanad lake viz. *Amblypharyngodon*, *Puntius* and *Labeo*. A brief review on the literature on these groups of fishes show that Day (1878) reported 4 species under *Amblypharyngodon*, 70 species under *Barbus* and 25 species under *Labeo* from Indian waters. Most of the Indian authors who have described the members of the family Cyprinidae have used the generic name *Barbus* in the wide sense throughout their work. However, Menon (1963a) favoured the inclusion of different species of *Barbus* occurring in India into four genera viz., *Acrassocheilus* Oshima, *Hampala* Smith, *Puntius* Hamilton and *Tor* Hamilton. Since Day's account, a series of faunastic surveys were conducted in the rivers and lakes of Travancore which include comprehensive accounts of fishes of the family Cyprinidae (Pillay, 1929; John, 1936; Hora and Law, 1941; Raj, 1941; Hora and Nair, 1941; Silas, 1949, 1951).

Sobhana (1976) reported 7 species of the genus *Puntius* from the rivers and lakes of Trivandrum and adjacent areas.

Key to genera

1. Lat. line incomplete; barbels absent; mouth directed somewhat upwards with prominent lower jaw; silvery band along the midline .... *Amblypharyngodon* Bleeker.

Lat. line complete; barbels present; mouth terminal or inferior; no silvery band along midline ....2.

2. Mouth slightly subterminal, rostrum not prominent, not covered with tubercles; lips thin and not fleshy, not papillate; dorsal spine osseous or non osseous .... *Puntius* Hamilton-Buchanan.

Mouth distinctly inferior; rostrum very prominent, covered with tubercles; lips thick and fleshy, often papillate; no ossified spine to fins .... *Labeo* Cuvier.

Amblypharyngodon Bleeker

Amblypharyngodon Bleeker, 1859: 433.

Key to species

Body depth 22.85–25.97% in SL; gill rakers on first arch 16–17; scales in lat. series 34–38 in tr. series 14–16; silvery lateral band; dorsal and caudal fins dusky .... *Amblypharyngodon mola* Hamilton-Buchanan.

Amblypharyngodon mola (Hamilton-Buchanan, 1822)
Plate 13.2

Cyprinus mola Hamilton-Buchanan, 1822: 334.
Amblypharyngodon mola Day, 1878: 555; Babu and Nair, 1978: 123; Jhingran, 1982: 16.

Description: Based on 20 specimens ranging in size 47.0–88.0 mm SL (63.0–108.0 mm TL).

Fin formula: D. 11, 7; A. 111, 4–5; P. 14; V. 9; C. 24.

Body measurements expressed in percent of standard length: greatest body depth 22.85–25.97 (M = 24.62); head length 26.50–28.86 (M = 27.71); snout to D fin origin 54.43–57.57 (M = 55.83); snout to A fin origin 66.46–70.21 (M = 69.03); snout to pectoral fin origin 24.43–27.83 (M = 25.91); snout to pelvic fin origin

48.05–50.47 (M = 48.98); base D fin 9.61–12.76 (M = 10.73); base A fin 9.23–11.70 (M = 10.29); pectoral fin length 15.24–17.44 (M = 16.74); pelvic fin length 13.63–15.95 (M = 15.08); D fin height 19.59–24.46 (M = 21.71); A fin height 13.51–17.26 (M = 15.46); least depth of caudal peduncle 11.03–12.76 (M = 12.01).

In percent of head length: snout length 26.66–30.55 (M = 28.66); orbit diameter 22.22–28.57 (M = 26.70); least width of interorbital space 33.33–39.02 (M = 36.33).

Body slender, elongated and compressed. Mouth superior, snout pointed. Cleft of mouth oblique, hind tip of maxillae ends in front of eyes. Gill rakers on first arch 2 + (14–15) = 16–17. Lateral line incomplete, cease at 14–16 scales. Caudal fin deeply forked.

<u>Scales</u>: In lateral series 34–38; in transverse series 14–16. Scales small, present on body, absent on head.

<u>Colour</u>: Dorsal profile dull green, ventral profile bright silvery. Opercle silvery. Silvery lateral stripe along the midline of the body with golden yellow reflection in very fresh condition. Dorsal and caudal fins dusky black. Other fins colourless.

Distribution: Sind throughout India: Assam and Burma.

Other material examined: ZSI Nos. 1182/1 (37.0 and 40 mm SL) Bengal, Acad. Nat. Sci. Philad. Exch.; F 2044/2 (44.0 mm SL) Assam, S.L. Hora Coll.

Remarks: Menon (1974) reported that *A. mola* does not occur in Malabar, Pakistan, Bangladesh and Burma. Three new species of fishes of the genus *Amblypharyngodon* have been described from India since Day's (1878) faunastic survey (Chaudhuri, 1912; Malhotra and Dutta, 1975; Babu and Nair, 1978).

Puntius Hamilton-Buchanan, 1822

Barbus Cuvier and Valenciennes, (part).
Puntius Hamilton-Buchanan, 1822: 310.
Lissochilus Weber and de Beaufort, 1916: 167.

Key to species

1. Dorsal osseous spine smooth; a single pair of barbels ....2.

Dorsal osseous spine serrated; two pairs of barbels ....3.

2. Gill rakers on first arch 8-11; barbel length less than half of eye diameter; caudal black blotch

covers the scales 15-18 of the lat. line .... *Puntius filamentosus* (Valenciennes).

Gill rakers on first arch 20-24; barbel length more than half of eye diameter; caudal black blotch covers the scales 22-24 of the lat. line .... *Puntius amphibius* (Valenciennes).

3. Gill rakers on first arch 7-10; orange red spot on opercle; black blotch on caudal peduncle .... *Puntius sarana* (Hamilton-Buchanan).

Puntius filamentosus (Valenciennes, 1831)
Plate 14.1

Leuciscus filamentosus Cuvier and Valenciennes, 1831: 492.

Leuciscus mahecola Cuvier and Valenciennes, 1844: 305.

Puntius filamentosus Day, 1865: 215; Munro, 1955: 44; Menon, 1967: 147; Sobhana, 1976: 45.

Barbus filamentosus Day, 1878: 582.

Description: Based on 25 specimens ranging in size 72.0-134.0 mm SL (96.0-170.0 mm TL).

Fin formula: D. IV, 8; A. III, 4-5; P. 14-15; V. 8; C. 24.

Body measurements expressed in percent of standard length: greatest body depth 30.55-35.98 (M =

33.24); head length 23.16–27.08 (M = 25.43); snout to D fin origin 48.19–52.77 (M = 50.28); snout to A fin origin 73.77–77.77 (M = 75.32); snout to pectoral fin origin 23.98–27.77 (M = 25.48); snout to pelvic fin origin 49.62–53.07 (M = 51.22); base D fin 15.90–17.46 (M = 16.82); base A fin 6.96–8.98 (M = 8.43); pectoral fin length 17.62–20.83 (M = 19.10); pelvic fin length 17.25–20.48 (M = 19.14); D fin height (female) 18.10–23.00 (M = 21.51), (male) 29.80–45.78 (M = 34.66); A fin height 11.66–14.06 (M = 12.22); barbel length 1.51–3.61 (M = 2.11); least depth of caudal peduncle 12.34–14.06 (M = 13.52).

In percent of head length: snout length 30.98–33.33 (M = 31.47); orbit diameter 24.18–30.16 (M = 25.89); least width of interorbital space 37.68–41.66 (M = 39.86).

Body oblong and slightly compressed. Snout blunt. Mouth terminal, protrusible, upper jaw slightly prominent. Cleft of mouth oblique, hind tip of maxilla not reaching to vertical below anterior margin of eye. Interorbital space slightly convex. A single pair of nostrils in front of eyes. A single pair of barbels, situated very close to angle of mouth. Gill rakers on first arch (1–3) + (7–8) = 8–11. Lateral line concave anteriorly, straight below end of dorsal, reaching to caudal peduncle. Caudal fin deeply forked.

Scales: Lateral line scales 21-23; in transverse series 7-8. Scales present on body, absent on head.

Colour: Greenish above, silvery below. Scales above lateral line has pinkish-yellow reflections in fresh condition. Opercle silvery. Caudal fin has a red and black oblique stripe on each lobe, the terminal portion is colourless. A caudal black blotch covers the scales 15-18 of the lateral line. Paired fins colourless or intensely coloured.

Sexual dimorphism: *P. filamentosus* exhibits sexual dimorphism. The male of this species is very intensely coloured than to female. The males can be easily distinguished from females by the presence of tubercles on snout and the characteristic elongated first five dorsal fin elements. The tubercles are present only during the breeding period. The elongated structures of the dorsal fin are very blackish. Paired fins are slightly pinkish with dark edges.

Distribution: Sri Lanka, India-Coromandel coast, Peninsular India and Rivers of Kerala.

Other materials examined: ZSI Nos. 2178 (114.0 mm SL) Iadkali, F. Day Coll; F 2085/2 (74.0-77.0 mm SL) (3 eg.) Mahe, Kerala, P.K. Jacob Coll.

Remarks: Menon (1967) briefly described the disparities existed on the taxonomic position of *P. filamentosus*. Valenciennes (1844) described two identical similar species from South India viz., *Leuciscus filamentosus* and *L. mahecola*. Day (1865) observed that *L. mahecola* may be the young one of *L. filamentosus* but Gunther (1868) disagreed with the observation by Day. However, later workers concluded that *L. filamentosus* (=*P. filamentosus*) and *L. mahecola* are synonyms as they represent the male and female sexes respectively of the same species (Hora, 1937a, 1937b, Hora and Law, 1941). Menon (1967) conducted extensive studies on the specimens of Zoological Survey of India and a specimen from Sri Lanka and described the secondary sexual characters, which fully solved the disparities existed in the taxonomic position. He also concluded that the presence of barbels is found in all specimens irrespective of the sex. Thobias (1974) reported that the origin and growth of tubercles in males of *P. filamentosus* are closely related to the development and maturity of the testes. Similarly, the elongated dorsal rays are partly or completely lost after the spawning season.

Puntius amphibius (Valenciennes, 1842)

Plate 14.2

Cyprinus amphibia Cuvier and Valenciennes, 1842: 478; Bleeker, 1853: 62.

Puntius amphibius Jerdon, 1849: 315; Munro, 1955: 55.

Puntius hamiltoni Day, 1865: 213.

Barbus amphibius Gunther, 1870: 144; Day, 1878: 574.

Description: Based on 25 specimens ranging in size 68.0–103.0 mm SL (85.0–124.0 mm TL).

Fin formula: D. III, 8; A. III, 5; P. 14; V. 8; C. 24.

Body measurements expressed in percent of standard length: greatest body depth 26.15–31.45 (M = 28.06); head length 23.25–26.69 (M = 25.27); snout to D fin origin 47.67–51.42 (M = 48.29); snout to A fin origin 72.94–77.10 (M = 74.52); snout to pectoral fin origin 24.17–26.42 (M = 25.53); snout to pelvic fin origin 47.56–52.77 (M = 49.99); base fin 12.82–14.70 (M = 13.84); base A fin 5.81–7.92 (M = 6.82); pectoral fin length 16.50–20.71 (M = 18.41); pelvic fin length 14.23–17.85 (M = 15.96); D fin height 19.76–23.57 (M = 22.31); A fin height 13.23–14.83 (M = 14.31); barbel length 2.91–4.81 (M = 3.80); least height of caudal peduncle 11.17–13.23 (M = 12.41).

In percent of head length: snout length 27.50–32.43 (M = 30.09); orbit diameter 25.00–27.50 (M = 26.39); least width of interorbital space 35.13–40.54 (M = 38.50).

Body slender and elongate. Snout blunt. Mouth terminal, protrusible, cleft of mouth slightly oblique, hind tip of maxilla not reaching to vertical below anterior margin of eye. A notch present on occiput. Interorbital space convex. A single pair of nostrils in front of eyes. A single pair of barbels situated very close to angle of mouth. Gill rakers on first arch (13–15) + (7–9) = 20–24. Lateral line slightly concave anteriorly, reaching to caudal peduncle. Caudal fin deeply forked.

Scales: Lateral line scales 22–24; in transverse series 6–7. Scales present on body, absent on head.

Colour: Bluish-green, silvery below. Scales of dorsal profile with slight pinkish reflections in fresh specimens. Tip of dorsal, anal and caudal fins black. A caudal black blotch covers the scales 22–24 of the lateral line. A crimson band appears in both sexes along the lateral line during breeding season, in males this band extend as far as the forking of caudal fin. This is the 'breeding costume' of the species (Sobhana, 1976).

Distribution: Sri Lanka, India - Deccan, Bombay, Western coasts, Madras to Orissa and rivers of Kerala.

Other materials examined: ZSI No. F 13529/1 (74.0 mm SL) Travancore, C.C. John Coll.

Puntius sarana (Hamilton-Buchanan, 1822)
Plate 15.1

Cyprinus sarana Hamilton-Buchanan, 1822: 307.
Barbus pinnauratus Day, 1878: 561.
Barbus saranus Day, 1878: 560.
Puntius sarana Munro, 1955: 45; Jhingran, 1982: 17.

Description: Based on 18 specimens ranging in size 78.0-190.0 mm SL (100.0-240.0 mm TL).

Fin formula: D. IV, 8; A. III, 5; P. 15-16; V. 8; C. 26.

Body measurements expressed in percent of standard length: greatest body depth 31.05-36.77 (M = 34.70); head length 24.67-27.68 (M = 26.12); snout to

D fin origin 52.10–54.90 (M = 53.46); snout to A fin origin 73.46–77.37 (M = 75.62); snout to pectoral fin origin 23.68–27.00 (M = 25.85); snout to pelvic fin origin 48.02–53.89 (M = 50.81); base D fin 12.23–14.87 (M = 14.06); base A fin 7.43–10.26 (M = 8.86); pectoral fin length 18.59–19.88 (M = 19.17); pelvic fin length 15.50–17.56 (M = 16.85); D fin height 21.05–24.51 (M = 22.93); A fin height 13.95–16.25 (M = 15.40); rostral barbel length 4.26–6.81 (M = 5.63); maxillary barbel 5.44–8.33 (M = 7.01); least depth of caudal peduncle 13.68–15.28 (M = 14.18).

In percent of head length: snout length 28.67–32.00 (M = 29.47); orbit diameter 22.35–26.19 (M = 23.59); least width of interorbital space 38.09–42.66 (M = 40.72).

Body deep and oblong. Snout blunt. Mouth terminal and protrusible, upper jaw slightly prominent. Cleft of mouth oblique, hind tip of maxilla not reaching to vertical below anterior margin of eye. Interorbital space convex. A single pair of nostrils in front of eyes. Two pairs of barbels, the maxillary pair distinctly longer. Gill rakers on first arch (2–3) + (5–7) = 7–10. Lateral line with concavity anteriorly, reaching to caudal peduncle. Caudal fin deeply forked.

Scales: Lateral line scales 27-28; in transverse series 9-10. Scales present on body, absent on head.

Colour: Dorsal profile dull green, ventral profile silvery. Opercle with an orange red blotch. Scales of dorsal profile mottled with dark green colour, appearing like longitudinal lines. Lateral line shielded by black colour. Distal margin of dorsal and caudal fins blackish. Pectoral fin dusky. A black blotch on caudal peduncle.

Distribution: Freshwaters of India, Burma and Sri Lanka.

Other materials examined: ZSI No. F 5460/1 (124.0 mm SL) Pegu, F. Day Coll.

Remarks: Two subspecies of P. sarana were reported (Menon, 1963a) of which P. sarana subnasutus has been recorded from Kerala (Sobhana, 1976). The present specimen do not fully agrees with the description of P. sarana subnasutus.

Labeo Cuvier, 1817

Labeo Cuvier, 1817: 194.

Key to species

Lat. rostral lobes absent; lat. line scales 47-50; tr. scales 15-17; 2 pairs of barbels; gill rakers on first arch 66-73; crimson lunules midlaterally .... Labeo dussumieri (Valenciennes).

Labeo dussumieri (Valenciennes, 1842)
Plate 15.2

Rohita dussumieri Cuvier and Valenciennes, 1842: 238.
Labeo dussumieri Day, 1878: 538; Munro, 1955: 46.

Description: Based on 12 specimens ranging in size 196.0-282.0 mm SL (238.0-363.0 mm TL).

Fin formula: D. III, 11-12; A. III, 4; P. 16; V. 9; C. 26.

Body measurements expressed in percent of standard length: greatest body depth 25.00-28.72 (M = 26.28); head length 23.01-24.22 (M = 23.54); snout to D fin origin 43.18-45.54 (M = 44.66); snout to A fin origin 74.20-80.14 (M = 77.35); snout to pectoral fin origin 22.42-23.96 (M = 22.97); snout to pelvic fin origin 50.00-53.06 (M = 51.11); base D fin 21.64- 23.75 (M = 22.89); base A fin 6.70-9.33 (M = 7.32); pectoral fin length 17.17-18.85 (M = 17.77); pelvic fin length 16.16-17.26 (M = 16.59); D fin height 18.27-20.58 (M = 19.27); A fin height 15.87-17.42 (M = 16.86); least depth of caudal peduncle 12.11-13.12 (M = 12.47).

In percent of head length: snout length 36.17-40.51 (M = 37.36); orbit diameter 21.21-22.34 (M = 21.96); least width of interorbital space 45.74-53.26 (M = 50.58).

Body oblong, anterio-dorsal profile convex. Snout blunt with rather large tubercles which extendin nearly upto preorbital region. Mouth distinctly inferior, lips fleshy and fringed, with inner fold above and below. Rostral fold not well developed and does not cover upper lip. No lateral lobes, although a lateral groove is present. Both lips have a single row of large papillae along the outer edge, double row in middle of lower lip. A single pair of nostrils in front of eyes. Lateral line complete. Caudal fin deeply forked.

Scales: Lateral line scales 47-51; in transverse series 15-17. Scales present on body, absent on head.

Colour: Body shining silvery, dorsal profile olive green. The scales on dorsal profile are mottled with dull green, thus imparting lateral stripes. Smaller specimens with an indistinct black blotch on caudal peduncle. Crimson lunules midlaterally. Head dark green or pale yellow. Dorsal fin olive green. Caudal and pectoral fins dusky black. Other fins colourless.

Distribution: Freshwaters of Sri Lanka and India.

Other materials examined: ZSI No. 1132 (154.0 mm SL) Malabar, F. Day Coll.

ORDER : SILURIFORMES

3.4.12. FAMILY : BAGRIDAE

Characters of taxonomic value: Body elongate, posteriorly compressed. Head depressed, covered with shields or naked. Occipital process present. Snout blunt. Mouth at lower side, upper jaw prominent. Nostrils wide apart. Eyes with free orbital margin or subcutaneous. 3-4 pairs of barbels. Villiform band of teeth in jaws. Median groove on head present. Gill membrane free or unite with isthmus. Adipose dorsal fin present. Lateral line continuous, extends upto caudal fin base. Dorsal and pectoral fins with pungent serrated spines. Caudal fin forked.

The earliest comprehensive descriptions on bagrid fishes of India was by Day (1878) who described 23 species under the genus Macrones Dumeril.

Subsequently, Weber and de Beaufort (1913) described 8 species of fishes under the above genus from the Indo-Australian Archipelago. The recent comprehensive study on bagrid fishes of India and adjacent countries was by Jayaram (1952, 1953, 1955, 1956, 1960a, 1965, 1966, 1971, 1973, 1977a, 1977b, 1978) who conducted a series of revisions, and the disparities existed in the taxonomic position on this group of fishes were more or less solved. Other significant works on Bagrid fishes of India and adjacent countries include those by Hora (1937), Munro (1955), Misra (1962, 1976) and Sarkar (1964).

Key to genera

1. 4 pairs of barbels; pungent spine of pectoral fin stronger than dorsal spine; orbital margin free; gill membrane free from isthmus; ventral rays 6; palatine teeth uninterrupted ....2.

2. Lower margin of eye well above from the line with the angle of mouth, eyes invisible from below; maxillary and mandibulary barbels longer than head; pelvic fin not reaching to anal fin origin; anal fin short, less than 16 rays; palatine teeth in semilunar band; no black oval blotch behind the pointed opercular margin .... Mystus Scopoli.

Lower margin of eye in the same line with angle of mouth, eyes visible from below; all barbels shorter than head; pelvic fin reaching to anal fin origin; anal fin long, 26–28 rays; palatine teeth in subcrescentic transverse band; a distinct black oval blotch behind the pointed opercular margin .... Horabagrus Jayaram.

Mystus Scopoli, 1777

Mystus Gronov, 1763: 124.

Mystus Scopoli, 1777: 451; Hora, 1948: 72; Jayaram, 1960: 240; Misra, 1976: 72.

Macrones Dumeril, 1856: 484.

Hemibagrus Bleeker, 1862: 9.

Aspidobagrus Bleeker, 1862: 9.

Aorichthys Wu, 1939: 131.

Key to sub-genus

No distinct separate interneural shield between occipital process and basal bone of dorsal fin .... Mystus Scopoli.

Key to species

1. Occipital process not reaching to basal bone of dorsal; median longitudinal groove on head not

reaching to the occipital process ....2.

Occipital process reaching to basal bone of dorsal; median longitudinal groove on head reaching to the occipital process ....3.

2. Adipose dorsal base less than one third of interdorsal space; snout to adipose origin 69.28-76.19% in SL; orbit diameter 15.21-18.46% in HL; maxillary barbel extends upto pelvic end .... __Mystus__ (__Mystus__) __gulio__ (Hamilton).

Adipose dorsal base 1.5 times of interdorsal space; snout to adipose origin around 50.66% in SL; orbit diameter around 26.31% in HL; maxillary barbel extends upto middle of anal ....__Mystus__ (__Mystus__) __malabaricus__ (Jerdon).

3. Adipose dorsal base nearly equal to interdorsal space; snout to adipose origin 68.96-72.47% in SL; orbit diameter 23.72-28.57% in HL; maxillary barbel extends upto anal fin end; a prominent black spot at dorsal fin origin .... __Mystus__ (__Mystus__) __oculatus__ (Valenciennes).

__Mystus__ (__Mystus__) __gulio__ (Hamilton, 1822)

Plate 16.1

__Pimelodus__ __gulio__ Hamilton, 1822: 201.

Macrones gulio Day, 1878: 445; Weber and de Beaufort, 1913: 344; Munro, 1955: 55.

Mystus gulio Hora, 1939: 111.

Mystus (_Mystus_) _gulio_ Jayaram, 1953: 543; Misra, 1976: 90.

Description: Based on 19 specimens ranging in size 94.0–166.0 mm SL(120.00–210.0 mm TL).

Fin formula: D. I, 7; A. 12–14; P. I–7; V. 6; C. 28.

Body measurements expressed in percent of standard length: greatest body depth 25.17–30.71 (M = 27.42); head length 27.73–29.25 (M = 28.53); snout to D fin origin 38.56–42.16 (M = 39.79); snout to adipose fin origin 69.28–76.19 (M = 73.59); snout to A fin origin 66.66–70.27 (M = 68.63); snout to pectoral fin origin 25.46–27.77 (M = 26.44); snout to pelvic fin origin 52.99–57.43 (M = 55.37); base D fin 9.18–12.16 (M = 11.28); base A fin 12.26–16.43 (M = 14.34); pelvic fin length 12.39–14.96 (M = 13.82); dorsal spine length 11.94–14.18 (M = 13.16); pectoral spine length 15.60–18.00 (M = 16.96); barbels: maxillary 54.16–62.96 (M = 57.26); mandibulary 27.77–33.33 (M = 30.16); mental 13.83–18.36 (M = 17.09); nasal 11.34–17.02 (M = 13.24); least depth of caudal peduncle 12.06–13.29 (M = 12.59).

In percent of head length: snout length 35.29–42.10 (M = 38.62); orbit diameter 15.21–18.46 (M = 17.01); least width of interorbital space 38.09–44.44 (M = 42.12).

Body elongate, caudal peduncle laterally well compressed. Head depressed, snout blunt, interorbital space flat. Mouth terminal, upper jaw slightly longer. Upper surface of the head granular. Shallow lanceolate median groove on head, reaching upto hind border of eye. Occipital process not reaching to basal bone of dorsal. Four pairs of barbels. Maxillary reaches end of pelvic fin, mandibulary reaches middle of pectoral fin, mental reaches slightly behind gill opening and nasal reaches to the preopercle. Gill rakers on first arch (10–12) + (33–36) = 43–48. Villiform teeth in band in jaws, narrow crescentic band of teeth in palate. Dorsal spine serrated posteriorly, pectoral spine strong and pungent with serrations on posterior margin. Caudal fin forked.

<u>Colour</u>: Body uniformly greyish brown, underside of head and body dull white. Head black. Distal margin of dorsal, anal, pectoral, caudal and adipose fins black. Ventral fin slightly yellowish. Maxillary barbels black.

Distribution: Malay Archipelago, Sri Lanka, Sumatra, Siam, Pakistan, Bangladesh and India: east and west coasts.

Other materials examined: ZSI Nos. 780 (97.0 mm SL) Bombay, 1082 (93.0 mm SL) Irrawady, 1083 (86.0 mm SL) Burma, 1165 (93.0 mm SL) Bombay, F. Day Coll.

Mystus (Mystus) malabaricus (Jerdon, 1849)
Plate 16.2

Bagrus malabaricus Jerdon, 1849: 338.
Macrones malabaricus Day, 1878: 450; Hora, 1937: 19.
Mystus (Mystus) malabaricus Jayaram, 1953: 544; Misra, 1976: 93.

Description: Based on one specimen, 75.0 mm SL (95.0 mm TL).

Fin formula: D. I, 7; A. 9; P. I, 6; V. 6; C. 28.

Body measurements expressed in percent of standard length: greatest body depth 21.33; head length 25.33; snout to D fin origin 37.33; snout to adipose fin origin 50.66; snout to A fin origin 68.66; snout to pectoral fin origin 23.33; snout to pelvic fin origin 47.99; base D fin 16.66; base A fin 12.66; pelvic fin length 14.66; dorsal spine length 11.33; pectoral spine length

11.66; barbels: maxillary 77.33; mandibulary 35.99; mental 23.33; nasal 17.99; least depth of caudal peduncle 11.99.

In percent of head length: snout length 42.10; orbit diameter 26.31; least width of interorbital space 39.47.

Body elongate, caudal peduncle laterally well compressed. Head depressed, snout rounded, interorbital space slightly concave. Mouth terminal, upper jaw slightly longer. Upper surface of head smooth, median groove not reaching upto occipital process. Occipital process not reaching to basal bone of dorsal. Four pairs of barbels. Maxillary reaching to middle of anal fin, mandibulary reaching to middle of the interspace between pectoral and pelvic fin origin. Mental barbel reaching to posterior end of pectoral fin, nasal reaching to just behind eye. Gill rakers on first arch 9 + 33 = 42. Villiform teeth in band in jaws, crescentic patch on palate. Dorsal spine serrated posteriorly in its distal half; pectoral spine strong and pungent, serrated posteriorly. Caudal fin forked.

<u>Colour</u>: Greyish green above, dull white below. Head slightly blackish. A prominent dark band along the

mid line of the body, ending in the caudal peduncle with a black blotch. Distal half of dorsal and anal fins black. Caudal fin dusky. Other fins colourless. Maxillary barbels brown.

Distribution: Maharashtra, Cauvery river, Poona, Ratnagiri, Canara, Wayanad, Malabar and now from Vembanad lake.

Mystus (*Mystus*) *oculatus* (Valenciennes, 1839)
Plate 16.3

Bagrus oculatus Valenciennes, 1839: 424.
Macrones oculatus Day, 1878: 448; Hora, 1941: 238;
Mystus (*Mystus*) *oculatus* Jayaram, 1953: 540; Misra, 1976: 99.

Description: Based on 25 specimens ranging in size 72.0–113.0 mm SL (94.0–144.0 mm TL).

Fin formula: D. I,7; A. 11–13; P. I,7; V. 6; C. 26.

Body measurements expressed in percent of standard length: greatest body depth 22.94–25.33 (M = 24.92); head length 23.86–26.66 (M = 24.93); snout to D fin origin 36.36–40.60 (M = 37.83); snout to adipose fin origin 67.70–71.11 (M = 69.51); snout to A fin origin 68.96–72.47 (M = 70.64); snout to pectoral fin origin 22.11-25.78 (M = 23.84); snout to pelvic fin origin 48.27-52.28 (M = 50.56); base D fin 13.52-16.36 (M = 15.50); base A fin 12.49-14.41 (M = 13.46); pelvic fin length 14.60-17.36 (M = 16.10); dorsal spine length 13.76-17.30 (M = 12.45); pectoral spine length 15.29-17.30 (M = 16.72); barbels: maxillary 72.84-78.35 (M = 72.76); mandibulary 26.37-37.64 (M = 34.06); mental 16.23-21.59 (M = 19.50); nasal 13.19-21.83 (M = 16.80); least depth of caudal peduncle 9.19-11.45 (M = 11.09).

In percent of head length: snout length 35.00-41.66 (M = 39.03); orbit diameter 23.72-28.57 (M = 25.93); least width of interorbital space 30.00-34.78 (M = 32.29).

Body elongate, caudal peduncle laterally well compressed. Head slightly depressed, snout blunt. Interorbital space flat. Mouth terminal, upper jaw slightly longer. Occipital region rather concave. Upper surface of the head not smooth, median longitudinal groove reaching to occipital process. Occipital process reaching to basal bone of dorsal. Four pairs of barbels. Maxillary reaching to middle of anal, mandibulary reaching to pelvic fin end, mental reaching to gill opening and nasal slightly behind eye.

Gill rakers on first arch (5-6) + (18-20) = 23-26. Villiform teeth in band in jaws, continuous crescentic band in palate. Dorsal spine pungent, three distinct serrations on the distal anterior margin, three fourth of the posterior margin well serrated. Caudal fin forked.

Colour: Upper profile brownish with golden yellow reflection, ventral profile and underside dull white. Opercle and nape with golden yellow colour in fresh condition. Caudal peduncle silvery. A black spot at the commencement of dorsal fin, its tip black and another black streak along its middle portion. Caudal pectoral and pelvic fins yellowish. Adipose dorsal black. Distal half of anal fin black.

Distribution: Coimbatore, Malabar and now from Vembanad lake.

Horabagrus Jayaram, 1955.

Horabagrus Jayaram, 1955: 261.

Horabagrus - monotypic

Horabagrus brachysoma (Gunther)

Plate 16.4

Pseudobagrus brachysoma Gunther, 1864: 86; Jayaram, 1952: 982; Misra, 1976: 109.

Pseudobagrus chryseus Day, 1865: 290.

Macrones chryseus Day, 1878: 443; Hora and Law, 1941: 254.

Horabagrus brachysoma Jayaram, 1955: 261.

Description: Based on 12 specimens ranging in size 153.0–243.0 mm SL (187.0–300.0 mm TL).

Fin formula: D. I,6; A. 26–28; P. I,6; V. 6; C. 24.

Body measurements expressed in percent of standard length: greatest body depth 26.14–31.25 (M = 28.76); head length 27.98–30.67 (M = 29.67); snout to D fin origin 38.27–40.82 (M = 39.30); snout to adipose fin origin 80.39–84.07 (M = 81.59); snout to A fin origin 63.39–66.27 (M = 64.59); snout to pectoral fin origin 24.20–28.12 (M = 26.53); snout to pelvic fin origin 51.59–54.60 (M = 53.88); base D fin 8.84–10.65 (M = 9.67); base A fin 24.26–26.54 (M = 25.27); pelvic fin length 11.11–13.43 (M = 12.70); dorsal spine length 14.81–17.79 (M = 16.58); pectoral spine length 16.99–19.82 (M = 18.33); barbels: maxillary 15.33–19.91 (M = 18.24); mandibulary 14.64–17.45 (M = 16.89); mental 9.81–14.91 (M = 11.44); nasal 11.25–15.28 (M = 13.19); least depth of caudal peduncle 10.69–11.46 (M = 11.11).

In percent of head length: snout length 38.46–41.17 (M = 39.60); orbit diameter 16.17–18.18

(M = 17.25); least width of interorbital space 52.17-61.36 (M = 54.35).

Body elongate and laterally compressed. Head well depressed and granulated on upper surface. Interorbital space broad and flat. Mouth terminal and transverse, upper jaw slightly larger. Cleft of mouth not reaching to anterior margin of eye. Shallow longitudinal median groove on head, reaching to hind border of eye. Occipital process reaching to basal bone of dorsal. Four pairs of barbels, none of them longer than head. Gill rakers on first arch (12-13) + (30-31) = 42-44. Villiform teeth in jaws, in narrow subcrescentic transverse band across the palate. Pectoral spine stronger than dorsal, denticulated posteriorly. Caudal fin forked.

Colour: Body uniformly golden yellow, back with slight greenish tinge. Belly dull white. Head dusky black with golden yellow reflections. A distinct oval black blotch behind the pointed opercular margin. Dorsal fin black in its distal margin. Caudal fin yellowish, base and tip blackish. Tip of anal fin fringed with black. Pectoral fin dusky black. Pelvic fin yellowish.

Distribution: Strictly endemic in the rivers of Central Kerala and now from southern most region of Vembanad lake.

Other material examined: ZSI No. 502 (114.0 mm SL) Canara, F.Day Coll.

Remarks: H. brachysoma have very good resemblances with the members of the genus Pseudobagrus, which is very endemic in Japan and China. Prior to the creation of the genus Horabagrus, this species was placed under Pseudobagrus Bleeker (Gunther, 1864; Day, 1865; Jayaram, 1952). Misra did not examined any species of the genus Pseudobagrus from Japan and China and so he (1976) had erroneously synonised Horabagrus under the genus Pseudobagrus (Jayaram, personal communication).

2.4.13. FAMILY : SILURIDAE

Characters of taxonomic value: Body elongated and compressed. Head well depressed, covered with skin. Mouth terminal. Nostrils wide apart. Villiform teeth in jaws and vomer. Usually two pairs of barbels. Adipose dorsal fin absent. Scales absent. Lateral line complete. Dorsal fin present or absent. Anal fin long, nearly reaches upto caudal fin origin. Gill membrane free from isthmus. Caudal fin deeply forked.

Literature regarding the taxonomic revision of this group of fishes are scanty. At present level there is the occurrence of 3 genera in Indian waters. The generic status of Wallago Bleeker have explained by

Hora (1936) and also suggested that it has priority over all other names proposed. There is only a single species under *Wallago* in India (Day, 1878; Misra, 1976). Day (1878) described 7 species under the genus *Callichrous* Hamilton-Buchanan from India and Weber and de Beaufort (1913) listed 3 species from Indo-Australian Archipelago. But Jayaram (1960b) elucidated that *Ompok* Lacepede supplants *Callichrous* hence it was the former name. Other notable works on the taxonomy of fishes of the family Siluridae are those of Hora (1936), Misra (1976) and Jayaram (1977a, 1977b, 1977c).

Key to genera

Gill rakers more than 20; cleft of mouth reaches far behind eye; mouth located below the level of eye ... . *Wallago* Bleeker.

Gill rakers less than 15; cleft of mouth situated far before eye; mouth located above or at the level of eye .... *Ompok* Lacepede.

Wallago Bleeker, 1851

Wallago Bleeker, 1851: 198.
Wallagonia Myers, 1938: 98.

The genus *Wallago* is represented by a single species in the Indian region.

Wallago attu (Schneider, 1801)

Plate 17.1

Silurus attu Schneider, 1801: 378.

Silurus boalis Hamilton, 1822: 154.

Silurus mulleri Bleeker, 1846: 198.

Wallago attu Gunther, 1864: 36; Day, 1878: 479; Weber and de Beaufort, 1913: 201; Hora and Misra, 1938: 23; Munro, 1955: 49; Misra, 1976: 206.

Wallagonia attu Hora and Misra, 1943: 221;

Description: Based on 8 specimens ranging in size 3[illegible]2.0–385.0 mm SL (333.0–435.0 mm TL).

Fin formula: D. I,4; A. 77–86; P. I, 12–13; V. 9; C. 18.

Body measurements expressed in percent of standard length: greatest body depth 15.73–19.74 (M = 17.61); head length 21.62–24.15 (M = 22.76); snout to D fin origin 26.63–28.8[illegible] (M = 28.[illegible]1); snout to A fin origin 39.[illegible]4–42.59 (M = 40.23); snout to pectoral fin origin 22.[illegible]5–23.89 (M = 22.79); snout to pelvic fin origin 35.[illegible]9–36.1[illegible] (M = 35.59); base D fin 1.65–1.81 (M = 1.71); base A fin 54.54–62.25 (M = 59.15); height of D fin 13.90–16.62 (M = 15.32); pectoral fin length 13.24–14.54 (M = 13.84); pelvic fin length 6.[illegible]8–8.05 (M = 7.33); barbels: maxillary 38.44–45.22 (M = 42.01); mandibulary 6.62–8.57 (M = 7.49); least depth of caudal peduncle 3.97–4.67 (M = 4.37).

In percent of head length: snout length 37.63–41.17 (M = 39.03); orbit diameter 10.75–13.97 (M = 12.56); least width of interorbital space 39.70–41.55 (M = 40.63).

Body elongate, laterally well compressed. Head slightly depressed. Inter orbital space flat. Snout blunt. Mouth oblique, cleft of mouth reaching behind eye. Eyes covered with skin. 2 pairs of barbels, maxillary reaching behind anal fin origin, mandibulary reaching behind the cleft of mouth. Gill rakers on first arch (5–6) + (17–19) = 22–25. Pointed teeth in bands in jaws, in two patches in vomer. No teeth on palate. Lateral line extends upto caudal fin base. Dorsal fin small, spineless. Anal fin long, not confluent with caudal fin. Pectoral fin with weak flexible spine, serrated internally. Caudal fin forked, upper lobe long and rounded, lower lobe small and pointed.

Colour: Greenish brown above, dull white below. Head slightly black. Dorsal, anal and caudal fins dusky. Other fins colourless.

Distribution: Thailand, Java, Sumatra, Sri Lanka, Pakistan and throughout India.

Other materials examined: ZSI Nos. 458 (141.0 mm SL) Calcutta, 8301 (262.0 mm SL) history unknown, F. Day Coll.

Ompok Lacepede, 1803

Ompok Lacepede, 1803: 49.
Callichrous Hamilton, 1822: 149.
Siluroides Bleeker, 1858: 271.
Pseudosilurus Bleeker, 1858: 275.

Key to species

Anal not confluent with caudal; caudal forked, lobes rounded; maxillary barbel reaching to anal origin; pelvic rays 8; anal rays 60-69 .... Ompok bimaculatus (Bloch).

Ompok bimaculatus (Bloch, 1797)
Plate 17.2

Silurus bimaculatus Bloch, 1797: 17.
Callichrous bimaculatus Gunther, 1864: 45; Day, 1878: 476; Weber and de Beaufort, 1913: 209; Hora, 1936: 361; Hora and Misra, 1938: 23.
Ompok bimaculatus Fowler, 1937: 134; Munro, 1955: 49; Misra, 1976: 189.

Description: Based on 13 specimens ranging in size 103.0–203.0 mm SL (117.0–233.0 mm TL).

Fin formula: D. 4; A. 60–69; P. I, 11–12; V. 8; C. 18.

Body measurements expressed in percent of standard length: greatest body depth 19.27–22.22 (M = 21.31); head length 19.41–21.79 (M = 20.46); snout to D fin origin 31.09–33.16 (M = 31.85); snout to A fin origin 33.33–36.74 (M = 35.23); snout to pectoral fin origin 19.38–22.22 (M = 20.55); snout to pelvic fin origin 28.78–35.46 (M = 31.63); base D fin 0.97–1.51 (M = 1.30); base A fin 59.82–66.01 (M = 61.58); height of D fin 8.29–10.67 (M = 9.18); pectoral fin length 13.59–16.26 (M = 15.38); pelvic fin length 6.12–7.33 (M = 6.86); barbels: maxillary 28.71–35.54 (M = 31.43); mandibulary 4.14–7.69 (M = 5.76); least depth of caudal peduncle 5.33–5.98 (M=5.61).

In percent of head length: snout length 35.29–40.00 (M = 36.09); orbit diameter 12.19–17.64 (M = 14.33); least width of interorbital space 44.44–51.85 (M = 48.20).

Body elongate, laterally well compressed. Head slightly depressed. Mouth oblique, lower jaw slightly longer than upper jaw, cleft of mouth far before eye.

Eyes subcutaneous. 2 pairs of barbels, maxillary nearly reaches upto anal fin origin, mandibulary very short, reaching just behind postorbital margin. Gill rakers on first arch 3 + (8–9) = 11–12. Villiform teeth in bands in jaws, oval patches in vomer. No teeth on palate. Lateral line extends upto caudal base. Dorsal fin spineless. Anal fin long, not confluent with caudal fin. Pectoral fin with a strong spine, internally as well as posteriorly serrated. Caudal fin forked, lobes rounded.

Colour: Body brownish above with golden reflection, white below. Opercle yellowish. Head slightly blackish. Dorsal fin very black. Caudal anal and pectoral fins dusky black. Pelvic fin yellowish. Maxillary barbel brown. A black oval shoulder spot behind the upper posterior angle of the opercle.

Distribution: Indo-Australian Archipelago, Thailand includin Sri Lanka and India (Gujarat, Maharastra, Canara and Kerala).

Other material examined: ZSI No. 489 (338.0 mm SL) Canara, F. Day Coll.

2.4.14. FAMILY : HETEROPNEUSTIDAE

Characters of taxonomic value: Body elongate, posteriorly well compressed. Head depressed, dorsal and lateral parts covered with osseous plates. Accessory respiratory organ present, extends upto caudal region. Nostrils wide apart, anterior tubular, posterior slit like. Mouth terminal. Villiform teeth in band in jaws, as patches in vomer. Four pairs of barbels. Adipose dorsal fin absent. Scales absent. Lateral line complete. Dorsal fin spineless, pectoral fin with a strong spine. Anal long and reaches upto caudal fin, pelvic fin with 6 rays. Gill membrane free from isthmus. Caudal fin rounded.

Day (1878) described two species of fishes of this family under the genus Saccobranchus Cuvier and Valenciennes from India. Hora (1936) briefly reviewed the history of nomenclature of the genus Heteropneustes Muller by elucidating it's priority over other proposed names and also explained the desirability of the family Heteoropneustidae for accommodating this group of catfishes. Subsequent works on the survey reports and taxonomical studies on this family were those of Hora and Misra (1938) and Misra (1976).

The family Heteropneustidae is represented by a single genus in Indian region.

Heteropneustes Muller, 1839

Heteropneustes Muller, 1839: 243.

Saccobranchus Cuvier and Valenciennes, 1840: 399.

Clarisilurus Fowler, 1937: 133.

Key to species

Anal fin not confluent with caudal fin; dorsal fin with 6 rays; anal fin with 60–65 rays .... Heteropneustes fossilis (Bloch).

Heteropneustes fossilis (Bloch, 1794)

Plate 17.3

Silurus fossilis Bloch, 1794: 46.

Saccobranchus singio Hamilton, 1822: 147; Gunther 1864: 50.

Saccobranchus fossilis Gunther, 1864: 51; Day, 1878: 486.

Heteropneustes fossilis Hora, 1936: 202; Hora and Misra, 1938: 23; Munro, 1955: 50; Misra, 1976: 135.

Description: Based on 12 specimens ranging in size 87.0–245.0 mm SL (98.0–279.0 mm TL).

Fin formula: D. 6; A. 60–65; P. I,[illegible]; V. 6; C. 20.

Body measurements expressed in percent of the standard length: greatest body depth 15.9[illegible]–19.07 (M = 17.26); head length 18.36–20.11 (M = 19.17); snout to D fin origin 31.43–35.71 (M = 33.06); snout to A fin origin 37.49–42.51 (M = 39.43); snout to pectoral fin origin 15.91–18.51 (M = 17.49); snout to pelvic fin origin 31.94–34.29 (M = 33.09); base D fin 4.48–6.42 (M = 5.59); base A fin 57.40–60.91 (M = 58.90); height of D fin 11.02–14.81 (M = 13.02); pectoral spine length 9.38–12.03 (M = 10.76); pelvic fin length 9.09–11.11 (M = 9.98); barbels: maxillary 35.22–45.39 (M = 41.21); mandibulary 28.16–38.07 (M = 33.20); mental 22.72–33.02 (M = 27.91); nasal 24.48–32.11 (M = 27.95); least depth of caudal peduncle 4.83–6.32 (M = 5.73).

In percent of head length: snout length 35.55–42.45 (M = 40.94); orbit diameter 14.28–19.19 (M = 17.86); least width of interorbital space 49.99–57.57 (M = 53.73).

Body elongate, laterally well compressed. Head well depressed. Interorbital space flat and broad. Snout rounded. Mouth transverse. 4 pairs of barbels, maxillary reaching behind anal fin origin, mandibulary reaching to middle of pelvic fin, mental nearly reaching to pelvic fin origin. Nasal reaching upto just in front of dorsal fin origin. Gill rakers on first arch (5–7) + (24–26) = 29–33. Villiform teeth in band in jaws, in two pyriform patches in vomer. No teeth on palate. Lateral line extends upto caudal fin base. Dorsal fin spineless. Anal fin long, not confluent with caudal fin. Pectoral fin with a strong spine, serrated behind. Caudal fin rounded.

Colour: Body uniformly dark brown, underside dull white. Anal and caudal fins very blackish. Dorsal, ventral and pectoral fins dusky black. Barbels black. Juveniles reddish brown.

Distribution: Thailand, Sri Lanka, Bangladesh, Nepal and India.

Other materials examined: ZSI Nos. Dup. Cat. 7 and 9 (104.0 mm and 105.0 mm SL) Burma, Dup. Cat. 145 (150.0 mm SL) Mergui (Burma), F. Day Coll.

2.4.15. FAMILY: ARIIDAE

Characters of taxonomic value: Body elongate, posteriorly compressed. Head depressed, covered with bony shield. Mouth inferior, snout not pointed. Nostrils close together, separated by the flap like structure of the posterior nostril. Teeth on palate conical, villiform, granular or absent. Jaw teeth are fine and in bands or patches. One to three pairs of barbels. Adipose dorsal fin present. Scales absent. Lateral line complete. Dorsal fin short with a serrated pungent spine and 7 rays. Pectoral with serrated pungent spine. Pelvic fin with 6 rays. Caudal fin forked.

The correct nomenclature of this family is still in confusion. Some authors (Weber and de Beaufort, 1913;

Hardenberg, 1936; Fischer and Whitehead, 1974) used Ariidae and *Arius* and others (Chandy, 1953; Munro, 1955; Misra, 1962, 1976; Talwar, 1971a) employed Tachysuridae and *Tachysurus*. However, Jayaram and Dhanze (1978b) reviewed the history of the nomenclature of the family and genus of this group of catfishes and elucidated that the family name Ariidae and the genus name *Tachysurus* Lacepede are valid based on the law of priority. Phylogenetically, Ariidae has been considered as advanced (Greenwood *et al.*, 1966) but some evolutionary biologists have opined (Srinivasachar, 1958) that they are primitive and not specialized.

The taxonomical studies on this group of Siluroid fishes of India was initiated by Hamilton-Buchanan (1822) who recorded 6 species of fishes, which are now referable to the family Ariidae. Day (1878) reported 23 species under the genus *Arius* from Indian waters. In addition to the 29 species of fishes of the genus *Arius* listed by Weber and de Beaufort (1913), Hardenberg (1936) described one new species and two rare species from the Indo-Australian Archipelago. Based on the pattern of palatine teeth bands Chandy (1953) prepared the momentous key for Tachysurid fishes of India and also catalogued them at Z.S.I. Calcutta. Subsequently, Misra (1962, 1976), Talwar (1971a, 1976), Jayaram and Dhanze (1978a, 1978b) and Dhanze and Jayaram (1979) contributed much to the taxonomy of Tachysurid fishes of India by which the systematic position of most of the little known fishes were explained. At present level there is the occurrence of 5 genera under the family Ariidae and 22 species under the genus Tachysurus in Indian waters.

Key to genus

Three pairs of fleshy barbels; upper jaw longer than lower jaw; villiform teeth in bands in the jaw; palate toothed .... Tachysurus Lacepede.

Tachysurus Lacepede, 1803

Tachysurus Lacepede, 1803: 150.
Galeichthys Valenciennes, 1840: 28.
Arius Valenciennes, 1840: 53.
Hexanematichthys Bleeker, 1858: 61.
Pseudarius Bleeker, 1863: 91.

Key to species

Maxillary barbel reaching upto pectoral origin; snout length 36.5-42.0% in HL; palatine teeth granular and globular in longitudinal semitriangular patches on either side, separated from the premaxillary band of teeth by a distance equal to the width of premaxillary band; premaxillary band of teeth 4 times as long as broad; median longitudinal groove on head not reaching base of occipital process .... *Tachysurus maculatus* (Thunberg).

Barbels short, not reaching behind eye; snout length 42.5-47.0% in HL; palatine teeth villiform, in one oval patches on either side, separated from premaxillary band of teeth by a distance of twice of its length; median longitudinal groove on head reaching base of occipital process .... *Tachysurus subrostratus* (Valenciennes).

Tachysurus maculatus (Thunberg, 1792)
Plate 18.1

Silurus maculatus Thunberg, 1792: 31.
Arius falcarius Richardson, 1844: 134; Gunther, 1864: 169; Day, 1878: 463; Raj, 1916: 264.
Arius maculatus Weber and de Beaufort, 1913: 284.
Tachysurus maculatus Fowler, 1941: 757; Munro, 1955: 53; Misra, 1976: 45; Jayaram and Dhanze, 1978: 48.

Description: Based on 25 specimens ranging in size 89.0-187.0 mm SL (108.0-224.0 mm TL).

<u>Fin formula</u>: D. I,7; A. 17–18; P. I, 1[illegible]; V. 6; C. 28.

Body measurements expressed on percent of standard length: greatest body depth 21.15–25.73 (M = 23.65); head length 26.44–29.41 (M = 28.33); snout to D fin origin 36.39–39.99 (M = 38.06); snout to adipose fin origin 72.79–77.77 (M = 75.07); snout to A fin origin 66.85–72.32 (M = 70.35); snout to pectoral fin origin 25.98–29.48 (M = 27.1[illegible]); snout to pelvic fin origin 52.20–57.05 (M = 54.91); base D fin 9.99–13.51 (M = 10.92); base A fin 14.32–17.61 (M = 15.70); pelvic fin length 14.52–20.04 (M = 16.79); dorsal spine length 17.3[illegible]–21.38 (M = 19.99); pectoral spine length 16.04–19.49 (M = 18.59); barbels: maxillary 25.76–32.[illegible]5 (M = 27.16); mandibulary 14.52–21.69 (M = 18.53); mental 11.17–14.28 (M = 11.65); least depth of caudal peduncle 6.26–8.75 (M = 8.17).

In percent of head length: snout length 36.88–42.22 (M = 41.12); orbit diameter 15.62–20.51 (M = 18.48); least width of interorbital space 46.66–52.45 (M = 51.2[illegible]).

Body elongate, caudal peduncle laterally well compressed. Head depressed, snout rounded. Mouth slightly inferior. Head shield granular. Median longitudinal groove on head, not reaching base of occipital process. Occipital process keeled, longer than wide at its base, reaching to the 'V' shaped basal bone of dorsal. Three pairs of barbels, maxillary reaching to pectoral origin, mandibulary reaching to gill opening and the mental barbel still shorter. Gill rakers on first arch (5-6) + (10-11) = 15-17. Palatine teeth in two semitriangular patches on either side, longer than wide, longitudinal and medially parallel. The anterior teeth of palate granular, posterior globular. Premaxillary teeth villiform, 4 times as long as wide, separated from the palatine by a distance equal to its width. Dorsal and pectoral spines strong and pungent, serrated anteriorly and posteriorly; first dorsal ray filamentoeus. Caudal fin forked.

Colour: Dorsal profile greyish blue with blue reflection. Ventral profile dull white. Caudal peduncle silvery. Dorsal fin dusky, elongated ray black. Caudal fin pale yellowish; distal forked margin black. Pectoral fin dusky. Anal fin yellowish. Adipose dorsal fin with a black spot. Pelvic fin flesh coloured.

Distribution: Hongkong, Formosa, Amoy, Canton, China, Japan, Pakistan, Bangladesh, Burma, Sri Lanka and India: both east and west coasts.

Other materials examined: ZSI Nos. 491 (161.0 mm SL) Malabar, 1115/1 (148.0 mm SL) Rangoon, F. Day Coll.

Remarks: *I. falcarius* (Richardson) is appears to be a synonym of *I. malaculatus*. I examined Day's materials of *I. falcarius* at Z.S.I. Calcutta and seems that it agrees well with the description of *I. maculatus*. Lenous (1968) described the morphology of the skull of *I. maculatus* collected from Cochin area.

Tachysurus subrostratus (Valenciennes, 1840)
Plate 18.2

Arius subrostratus Valenciennes, 1840: 62; Day, 1878: 461.
Tachysurus subrostratus Chandy, 1953: 12; Munro, 1955: 53; Misra, 1976: 65; Jayaram and Dhanze, 1978: 48.

Description: Based on 25 specimens ranging in size 68.0–222.0 mm SL (83.0–255.0 mm TL).

Fin formula: D. I,7; A. 17–18; P. I, 10; V. 6; C. 28–30.

Body measurements expressed in percent of standard length: greatest body depth 19.56–23.37 (M = 22.12); head length 29.41–34.06 (M = 31.60); snout to D fin origin 39.33–44.14 (M = 41.38); snout to adipose fin origin 73.13–79.56 (M = 76.2_); snout to A fin origin 69.33–76.34 (M = 72.40); snout to pectoral fin origin 27.14–33.53 (M = 30.85); snout to pelvic fin origin 54.28–59.28 (M = 56.88); base D fin 9.45–11.97 (M = 10.32); base A fin 11.76–15.99 (M = 13.13); pelvic fin length 14.66–18.63 (M = 16.44); dorsal spine length 19.99–22.72 (M = 20.99); pectoral spine length 16.66–19.16 (M = 17.66); barbels: maxillary 12.08–17.96 (M = 13.98); mandibular 8.38–10.34 (M = 9.78); mental 5.84–9.33 (M = 7.59); least depth of caudal peduncle 7.14–8.59 (M = 7.89).

In percent of head length: snout length 42.50–47.05 (M = 45.23); orbit diameter 18.18–23.91 (M = 21.72); least width of interorbital space 32.60–39.21 (M = 35.92).

Body elongate, caudal peduncle laterally well compressed. Head slightly depressed, snout elongated. Mouth slightly inferior. Head shield granular. Median longitudinal groove on head rather wide, reaching base of occipital process. Occipital process keeled, wider than long, reaching to narrow basal bone of dorsal. Three pairs of barbels, not reachin behind eye. Gill rakers on first arch (8–9) + (14–15) = 22–24. Palatine teeth villiform, in one oval patch on either side, equal to eye diameter and widely separated from each other by a distance 2.5 times of its length. Premaxillary band of teeth villiform, 5 times long as broad, separated by palatine patch by a distance 2.5 times of palatine length. Dorsal and pectoral spines strong and pungent, serrated anteriorly and posteriorly, first dorsal ray filamentosus. Caudal fin forked.

Colour: Dorsal profile bluish with silvery reflection. Ventral profile silvery white. Opercle and caudal peduncle silvery. Distal margin of dorsal fin black. Caudal fin dusky, forked margin black. Pectoral and anal fins dusky. Ventral fin flesh coloured.

Distribution: Sri Lanka, Malabar and Alleppey coasts of Southern India and now from Vembanad lake.

Other materials examined: ZSI Nos. Cat. 567 (145.0 mm SL); 480 (150.0 mm SL); 481 (110.0 mm SL); 1207 (148.0 mm SL) Canara, S. India, F. Day Coll.

SUPER ORDER	: SCOPELOMORPHA
ORDER	: MYCTOPHIFORMES
SUB ORDER	: MYCTOPHOIDEI

2.4.16. FAMILY : SYNODONTIDAE

Characters of taxonomic value: Body elongate, cylindrical. Adipose dorsal fin present. Head lizard like and usually scally. Mouth terminal, oblique and large. Cleft of mouth reaches far beyond eye. Teeth numerous, slender and sharp. Teeth present in palate and tongue. Caudal fin forked.

Day (1878) described two species of fishes of the genus *Saurida* Valenciennes from Indian waters and Weber and de Beaufort (1913) included one more species from Indo-Australian Archipelago. Norman (1936) in his revision of Lizard fishes of the Indo-Pacific area described five species of this genus and Misra (1949, 1976) reported three species from India and adjacent countries. Fischer and Whitehead (1974) listed ten species from Eastern Indian Ocean and Western Central Pacific. Subba Rao (1977) reported 4 species from Indian waters. Nanda (1980) recently conducted the systematic studies on Lizard fishes of Porto Novo waters and described five species. Dutt (1973) suggested that Synodidae is the best nomenclature for the family of Lizard fishes but the name Synodontidae is found to be used in recent literature (Fischer and Whitehead, 1974; Greenwood, 1975).

Key to genus

Outer rays of pelvic fin almost equal to inner rays; dorsal origin behind pelvic origin; a double bands of teeth on palate; caudal fin forked .... *Saurida* Valenciennes.

Saurida Valenciennes, 1849

Saurida Valenciennes, 1849: 499.

Key to species

Upper and lower jaws almost equal; outer band of palatine teeth in two rows anteriorly; ten dark blotches along the mid-line of body; dark dots on upper edge of caudal and first dorsal ray .... Saurida undosquamis (Richardson).

Saurida undosquamis (Richardson, 1848)
Plate 19.1

Saurus undosquamis Richardson, 1848: 138.

Saurida grandisquamis Gunther, 1864: 400; Weber and de Beaufort, 1913: 141; Fowler, 1938: 70.

Saurida undosquamis Norman, 1935: 131; Misra, 1949: 429, 1976: 296; Subba Rao, 1964: 265; Fischer and Whitehead, 1974.

Description: Based on one specimen, 133.0 mm SL (156.0 mm TL).

Fin formula: D. 12; A. 11; P. 14; V. 9; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 14.66; head length 24.43; snout to D fin origin 42.48; snout to A fin origin 77.06; snout to pectoral fin origin 24.43; snout to pelvic fin origin 38.34; base D fin 12.03; base A fin 6.39; pectoral fin length 12.03; pelvic fin length 17.66;

least depth of caudal peduncle 6.39.

In percent of head length: snout length 24.61; orbit diameter 15.38; least width of interorbital space 21.53.

Body elongated and cylindrical. Head depressed, snout rounded. Mouth oblique, cleft of mouth extending far behind orbit. Adipose eyelid present. Gill rakers rudimentary. Lateral line complete. Palate is having two bands of teeth; outer band in two rows anteriorly. Upper and lower jaws are having numerous minute fine teeth, the inner row is larger and outer row is rather smaller. Origin of dorsal behind ventral. The rays of ventral fin nearly uniform. Caudal fin forked.

Scales: Lateral line scales 47, in transverse series 9. Scales present all over the body, head and caudal fin base. Axillary scale present on pelvic fin axis.

Colour: Greyish brown on the dorsal profile, dull white below. Ten dark blotches along the midline of the body. Six dark dots on upper edge of caudal fin and five dots on first dorsal ray. The distal half of caudal and pectoral fins dusky. Pelvic fin yellowish.

Distribution: East and South Africa, Red Sea, Gulf of Oman, Zanzibar, Singapore, Indonesia, China, Japan, Philippines, North West Australia, Sri Lanka, Pakistan and India: east and west coasts..

Remarks: Subba Rao (1964) redescribed *S. undosquamis* based on the large number of specimens collected from Visakhapatnam, east coast of India and the present specimen agrees well with the above description. Ben-Yami and Glaser (1974) reported the invasion of *S. undosquamis* into the Levant Basin.

SUPER ORDER : PARACANTHOPTERYGII

SERIES : SALMOPERCOMORPHA

ORDER : BATRACHOIDIFORMES

2.4.17. FAMILY : BATRACHOIDIDAE

Characters of taxonomic value: Body robust, head broad and depressed. Mouth large, jaws and palate with conical teeth. Scales generally absent. Single lateral line. Two dorsal fins, first with 2-4 short pungent spines. Soft dorsal and anal fins with elongated base. Pelvic fin encased in thick skin. Caudal fin obtusely rounded.

It is well known that only two species of Toad fishes inhabit Indian waters (Day, 1878; Beaufort and Briggs, 1962; Menon, 1963b; Nagabhushanam and Rama Rao, 1970; Hutchins, 1981). A single species is represented in Vembanad lake.

<u>Key to genus</u>

A prominent foramen in the pectoral axil; gill cover with 3–4 spines; gill opening large .... *Austrobatrachus* Smith.

Austrobatrachus Smith, 1949

Austrobatrachus Smith, 1949: 423.

A single species of this genus is known from India (Menon, 1963b; Hutchins, 1981).

Austrobatrachus dussumieri (Valenciennes, 1837)
Plate 19.2

Batrachus dussumieri Valenciennes, 1837: 474; Gunther, 1861: 169.

Austrobatrachus dussumieri Menon, 1963: 1; Hutchins, 1981: 336.

Halophryne dussumieri Nagabhushanam and Rama Rao, 1970: 339.

<u>Description</u>: Based on 17 specimens ranging in size 43.0–168.0 mm SL (51.0–200.0 mm TL).

<u>Fin formula</u>: D. 111, 20–21; A. 14–16; P. 22; V. 1,2; C. 16.

Body measurements expressed in percent of standard length: greatest body depth 22.00–29.12 (M = 25.46); head

length 40.13–44.33 (M = 42.10); snout to D fin origin 35.18–39.58 (M = 37.36); snout to D_2 fin origin 48.83–53.29 (M = 50.12); snout to A fin origin 59.32–64.75 (M = 62.94); snout to pectoral fin origin 39.50–43.39 (M = 41.13); snout to pelvic fin origin 29.87–33.96 (M = 30.70); base D fin 7.37–10.37 (M = 9.01); base D_2 fin 40.98–48.75 (M = 44.47); base A fin 27.38–32.46 (M = 30.28); pectoral fin length 20.39–25.58 (M = 23.74); pelvic fin length 19.86–25.58 (M = 21.92); least depth of caudal peduncle 9.87–11.32 (M = 10.82).

In percent of head length: snout length 24.24–27.11 (M = 24.77); orbit diameter 17.72–23.68 (M = 19.95); least width of interorbital space 27.84–32.43 (M = 29.56).

Body robust, elongated, posteriorly compressed. Head broad and well depressed. Mouth large, gape of mouth slightly oblique. Hind tip of maxilla reaching to below posterior margin of eye. Interorbital space broad and flat. Preopercular margin with 3–4 spines. Wreath of tentacles on dorsal surface of head and chin. Gill rakers rudimentary. Pointed conical teeth, three rows in lower jaw a single row in upper jaw and palate. Lateral line nearly straight and reaching to caudal fin base. Pectoral fin rounded. Upper pectoral axil with a prominent foramen. Pelvic fin encased in a thick skin. Caudal fin obtusely rounded.

Colour: Brownish-black. 3-4 vertical black cross bands on body. Head dark brown. Fins blackish.

Distribution: Red Sea, Persian Gulf, Sri Lanka and West Coast of India.

Other materials examined: ZSI No. F 4277/2 (82.0-142.0 mm SL, 3 eg.) Raffles Museum, Singapore, A. G.K.Menon Coll.

SUPER ORDER	: ACANTHOPTERYGII
SERIES	: ATHERINOMORPHA
ORDER	: ATHERINIFORMES
SUB ORDER	: EXOCOETOIDEI

2.4.18. FAMILY : HEMIRAMPHIDAE

Characters of taxonomic value: Body elongate and cylindrical. Lower jaw often prolonged into a beak. Upper jaw short and triangular. Small teeth in jaws. Gill membrane free from isthmus. Scales cycloid. Nostril in a pit anterior to eye. Lateral line running down to pectoral origin and then running along the ventral margin of body. No spines in fins; dorsal and anal fins posteriorly placed, pelvic fin abdominal with 6 rays. Caudal fin rounded, truncate or forked.

Of the fishes of the family Hemiramphidae, Day (1878, 1889) reported 13 species from Indian waters;

Weber and de Beaufort (1922) described 32 species from Indo-Australian Archipelago; Smith (1949) listed 8 species from South Africa and Munro (1955) reported 6 species from Sri Lanka waters. The monumental contributions on Indo-Pacific halfbeaks were presented by Collette (1962, 1965, 1973, 1974, 1976) who conducted a series of revisions of the Synentognathia and also described so many new species from this area. Collette and Parin (1978) described 5 more new species of halfbeaks from Indo-West Pacific area. Very recently Parin *et al.* (1980) conducted a preliminary revision of the marine halfbeaks of the tropical Indo-West Pacific area and the disparities existed in many species were cleared. Kurup and Samuel (1985b) re-discovered the little known halfbeak *Hyporhamphus* (*H.*) *xanthopterus* from Vembanad lake and also presented a re-description of this species.

Key to genera

1. Nasal papilla elongate and pointed, extending well out of nasal fossa; caudal fin truncate; anal rays of males specialized .... *Zenarchopterus* Gill.

Nasal papilla fimbriate, rounded or fan shaped, mostly confined to the nasal fossa; caudal fin emarginate or well forked; anal rays of males not specialized ......2.

2. Upper jaw large and dome shaped; gill rakers on first arch 47–73; two dorsally directed branches of lateral lines; P–V distance much greater than V–C distance; preorbital without posterior branch; nasal papilla fimbriate .... Rhynchorhamphus Fowler.

Upper jaw flat or only slightly arched; gill rakers on first arch 19–33; one dorsally directed branch of lateral line; P–V distance much less than V–C distance; preorbital with or without posterior branch; nasal papilla rounded or fan shaped .... Hyporhamphus Gill.

Zenarchopterus Gill, 1863

Zenarchopterus Gill, 1863: 273.

Key to species

Triangular part of upper jaw broader than long; anal fin with 8–9 rays; 5th and 6th anal rays of males greatly elongated and modified; 5th and 6th dorsal rays of males elongated .... Zenarchopterus dispar (Valenciennes).

Zenarchopterus dispar (Valenciennes, 1846)

Plate 2[illegible].1

Hemiramphus dispar Valenciennes in Cuvier and Valenciennes, 1846: 58; Bleeker, 1854: 498; Gunther, 1866: 274; Day, 1878: 517.

Zenarchopterus dispar Ogilby, 1913: 92; Weber and de Beaufort, 1922; Munro; 1955: 73; Collette, 1974: 95.

Description: Based on 3 specimens ranging in size 97.5–102.5 mm SL (116.0–123.0 mm TL).

Fin formula: D. 11–12; A. 8–9; P. 8–9; V. 6; C. 18.

Body measurements expressed in percent of standard length: greatest body depth 13.65–14.35 (M = 14.[illegible]4); head length 25.64–26.26 (M = 25.91); upper jaw length 5.64–6.34 (M = 6.01); upper jaw width 5.85–6.15 (M = 6.02); lower jaw length 43.90–45.12 (M = 44.48); snout to D fin origin 78.97–80.97 (M = 80.24); snout to A fin origin 81.46–82.56 (M = [illegible]); snout to pectoral fin origin 27.69–29.29 (M = 28.42); snout to pelvic fin origin 68.71–71.21 (M = 69.72); P–V 41.[illegible]2–43.43 (M = 41.93); V–C 29.26–31.31 (M = 30.10); base D fin 17.56–19.19 (M = 18.4[illegible]); base A fin 7.07–7.8[illegible] (M = 7.34); pectoral fin length 18.04–18.46 (M = 18.22); pelvic fin length 7.69–8.08 (M = 7.85); least depth of caudal peduncle 6.82–7.17 (M = 7.02).

In percent of head length: snout length 35.85–36.50 (M = 36.11); orbit diameter 24.50–28.00 (M = 25.83); least width of interorbital space 30.10–34.60 (M = 32.23).

Body cylindrical, somewhat compressed. Head length nearly one-fourth of SL. Lower jaw much longer than head. Upper jaw distinctly wider than long. Interorbital space slightly concave. Nasal papilla elongated and pointed. Gill rakers on first arch (4–6) + (10–13) = 14–19. Teeth very small and tricuspid, 4–6 rows in jaws. Lateral line straight, reaching to caudal base. Either 4th and 5th or 5th and 6th dorsal rays elongated. Anal rays of 5th and 6th of males greatly elongated, reaching to caudal fin. Pelvic fin closer to caudal fin than to pectoral. Caudal fin rounded.

Scales: In lateral series 43–44; in transverse series 6–7. Scales present on triangular upper jaw, operculum, body and caudal fin base.

Colour: Silvery-greenish. Scales of back black. A silvery lateral stripe along the midline of the body, bordered above by black. Snout uniform brown. Opercle silvery. Dorsal, anal, caudal and pectoral fins dusky black. Pelvic fin colourless.

Distribution: New Caledonia, Fiji, Samoa, Solomon Islands, New Guinea, Australia, Sri Lanka and India including Andamans.

Other materials examined: ZSI Nos. 1255 (80.0 mm SL) Nicobar, 1301 (87.0 mm SL) Andamans, F. Day Coll.

Remarks: Collette's (1974) description of Z. dispar shows that the 6th and 7th anal rays of males are elongated but in the present specimens the 5th and 6th anal rays are elongated. Similarly, Collette (1974) mentioned that either dorsal ray 4 or 5 or both elongated and thickened but in the present study, out of the 3 specimens examined two of them have 5th and 6th dorsal rays elongated and in one specimen the 4th and 5th dorsal rays are elongated.

Rhynchorhamphus Fowler, 1928

Hemiramphus (Rhynchoramphus) Fowler, 1928: 75.
Loligorhamphus Whitley, 1931: 105.

Key to species

Upper jaw more highly domed; snout and upper jaw significantly longer; lower jaw length 47.46-48.05% in SL; gill rakers 52-67; dorsal with 13-15 rays; anal with 14-15 rays .... Rhynchorhamphus georgii (Valenciennes).

Rhynchorhamphus georgii (Valenciennes, 1846)

Plate 20.2

Hemiramphus georgii Valenciennes in Cuvier and Valenciennes, 1846: 37; Bleeker, 1853: 72.

Hemiramphus cantori Bleeker, 1866: 145.

Hemiramphus georgii Gunther, 1866: 264; Day, 1878: 515; Weber and de Beaufort, 1922: 147; Munro, 1955: 74.

Rhynchorhamphus georgii Seed, 1933: 57; Fowler, 1956: 146; Collette, 1974: 9?.

Description: Based on 3 specimens ranging in size 89.0–158.0 mm SL (105.0–178.0 mm TL).

Fin formula: D. 13–15; A. 14–15; P. 10; V. 6; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 7.36–1?.71 (M = 9.38); head length 23.?3–24.68 (M = 23.69); upper jaw length 6.64–6.81 (M = 6.73); upper jaw width 4.49–5.?6 (M = 4.69); lower jaw length 47.46–48.05 (M = 47.75); snout to D fin origin 75.28–79.11 (M = 77.43); snout to A fin origin 76.4?–79.22 (M = 78.24); snout to pectoral fin origin 24.71–25.94 (M = 25.32); snout to pelvic fin origin 66.29–7?.25 (M = 68.13); P–V 43.82–44.93 (M = 44.30); V–C 30.33–33.11 (M = 31.27); base D fin 14.55–16.85 (M = 15.87); base A fin 12.?2–13.48 (M = 12.82); pectoral fin length 12.35–12.98 (M = 12.76); pelvic fin length 6.49–6.74 (M = 6.62); least depth of caudal peduncle 4.49–5.51 (M = 5.02).

In percent of head length: snout length 43.90–44.87 (M = 44.40); orbit diameter 21.79–26.82 (M = 24.53); least width of interorbital space 24.35–27.70 (M = 26.29).

Body cylindrical. Head length nearly one-fourth of SL. Lower jaw length almost twice in length of head. Upper jaw highly domed and significantly longer than wide. Interorbital space convex. Nasal papilla fimbriate. Preorbital canal as a long narrow tube. Gill rakers on first arch (14–15) + (44–45) = 58–60. Teeth in jaws tricuspid, pharyngeal teeth small. Lateral line straight, reaching to caudal peduncle. Dorsal and anal fin rays elongated anteriorly. Pelvic fin placed far posteriorly. Caudal fin deeply forked, the lower lobe longer.

Scales: In lateral series 56–58; in transverse series 7–8. Scales present on triangular upper jaw, body and caudal fin base.

Colour: Silvery-greenish. Scales of upper profile black. Opercle silvery. A broad silvery lateral stripe along the midline of body. Upper and lower jaws black. Dorsal and anal fins fringed with black.

__Distribution:__ Persian Gulf through Arabian Sea and Bay of Bengal to East Indies and Malaysia, Seychelles, Gulf of Thailand through the South China sea, Philippines, Borneo, New Guinea and Australia.

__Other material examined:__ ZSI No. 1224/2 (183.0 and 218.0 mm SL) Pondicherry, A. G. K. Menon Coll.

__Remarks:__ Collette (1976) placed six nominal species in the synonymy of __R. georgii__ and also described a new species from southern India and Sri Lanka waters.

__Hyporhamphus__ Gill, 1859

__Hyporhamphus__ Gill, 1859: 131.

__Key to sub-genus__

Preorbital canal without a posterior branch; caudal fin emarginate .... __Hyporhamphus.__

__Key to species__

Head length much greater than lower jaw length; gill rakers on first arch 41-53; upper jaw longer than wide with a central scaleless area; dorsal and caudal fins yellowish .... __Hyporhamphus__ (__Hyporhamphus__) __xanthopterus__ (Valenciennes

Head length shorter or equal to (in juveniles) lower jaw length; gill rakers on first arch 28–36; upper jaw wider than long, fully covered with scales; dorsal and caudal fins blackish .... *Hyporhamphus* (*Hyporhamphus*) *limbatus* (Valenciennes).

Hyporhamphus (*Hyporhamphus*) *xanthopterus* (Valenciennes, 1846)

Plate 2[illegible].3

Hemiramphus xanthopterus Valenciennes in Cuvier and Valenciennes, 1846: 47; Gunther, 1866: 259; Day, 1878: 516; Talwar and Chakrapany, 1970: 128; Parin *et al*., 1980: 41; Kurup and Samuel, 1980b: 1.

Description: Based on 28 specimens ranging in size 90.0–23[illegible].0 mm SL (114.0–26[illegible].0 mm TL).

Fin formula: D. 15; A. 15; P. 12; V. 6; C. 2[illegible].

Body measurements expressed in percent of standard length: greatest body depth 10.[illegible]–13.50 (M = 11.82); head length 19.07–24.81 (M = 22.44); upper jaw length 4.82–7.1[illegible] (M = 5.39); upper jaw width 3.91–6.02 (M = 4.74); lower jaw length 12.11–17.32 (M = 14.46); snout to D fin origin 67.35–78.02 (M = 74.67); snout to A fin origin 71.[illegible]–80.71 (M = 76.84); snout to pectoral fin origin 19.14–25.62 (M = 22.5[illegible]); snout to pelvic fin origin 49.18–57.02 (M = 54.54); [illegible]–V 29.12–33.64 (M =

31.72); V-C 39.22-45.84 (M = 42.73); base D fin 12.48-15.82 (M = 14.44); base A fin 11.96-14.92 (M = 13.40); pectoral fin length 10.48-14.80 (M = 13.14); pelvic fin length 7.74-11.02 (M = 9.00); least depth of caudal peduncle 4.40-6.32 (M = 5.35).

In percent of head length: snout length 37.14-41.08 (M = 38.20); orbit diameter 23.04-29.22 (M = 25.65); least width of interorbital space 25.00-29.64 (M = 28.26);

Body elongate, somewhat laterally compressed. Head length one-fourth of SL. Lower jaw shorter than head length. Triangular upper jaw projection pointed, length slightly greater than width. Interorbitalspace flat. Nasal papille nearly rounded. Preorbital canal narrow, slightly enlarged ventrally. Gill rakers on first arch (19-13) + (32-40) = 41-53. Teeth small and tricuspid, 7-9 rows in lower jaw and 5-6 rows in upper jaw. Lateral line straight, reaching to caudal fin base. Anterior lobe of dorsal and anal fins elongated. Pelvic fin located significantly closer to origin of pectoral fin than to base of caudal fin. Caudal fin emarginate, lower lobe longer.

Scales: In lateral series 48-51; in transverse series 7-8. Scales present on each side of upper jaw with the central naked portion, opercle, body, caudal fin base, anterior base of dorsal and anal fins.

<u>Colour</u>: Dorsal body profile greenish-yellow, ventral profile silvery. Scales on dorsal profile black. Three line on dorsal profile, commencing from occipital region and ends slightly in front of dorsal fin origin. A silvery lateral stripe along the midline of the body. Opercle shining silvery. The region between the orbit and commencements of jaws silvery. Lower jaw with slight bluish tinge in fresh condition. Upper jaw black. Tip of lower jaw with an orange red spot. Pectoral axil black. Caudal and dorsal fins yellowish. Other fins colourless.

<u>Distribution</u>: Known only from Vembanad lake, South West Coast of India.

<u>Other material examined</u>: ZSI No. 1296 (120.0 mm SL) Malabar, F. Day Coll.

<u>Remarks</u>: <u>H.</u> (<u>H.</u>) <u>xanthopterus</u> has a very good resemblance to <u>H.</u> (<u>H.</u>) <u>limbatus</u> and most of the reference of <u>H.</u> (<u>H.</u>) <u>xanthopterus</u> may be based on <u>H.</u> (<u>H.</u>) <u>limbatus</u>. Kurup and Samuel (1980b) diagnozed the two species from Vembanad lake and differenciated them based on gill raker numbers, size and shape of upper jaw and colour pattern. There are only very few type specimens of this species in

Zoological Museums. The reports of *H.* (*H.*) *xanthopterus* from regions other than South India such as Persian Gulf and Gulf of Oman (Steindachner, 1902), Mediterranean coast of Israel (Fowler and Steinitz, 1956), Iraq waters (Al-Nasiri and Hoda, 1975) and Sri Lanka waters (Munro, 1955) are based on misidentification (Parin *et al.*, 1980), so this species is found to be endemic to Vembanad lake.

Hyporhamphus (*Hyporhamphus*) *limbatus* (Valenciennes, 1846)

Plate 20.4

Hemiramphus limbatus Valenciennes in Cuvier and Valenciennes, 1846: 44; Day, 1878: 516.

Hyporhamphus (*Hyporhamphus*) *limbatus* Parin *et al.*, 1980: 44; Kurup and Samuel, 1980b: 1.

Description: Based on 25 specimens ranging in size 81.0-140.1 mm SL (116.0-196.0 mm TL).

Fin formula: D. 13-14; A. 14-15; P. 11; V. 6; C. 18.

Body measurements expressed in percent of standard length: greatest body depth 11.01-14.72 (M = 12.72); head length 20.58-23.47 (M = 22.01); upper jaw length 3.57-4.70 (M = 4.09); upper jaw width 4.05-5.58 (M = 4.90); lower jaw length 21.13-24.34 (M = 22.76); snout to D fin origin 75.55-77.85 (M = 76.85); snout to A fin origin 75.94-78.78 (M = 77.40); snout to pectoral fin origin 20.72–24.70 (M = 22.82); snout to pelvic fin origin 54.20–57.37 (M = 55.54); P–V 32.17–34.74 (M = 33.31); V–C 41.97–46.45 (M = 44.31); base D fin 14.12–17.42 (M = 16.06); base A fin 11.71–14.72 (M = 13.57); pectoral fin length 13.44–16.52 (M = 14.67); pelvic fin length 7.20–9.44 (M = 8.45); least depth of caudal peduncle 5.46–6.47 (M = 6.06).

In percent of head length: snout length 31.03–36.36 (M = 34.75); orbit diameter 24.10–28.57 (M = 25.85); least width of interorbital space 25.30–30.60 (M = 28.35).

Body elongated. Head length less than one-fourth of SL. Lower jaw slightly longer or equal to (in juveniles) head length. Triangular part of upper jaw rounded, wider than long. Interorbital space flat. Nasal papilla nearly rounded. Preorbital canal moderately wide. Gill rakers on first arch (7–10) + (21–26) = 28–36. Teeth on jaws tricuspid, 4–6 rows in each jaw. Lateral line straight, reaching to caudal fin base. Anterior lobe of dorsal and anal fins well developed. Pelvic fin located closer to pectoral origin than to base of caudal fin. Caudal fin emarginate, lower lobe longer.

__Scales__: In lateral series 46–48; in transverse series 6–7. Scales present on whole upper jaw, opercle, body, caudal fin base and anterior base of dorsal and anal fins.

Colour: Body silvery-greenish. The scales on back blackish. Three lines on dorsal side, commencing from occipital and end in front of dorsal fin origin. Silvery lateral stripe along the midline of the body, widening below the dorsal fin. Opercle silvery. Tip of lower jaw with an orange red spot. Dorsal and caudal fins blackish. Other fins colourless.

Distribution: Persian Gulf, Thailand, China and coasts of India.

2.4.19. FAMILY : BELONIDAE

Characters of taxonomic value: Body elongated, upper and lower jaws extended into long beak with sharp teeth. Nostrils in a pit. Spines absent in fins. Pectorals inserted somewhat high. Pelvic fins abdominal in location, with 6 rays. Dorsal and anal fins posteriorly located. Lateral line running down from pectoral origin, raises to the midline at caudal peduncle. Scales cycloid.

The taxonomy, species composition and distribution of Needle fishes of the Indo-Pacific region was inadequately studied prior to 1960. A preliminary revision of needle fishes by Mees (1962, 1964) showed the exact identity of some of the nominal species of South India. But Mees (1962) was unable to detect distinctions between specific and generic differences, as a result of which the natural interrelationships between species within the family were not properly given (Parin, 1967). Subsequently Collette and Berry (1965, 1966) reviewed the family Belonidae and recognized nine genera from the Indo-Pacific area which are widely accepted. Parin (1967) conducted a regional review of marine Needle fishes of the Indian and Western part of Pacific Oceans. His results show the exact taxonomic position of the Belonid fishes of this area. Collette and Parin (1970) conducted the systematic studies on the Belonid fishes of Eastern Atlantic Ocean and described one new species and two subspecies. Descriptive works of a general nature and faunastic surveys on Belonid fishes of the Indo-Pacific area are those of Gunther (1866), Day (1878, 1889), Weber and de Beaufort (1922), Fowler, (1928), Smith (1949), Munro (1955) and Misra (1962).

<u>Key to genera</u>

1. Dorsal fin is usually having 2-4 rays less than anal fin; gill rakers absent; lateral keel on caudal peduncle absent; melanistic posterior dorsal fin lobe

absent in any size; width of caudal peduncle is less than depth; scales present on the dorsal, anal and caudal fins base; caudal fin slightly forked or rounded .... _Strongylura_ van Hasselt.

2. Dorsal fin is having more rays than anal; gill rakers absent; small lateral keel on each side of caudal peduncle; juveniles with melanistic posterior dorsal fin lobe; width and depth of caudal peduncle is nearly equal; scales absent on the dorsal, anal and caudal fins base; caudal fin deeply forked .... _Tylosurus_ Cocco.

3. Dorsal and anal fins are having nearly equal numbers of rays; gill rakers absent; no lateral keel on caudal peduncle; melanistic posterior dorsal lobe absent in any size; only one pair of maxillary bones; opercle scaleless; caudal fin subtruncate or rounded ... . _Xenentodon_ Regan.

Strongylura van Hasselt, 1824

Strongylura van Hasselt, 1824: 374.

Stenocaulus Ogilby, 1908: 91.

Lewinichthys Whitley, 1933: 67.

Rhaphiobelone Fowler, 1934: 322.

Dorybelone Fowler, 1944: 215.

Belone Mees, 1962: 11.

Key to species and sub-species

Origin of dorsal fin above 5-7th rays of anal fin; dorsal with 13-14 rays; anal with 16-17 rays; lat. line scales 138-147; caudal fin rounded with a prominent black spot at its base .... *Strongylura strongylura* (van Hasselt).

Origin of dorsal fin above 7-9th rays of anal fin; dorsal with 19-21 rays; anal with 24-25 rays; lat. line scales 217-222; caudal fin subtruncate; black patch on the distal middle of caudal and pectoral fins .... *Strongylura leiura leiura* (Bleeker).

Strongylura strongylura (van Hasselt, 1823)

Plate 21.1

Belone strongylura van Hasselt, 1823: 130.

Strongylura caudimaculata van Hasselt, 1824: 374.

Belone caudimaculata Cuvier, 1829: 285; Bleeker, 1845: 512; Gunther, 1866: 245.

Belone occulata Valenciennes, 1846: 333.

Tylosurus strongylurus Seale, 1910: 267; Weber and de Beaufort, 1922: 121; Munro, 1955: 73.

__Strongylura strongylura__ Fowler, 1927a, 261; Munro, 1958: 133; Misra, 1959: 198; Parin, 1967: 26.

__Description:__ Based on 18 specimens ranging in size 165.0–275.0 mm SL (188.0–290.0 mm TL).

__Fin formula:__ D. 13–14; A. 16–17; P. 10–11; V. 6; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 7.87–9.57 (M = 8.95); head length 18.97–21.98 (M = 20.26); upper jaw length 30.42–35.20 (= 33.38); lower jaw length 32.68–36.00 (M = 34.31); snout to D fin origin 77.60–81.19 (M = 78.92); snout to A fin origin 72.72–77.22 (M = 74.83); snout to pectoral fin origin 21.02–23.01 (M = 21.98); snout to pelvic fin origin 51.48–54.70 (M = 52.28); pectoral fin origin to pelvic fin origin 30.85–32.68 (M = 31.76); pelvic fin origin to caudal base 42.27–49.60 (M = 48.32); base D fin 13.19–14.85 (M = 13.85); base A fin 15.20–17.87 (M = 16.59); pectoral fin length 10.90–13.00 (M = 12.07); pelvic fin length 6.66–8.29 (M = 7.53); least depth of caudal peduncle 3.84–4.45 (M = 4.05).

In percent of head length: snout length 10.41–16.21 (M = 13.35); orbit diameter 21.15–22.91 (M = 21.72); least width of interorbital space 21.59–24.32 (M = 23.13).

Body nearly laterally compressed, caudal peduncle laterally well compressed. Head is having a deep median groove on the upper surface. Lower margin of the maxillary reaches below the orbit. Skin fold absent along the upper margin of lower jaw. Lateral line passes along the lower margin of the trunk, raises to midline on caudal peduncle, ceases at the end of scale sheath. Jaw teeth are small, arranged in several rows, having alternate rows of backwardly directed canines. Dorsal and anal fins are short, anterior region is having lobes. Dorsal fin origin is vertical to 4-6th anal rays. Caudal fin rounded.

Scales: Lateral line scales 138-147; in transverse series 11-13. Scales present in the body, opercle, cheeks, jaws, anterior region of dorsal, anal and caudal fin base.

Colour: Brownish green on dorsal profile and above, three distinct parallel longitudinal black lines on upper surface, starting from occiput and ceases in front of dorsal fin origin. Lower profile silvery, opercle and preopercle silvery. A red mark on the dorsal groove. A longitudinal bright silvery band along the midline which broadens and brownish below dorsal origin. Tip of dorsal rays brownish red, pectoral fin base dotted black. A prominent round black spot an caudal fin base, its tip fringed with black.

__Distribution__: It is rather common along the entire coast of South and South East Asia. It's occurrence is noticed in Persian Gulf, Pakistan, Sri Lanka, Burma, Malaysia, Singapore, Philippines, Thailand, Vietnam, South China, Northern Australia and India: east and west coasts.

__Other materials examined__: ZSI Nos. F 1213 (124.0 mm SL) Moulmein, F 1214 (145.0 mm SL) Burma, F 1273 (302.0 mm SL) Canara, F 1573 (?48.0 mm SL) Calcutta, F.Day Coll.

__*Strongylura leiura leiura*__ (Bleeker, 1850)
Plate 21.2

__*Belone leiurus*__ Bleeker, 1850: 94; Gunther, 1866: 250.
__*Mastacembelus leiurus*__ Bleeker, 1866: 46.
__*Belone leiura*__ Day, 1878: 511.
__*Tylosurus leiurus*__ Jordan and Evermann, 1903: 329; Weber and de Beaufort, 1922: 124; Munro, 1955: 73.
__*Strongylura leiura*__ Fowler, 1927: 261; Munro, 1958: 133.
__*Strongylura leiura leiura*__ Parin, 1967: 40.

__Description__: Based on 16 specimens ranging size 238.0–378.0 mm SL (262.0–416.0 mm TL).

<u>Fin formula</u>: D. 19–21; A. 24–25; V. 6; P. 10–11; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 6.30–9.25 (M = 8.25); head length 15.38–16.90 (M = 16.47); upper jaw length 23.80–26.82 (M = 25.14); lower jaw length 24.48–27.40 (M = 25.67); snout to D fin origin 75.20–76.69 (M = 75.97); snout to A fin origin 69.31–72.85 (M = 70.81); snout to pectoral fin origin 17.01–18.65 (M = 17.97); snout to pelvic fin origin 51.44–54.28 (M = 53.10); pectoral fin origin to pelvic fin origin 34.40–37.14 (M = 35.77); pelvic fin origin to caudal base 45.42–48.52 (M = 46.65); base D fin 17.57–19.77 (M = 18.07); base A fin 20.57–23.94 (M = 22.09); pectoral fin length 9.43–11.51 (M = 10.48); pelvic fin length 6.43–7.87 (M = 7.21); least depth of caudal peduncle 2.73–3.14 (M = 3.04).

In percent of head length: snout length 11.11–14.40 (M = 12.74); orbit diameter 20.80–24.54 (M = 22.52); least width of interorbital space 25.64–30.90 (M = 28.05).

Body is laterally compressed. Head is having a deep broad median groove on the upper surface. Lower margin of maxillary reaches below orbit. Skin fold absent along the upper margin of lower jaw. Lateral line passes along the lower margin of the trunk, raises somewhat upwards on caudal peduncle, ceases in front of scale sheath. Jaw teeth are small, arranged in several rows, alternating with sharp canines which are notably retrouse. Dorsal and anal fins rather long, anterior region is having enlarged lobes. Dorsal fin origin is vertical to 7-9th anal rays. Caudal fin subtruncate.

Scales: Lateral line scales 207-212; in transverse series 14-18. Scales present on the body, opercle, lower jaw, dorsal, anal vertical and caudal fins base.

Colour: Bluish green on dorsal profile and above, three distinct parallel longitudinal black lines on upper surface, starting from occiput and ceases in front of dorsal fin origin. Ventral profile silvery white. Opercle and preopercle silvery. Head green. Along the midline of body a silvery line, fringed above by yellowish brown, broadens posteriorly. Distal tip of pectoral fin is having a black spot. Dorsal and anal fins tip dusky. Black patch on the distal middle portion of caudal fin.

Distribution: Southern and South Eastern Asia, Northern Australia, Eastern Africa, South China, Japan, Vietnam, Thailand, Philippines, Indonesia, New Guinea, Malacca, Sri Lanka, Persian Gulf, Seychelles, India: east and west coasts including Nicobar Islands.

Other materials examined: ZSI No. 1534 (261.0 mm SL) Malabar, F. Day Coll.

Remarks: *Strongylura leiura leiura* is a tropical subspecies of *S. leiura* (Bleeker). Mees (1962) replaced this generally accepted nomenclature on the basis of law of priority as *Belone ciconia* Richardson. But Richardson's (1846) description is quiet incomplete and can be referred to this species in question only conditionally and so the proposed name falls into the category of forgotten names (Parin, 1967). Another subspecies of *S. leiura* is *S. leiura ferox* which is present in subtropical and warm temperate waters of Australia. The differences between two subspecies is in the number rays in dorsal and anal fins and in the rate of earlier development (Parin, 1967).

Tylosurus Cocco, 1833

Tylosurus Cocco, 1833: 18.
Thalassosteus Jordan, Everman and Tanaka, 1927: 65.
Busuanga Herre, 1930: 132.
Giulongius Whitley, 1935: 233.

Key to species and sub-species

Dorsal rays 22-23; anal rays 19-20; teeth in upper jaw with an anterior inclination; length of pectoral and pelvic fins and height of dorsal and anal fin lobes are relatively higher; head length 15.85-17.70% in SL .... *Tylosurus crocodilus crocodilus* (Le Sueur).

Tylosurus crocodilus crocodilus (Le Sueur, 1821)
Plate 21.3

Belone crocodila Le Sueur, 1821: 129.
Belone annulata Valenciennes, 1846: 447; Gunther, 1866: 240; Day, 1878: 510.
Belone melanurus Bleeker, 1849: 11.
Tylosurus crocodilus Fowler, 1904: 501; Munro, 1955: 72.
Tylosurus annulatus Weber and de Beaufort, 1922: 126.
Tylosurus crocodilus crocodilus Parin, 1967: 74
Fischer and Whitehead, 1977.

Description: Based on 14 specimens ranging in size 192.0-277.0 mm SL (209.0-310.0 mm TL).

Fin formula: D. 22-23; A. 19-20; P. 11-13; V. 6; C. 24.

Body measurements expressed in percent of standard length: greatest body depth 6.00-7.92 (M = 7.16);

head length 15.85–17.70 (M = 16.92); upper jaw length 21.54–23.98 (M = 23.03); lower jaw length 21.54–24.50 (M = 23.56); snout to D fin origin 69.51–73.50 (M = 70.71); snout to A fin origin 68.22–73.00 (M = 69.60); snout to pectoral fin origin 17.32–19.53 (M = 18.06); snout to pelvic fin origin 48.57–55.00 (M = 51.68); pectoral fin origin to pelvic fin origin 31.91–37.00 (M = 33.94); pelvic fin origin to caudal base 46.93–50.90 (M = 49.16); base D fin 23.57–24.90 (M = 24.38); base A fin 20.73–22.37 (M = 21.86); pectoral fin length 9.32–10.67 (M = 10.06); pelvic fin length 8.00–10.18 (M = 8.81); least depth of caudal peduncle 2.75–3.44 (M = 3.13).

In percent of head length: snout length 14.70–17.77 (M = 16.94); orbit diameter 24.35–27.94 (M = 25.57); least width of interorbital space 30.10–34.04 (M = 32.09).

Body elongate, cylindrical caudal peduncle almost tetrahedral, its width and depth are almost equal. Head is having deep median groove on upper surface. Maxillary reaches below middle of eye. Skin fold present along the border of lower jaw. Lateral line passes along the border of trunk, raises up in the caudal peduncle, forming a black lateral keel on caudal peduncle, reaches the end of scale cover. Jaw teeth are sharp with an anterior inclination. Granular teeth in tongue. The anterior rays of dorsal and anal fins are rather enlarged, posterior dorsal fin also forms a small lobe. Dorsal fin origin is vertical to 4-5th anal rays. Caudal fin deeply forked, lower lobe is longer.

__Scales__: Lateral line scales 320-365; in transverse series 21-29. Scales present on the body, cheek, anterior region of opercle and head.

__Colour__: Bluish green above, three distinct parallel longitudinal bands on upper surface, starting from occiput, ceases in front of dorsal fin origin. Silvery below. Preopercle and opercle silvery. Skin fold of lower jaw black. A median silvery band along the midline of the body which broadens below dorsal origin, bordered above by a black line. Dorsal, anal and caudal fins black distally. Other fins colourless.

__Distribution__: It is a worldwide species in tropical and subtropical seas. It's range extends from Indian Ocean, Western part of Pacific Ocean, Eastern Atlantic, shores of East Africa, South Japan, Red Sea to Islands of Polynesia, North Corolina to Brazil and India: east and west coasts.

__Other materials examined__: ZSI Nos. 1215 (272.0 mm SL) Andamans, 1536 (402.0 mm SL) Bombay, F. Day Coll.

Remarks: *I. crocodilus crocodilus* is one of the subspecies of the most widely spread tropical Needlefish *I. crocodilus* (Le Sueur). Mees (1962) resurrected the above species name as *B. mariaerubri* Bloch and Schneider but his name was rejected since it has not been used as a synonym for more than 150 years and has thus entered the category of forgotten names (Collette and Berry, 1965, 1966). Mees (1962) considered *I. crocodilus crocodilus* and *I. choram* (Ruppell) as a single species namely *B. mariaerubri mariaerubri* but Parin (1967) revealed the exact identity of the above two species by substantiating the differences between them. Collette and Parin (1970) described them as two separate species. *I. crocodilus fodiator* is another subspecies of *I. crocodilus*, which is distributed in Eastern Pacific. The difference between the two subspecies is only in the number of rays in dorsal and anal fins (Parin, 1967).

Xenentodon Regan, 1911

Xenentodon Regan, 1911: 332.

Key to species

Origin of dorsal fin is in a vertical with origin of the anal fin; lat. line scales 127–132; caudal fin subtruncate .... *Xenentodon cancila* (Hamilton-Buchanan).

<u>*Xenentodon cancila*</u> (Hamilton-Buchanan, 1822)

Plate 21.4

<u>*Esox cancila*</u> Hamilton-Buchanan, 1822: 213.

<u>*Belone cancila*</u> Cuvier and Valenciennes, 1846: 455; Bleeker, 1853: 145; Gunther, 1866: 253; Day, 1878: 511.

<u>*Xenentodon cancilla*</u> Weber and de Beaufort, 1922: 134; Munro, 1955: 71; Parin, 1967: 9.

<u>Description</u>: Based on 25 specimens ranging in size 89.0-183.0 mm SL (99.0-205.0 mm TL).

<u>Fin formula</u>: D. 14-16; A. 14-16; P. 10; V. 6; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 8.66-11.45 (M = 10.18); head length 21.48-24.12 (M = 22.64); upper jaw length 28.07-31.95 (M = 30.73); lower jaw length 28.94-33.56 (M = 31.07); snout to D fin origin 73.06-77.04 (M = 75.48); snout to pectoral fin origin 23.96-26.75 (M = 24.86); snout to pelvic fin origin 55.23-58.90 (M = 57.22); pectoral fin origin to pelvic fin origin 30.43-34.71 (M = 33.04); pelvic fin origin to caudal base 40.14-44.34 (M = 43.11); base D fin 18.00-20.78 (M = 18.86); base A fin 17.54-19.52 (M = 18.24); pectoral fin length 9.28-11.42 (M = 10.38); pelvic fin length 5.47-6.95 (M = 6.21); least depth of caudal peduncle 4.09-5.65 (M = 4.64).

In percent of head length: snout length 18.18–21.53 (M = 20.39); orbit diameter 20.33–25.33 (M = 23.16); least width of interorbital space 24.00–30.00 (M = 26.40).

Body elongate, cylindrical, caudal peduncle nearly compressed. Head is having deep median groove on the upper surface. Lower margin of the maxillary reaches below the middle of eye. Skin fold absent along the upper margin of lower jaw. Lateral line passes along the lower margin of trunk, raises on the caudal peduncle, ceases near the scale sheath. Teeth very strong, in several rows. Anterior dorsaland anal fin rays elongated,no lobe posteriorly. Dorsal fin origin is in line with the origin of anal. Caudal fin subtruncate.

<u>Scales</u>: Lateral line scales 127–132, in transverse series 24–28. Scales are small, present all over the body, preopercle, dorsal, anal and caudal fins bases and on pectoral axil.

<u>Colour</u>: Greyish green above, scales mottled with fine small dots. Silvery below. Preopercle and opercle silvery. Along the midline of the body a silvery band which is bordered above by dark margin, broadens in front of dorsal origin. Dorsal, anal and caudal fins dusky at its distal portion. Other fins colourless.

Distribution: Freshwaters of India, Sri Lanka, Burma, Malayan Peninsula, Japan and Borneo.

Other materials examined: ZSI Nos. Cat. 613 and 614 (154.0 and 113.0 mm SL) Orissa, 1261 (154.0 mm SL) Malabar, 1293 (151.0 mm SL) Calcutta, 1294 (178.0 mm SL) Jabalpur, 1295 (135.0 mm SL) Punjab, F. Day Coll.

SUB.ORDER : CYPRINODONTOIDEI

2.4.20. FAMILY : POECILIIDAE

Body elongate and compressed. Head flattened, mouth horizontal and superior. Teeth present in jaws. Scales cycloid, present on body and head. In male, often the anal fin is modified into an intromittent organ. Single dorsal fin. Caudal fin rounded. Viviparous and carnivorous fishes.

The live bearing genera of tooth carps were confined to the New World, where they are distributed from the South U.S.A. through Central America, the West Indies and South America as far as Northern Argentine (Sterba, 1962). Due to its importance as a mosquito larvae destroyer, it have been introduced into many tropical regions of the world. The genus *Gambusia* is represented in the present collections. Gunther (1866) described 8 species in the catalogue of fishes of British Museum. Though there is the occurrence of 12 species of *Gambusia* in the world (Frey, 1961), Sterba (1962) described only 7 species.

Key to genus

Teeth pointed; dorsal fin short; eye normal; snout not produced; anal fin of males modified into an intromittent organ .... *Gambusia* Poey.

Gambusia Poey, 1851

Gambusia Poey, 1851: 382.

A single species is known from India (Jhingran, 1982).

Gambusia affinis patruelis (Baird and Girard, 1853)
Plate 22.1

Heterandria affinis Baird and Girard, 1853: 390.
Gambusia affinis Girard, 1854: 72.
Gambusia affinis patruelis Jhingran, 1982: 26.

Description: Based on 20 specimens, 1 male and 19 females, ranging in size 39.0–73.0 mm SL (52.0–93.0 mm TL).

Fin formula: D. 9; A. 7–9; P. 14; V. 6; C. 26.

Body measurements expressed in percent of standard length: greatest body depth 29.41–35.89 (M = 33.28); head length 28.78–31.39 (M = 30.31); snout to D fin origin 59.80–62.82 (M = 61.21); snout to A fin origin (male) 57.40, (females) 66.66–69.23 (M = 68.77); snout to pectoral fin origin 30.50–33.33 (M = 31.55); snout to pelvic fin origin 52.05–56.41 (M = 53.62); base D fin 12.12–14.28 (M = 13.15); base A fin (male) 11.28, (females) 16.43–20.51 (M = 18.51); pectoral fin length 19.86–23.25 (M = 21.53); pelvic fin length 11.62–14.10 (M = 13.17); least depth of caudal peduncle 20.93–22.48 (M = 21.17).

In percent of head length: snout length 31.25–37.50 (M = 36.86); orbit diameter 19.35–23.68 (M = 22.43); least width of interorbital space 47.50–56.00 (M = 51.72).

Body elongated and posteriorly well compressed. Mouth superior, small and horizontal. Two pairs of nostrils situated in front of eyes. Lower jaw slightly projecting. Interorbital space flat. Gill rakers on first arch (2–3) + (24–25) = 26–28. Jaws with a single series of pointed teeth. Lateral line absent. Caudal fin rounded.

<u>Scales</u>: In lateral series 26–27; in transverse series 8. Scales present on head and body.

Colour: Bluish-green above, silvery white on abdomen. Interorbital space dull green. Exhibits colour dimorphism.

Sexual dimorphism: G. affinis patruelis exhibits sexual dimorphism. In males, the last 4-5 dorsal rays are elongated and 3-5 thick rays of the anal fin are prolonged and have a sickle-shaped appendage at the end of the 3rd ray. The anal fin is located very close to pelvic fin. The elongated rays of the dorsal fin have rows of black spots. Basal part of caudal fin black with distinct rows of black spots, the distal margin with a white band. In females, the dorsal and anal fins normal, anal fin not close to pelvic fin. 4-5 longitudinal black bands on the upper half of body, which is formed by rows of black spots of the scale.

Distribution: G. affinis patruelis is a native of the coastal waters of United States from New Jersey southwards. This species was introduced throughout India, Pakistan, Bangladesh, Sri Lanka, Burma, Thailand, Malaya, Philippines, Hawaii and Formosa.

SUB ORDER : ATHERINOIDEI

2.4.21. FAMILY : ATHERINIDAE

Characters of taxonomic value: Body slender, elongate and subcylindrical. Snout pointed. Mouth terminal, cleft of mouth oblique. Teeth small in jaws, sometimes on vomer, palatines and pterygoids. Gill membrane free from isthmus. Scales cycloid, sometimes ctenoid. No lateral line. Two dorsals, widely separated. First dorsal with 3-8 slender spines and second with one weak spine and 8-12 rays. Second dorsal opposite to anal. Pelvic fin abdominal with a weak spine and 5 rays. Caudal fin forked.

A comprehensive account on Atherinid fishes of India is still lacking and the available literature is only based on Day's (1878) account, who reported 4 species under the genus Athrina. Weber and de Beaufort (1922) described 5 species from Indo-Australian Archipelago.

Key to genus

Body very slender; head without spinules; lower jaw with an upper expansion within the mouth; pectoral and lateral stripe midway up side; vent. nearly in middle between snout and caudal; first dorsal with 5-7 spines; gill rakers more than 12 .... Atherina Linnaeus.

Atherina Linnaeus, 1758

Atherina Linnaeus, 1758: 315.

Key to species

Lat. line scales 36–37, tr. scales 7; gill rakers 25–29; first dorsal origin opposite 13–14th scales; second dorsal opposite 21–23rd scales; vent opposite 9–10th scale .... *Atherina duodecimalis* Cuvier and Valenciennes.

Atherina duodecimalis Cuvier and Valenciennes, 1835
Plate 22.2

Atherina duodecimalis Cuvier and Valenciennes, 1835: 458; Bleeker, 1851: 485; Gunther, 1861: 400; Day, 1878: 345; Weber and de Beaufort, 1922: 275.

Pranesus duodecimalis Munro, 1955: 95.

Description: Based on 5 specimens ranging in size 46.0–54.0 mm SL (57.0–66.0 mm TL).

Fin formula: D. V, 1,10; A. 1,12; P. 14; V. 1,5; C. 26.

Body measurements expressed in percent of standard length: greatest body depth 16.66–18.94 (M = 18.14); head length 23.14–25.26 (M = 24.36); snout to D_1 fin origin 53.70–56.52 (M = 54.89); snout to D_2 fin origin 70.37–71.73 (M = 70.97); snout to A fin origin 66.66–68.47 (M = 67.28); snout to pectoral fin origin 24.07–26.31 (M = 25.36); snout to pelvic fin origin

37.96–41.30 (M = 39.76); base D_1 fin 3.15–4.62 (M = 3.95); base D_2 fin 9.47–11.11 (M = 10.40); base A fin 10.81–13.10 (M = 11.48); pectoral fin length 18.51–20.00 (M = 19.37); pelvic fin length 12.63–13.04 (M = 12.89); longest D spine (2nd) 9.25–10.86) (M = 10.20); longest A spine 14.81–15.78 (M = 15.38); least depth of caudal peduncle 7.60–8.33 (M = 8.17).

In percent of head length: snout length 25.00–30.76 (M = 28.06); orbit diameter 33.33–36.52 (M = 35.11); least width of interorbital space 38.46–40.86 (M = 39.82).

Body slender and elongated. Hind end of maxilla nearly reaching to anterior margin of eye. Lower jaw prominent. Interorbital space flat. Two nostrils on each side. Gill rakers on first arch (5–7) + (20–22) = 25–29. Teeth villiform in band in jaws, palate, vomer and pterygoids. Axillary scale present at pelvic fin axis. Caudal fin deeply forked.

Scales: Cycloid scales present on body, absent on head and fins base.

Colour: Silvery, scales of upper profile are mottled with black tinge. A bright silvery band along the midline of the body from opercle to caudal peduncle. Snout tip and caudal fin margin blackish. Other fins grey.

<u>Distribution</u>: Sri Lanka and coasts of India including Andamans.

<u>Other materials examined</u>: ZSI No. F 4017 (49.0-55.0 mm SL, 5 ex.) Andamans, K.K. Tiwari Coll.

SERIES	: PERCOMORPHA
ORDER	: SCORPAENIFORMES
SUB ORDER	: PLATYCEPHALOIDEI

2.4.22. <u>FAMILY : PLATYCEPHALIDAE</u>

<u>Characters of taxonomic value</u>: Fishes with elongated and cylindrical body, posteriorly well compressed. Head triangular, depressed, ridged and spinose. Mouth large, lower jaw longer. Two pairs of nostrils. Villiform teeth in jaws, vomer and palatine. Lateral line complete. Scales cycloid and ctenoid. Two dorsal fins, first with 6-9 spines. Pelvic fins placed apart, directly below pectoral with one spine and 5 rays.

Day (1878) described 7 species of Platycephalids from Indian Seas and Munro (1955) listed 8 species from Gulf of Mannar and coastal waters of Sri Lanka. Beaufort and Briggs (1962) recorded 21 species from Indo-Australian Archipelago of which 7 species were reported from India. Visweswara Rao (1966) described a new species of Flathead from Bay of Bengal and also provided a provisional key to the known Indian species of *Platycephalus*. Other taxonomical studies and new distributional records of this group of fishes from Indian seas were those of Murty (1968) and George (1968). 11 species of Flatheads were reported from the seas around India (Murty, 1969). Wongratana (1975) recorded *Thysanophrys papillolabium* Schultz from Andaman Sea and also provided a key to the 14 species of Flatheads of Thai waters.

Key to genus

Head triangular and depressed; 7-9 dorsal spines in first dorsal fin; caudal truncate or rounded .... *Platycephalus* Bloch.

Platycephalus Bloch, 1795

Platycephalus Bloch, 1795: 96.
Thysanophrys Ogilby, 1898: 40.
Insidiator Jordan and Snyder, 1900: 368.

Key to species

Lat. line without spines; preopercle angle with two spines; no tentacle or papilla over eye .... 1 and 2.

1. Head almost smooth and well depressed, ridges on head low and not serrated or spinose; interorbital

space slightly concave, 13.33–17.12% in HL; orbit diameter 11.39–15.00% in HL; vomerine teeth in transverse patch .... *Platycephalus indicus* (Linnaeus).

2. Head spiny and depressed, ridges on head high and spinose; interorbital space concave, 8.21–11.42% in HL; orbit diameter 17.02–22.05% in HL; vomerine teeth in two villiform patches; 5 dark cross bands across the body .... *Platycephalus crocodilus* Tilesius.

Platycephalus indicus (Linnaeus, 1758)

Plate 23.1

Callionymus indicus Linnaeus, 1758: 250.

Platycephalus insidiator Bloch and Schneider, 1801: 59; Cuvier and Valenciennes, 1829: 227; Bleeker, 1849: 6; Gunther, 1860: 177; Day, 1878: 276.

Platycephalus indicus Bleeker, 1878: 49; Fowler, 1928: 300; Weber and de Beaufort, 1962: 131; Wongratana, 1975: 4.

Thysanophrys indicus Munro, 1955: 253.

Description: Based on 25 specimens ranging in size 62.0–250.0 mm SL (72.0–290.0 mm TL).

Fin formula: D. 1,7; 13–14; A. 13; P. 18; V. 1,5; C. 18.

Body measurements expressed in percent of standard length: greatest body depth 7.81–13.79 (M = 9.51); head length 30.52–34.19 (M = 32.30); head width 21.42–26.61 (M = 23.54); snout to D_1 fin origin 31.61–35.33 (M = 34.11); snout to D_2 fin origin 52.90–57.72 (M = 55.01); snout to A fin origin 50.34–55.28 (M = 53.77); snout to pectoral fin origin 26.16–30.64 (M = 28.09); snout to pelvic fin origin 34.69–38.20 (M = 36.84); base D_1 fin 13.22–16.88 (M = 14.91); base D_2 fin 31.46–36.36 (M = 33.41); base A fin 33.81–39.48 (M = 36.86); pectoral fin length 12.90–15.73 (M = 14.85); pelvic fin length 19.00–22.76 (M = 20.92); longest D spine (3rd) 11.04–15.60 (M = 13.79); longest A spine (2nd) 6.27–7.25 (M = 6.69); least depth of caudal peduncle 4.00–4.83 (M = 4.43).

In percent of head length: snout length 30.00–33.33 (M = 31.49); orbit diameter 11.39–15.00 (M = 13.57); least width of interorbital space 13.33–17.12 (M = 15.35).

Body elongated and depressed. Head triangular, well depressed and not spiny. Caudal peduncle laterally compressed. Mouth horizontal, cleft of mouth reaching upto middle of orbit. Lower jaw well projecting. Eyes partly covered with thick skin, interorbital space broad and slightly concave with two smooth ridges. Anterior nostril with a small tentacle, posterior one with low rim. Preorbital margin with a weak flat spine. Preopercle angle with two strong spines. One weak flat opercular spine. The spiny ridges behind the eyes are radiating and are very low, the posterior most spine very strong, other spines very weak and low. Suborbital ridges smooth, reaching upto preopercular angle. Gill rakers on first arch 3+(5-6) = 8-9. Curved bands of teeth in upper and lower jaws and vomer. Canine teeth on palate. Lateral line extends to caudal fin base. First dorsal spine very small and separated. Some of the rays of second dorsal and pectoral fins forked. Caudal fin truncate.

Scales: Lateral line scales 92-103; in transverse series 22-26. Ctenoid scales present on upper part of the body including snout, preopercle and opercle. Scales of the lower part cycloid. Scales absent at pectoral axis.

Colour: Body uniformly dark brown above, dull white below. Numerous small brown spots above. Dorsal fin pale brown and indistinctly spotted. Pectoral and pelvic fins dark brown and intensely spotted. Anal fin colourless. Caudal fin is having oblique black, white and yellow stripes.

Distribution: Thailand, Coasts of Africa, Madagascar, Red Sea, Aden, Malay Peninsula, China, Korea, Japan, Riukiu Islands, Formosa, Philippines, West Australia, Singapore, Sri Lanka waters and India: east and west coasts including Andamans.

Other materials examined: ZSI Nos. Dup. Cat. 47 (190.0 mm SL), Dup. Cat. 272 (230.0 mm SL), Dup. Cat. 398 (324.0 mm SL) Burma, F. Day Coll.

Platycephalus crocodilus Tilesius, 1812

Plate 23.2

Platycephalus crocodilus Tilesius, 1812: 2; Fowler, 1934: 488; Smith, 1950: 378; Weber and de Beaufort, 1962: 159.

Platycephalus punctatus Cuvier and Valenciennes, 1829: 243; Bleeker, 1850: 25; Gunther, 1860: 180; Day, 1878: 277.

Thysanophrys crocodilus Jordan and Richardson, 1908: 638; Fowler, 1928: 300; Munro, 1955: 253; Wongratana, 1975: 5.

Description: Based on 25 specimens ranging in size 44.0–210.0 mm SL (53.0–250.0 mm TL).

Fin formula: D. 1, VIII; 1, 10; A. 11; P. 18–19; V. 1,5; C. 18.

Body measurements expressed in percent of standard length: greatest body depth 9.25–13.80 (M = 11.82); head length 34.19–37.96 (M = 35.72); head width 19.31–23.48 (M = 20.92); snout to D_1 fin origin 35.21–39.28 (M = 37.41); snout to D_2 fin origin 57.35–61.36 (M = 59.22); snout to A fin origin 57.76–62.12 (M = 61.13); snout to pectoral fin origin 29.12–34.25 (M = 31.89); snout to pelvic fin origin 37.00–42.85 (M = 39.20); base D_1 fin 15.65–18.86 (M = 17.45); base D_2 fin 26.51–30.55 (M = 27.39); base A fin 28.17–32.03 (M = 29.47); pectoral fin length 13.48–17.04 (M = 14.73); pelvic fin length 18.86–23.80 (M = 21.51); longest D spine (3rd) 12.62–15.90 (M = 14.31); longest A spine (2nd) 6.25–8.80 (M = 7.79); least depth of caudal peduncle 4.54–5.55 (M = 5.10).

In percent of head length: snout length 29.41–34.44 (M = 33.82); orbit diameter 17.02–22.05 (M = 19.23); least width of interorbital space 8.21–11.42 (M = 9.11).

Body elongated and slightly compressed. Head triangular, depressed and spiny. Caudal peduncle laterally compressed. Mouth horizontal, cleft of mouth reaching upto preorbital margin. Lower jaw projecting. Eyes partly covered with thick skin, interorbital space narrow and concave with two spiny ridges. Anterior nostril with a small tentacle, posterior one tubular. Preorbital margin with a small spine. Preopercle angle is having two spines, the outer very strong. Opercle with two weak flat spines. Four spiny longitudinal ridges behind the eyes, the outer ridges nearly extend upto the post opercular margin. Suborbital ridge spiny, reaching upto preopercular angle. Gill rakers on first arch 2+(4-5) = 6-7. Villiform teeth in jaws, as two narrow elongated bands in vomer. Palatine teeth small. Lateral line extends upto caudal fin base. First dorsal spine small. Forked rays in pectoral fin. Caudal fin rounded.

Scales: Lateral line scales 90-96; in transverse series 19-23. Ctenoid scales on upper profile including preopercle and opercle, cycloid scales below. Scales absent at pectoral axis.

Colour: Five black cross bands on the back side. First dorsal fin, pectoral and pelvic fins blackish. Pectoral fin tip grey. Anal fin colourless. Three oblique cross bands on caudal fin.

Distribution: Thailand, Madagascar, Zanzibar, Singapore, Sumatra, Japan, Philippines, New Hebrides, Sri Lanka and coasts of India including Andamans.

ORDER : PERCIFORMES

SUB ORDER : PERCOIDEI

2.4.23. FAMILY : CENTROPOMIDAE

Characters of taxonomic value: Body elongated or oblong. Snout pointed, notch above the eyes on the upper surface. Mouth oblique, lower jaw prominent. Maxillary exposed. Scales cycloid, present on head. Teeth villiform, present in jaws, palate and vomer. Preopercle serrated. Two dorsal fins, almost separated. 7-8 spines on first dorsal, 1 spine and 9-12 rays in second dorsal. 3 spines and 8-10 rays in anal fin. Pelvic fin with one spine and 5 rays caudal fin deeply forked or rounded.

The taxonomy of this group is still unsatisfactory and requires urgent revision as suggested by Fischer and Whitehead (1974). Our knowledge about this group of fishes of India still pertains on Day's (1878) work who described 13 species under two different groups. Weber and de Beaufort (1929) described 19 species from Indo-Australian Archipelago. Munro (1955) recorded 7 species from Sri Lanka waters under two separate families, Latidae and Ambassidae. Holden (1967) conducted the systematic studies on fishes of the genus *Lates* in the Lake Albert, East Africa. Talwar and Chakrapany (1978) reported the occurrence of *Ambassis kopsi* Bleeker from

Indian waters thus raising the number of glassy perchlets to 13 from India.

Key to genera

3rd dorsal spine the longest; no recumbent spine before spinous dorsal fin; pectoral axil scaly; scale sheath absent at spinous dorsal base; preopercle and opercle is having prominent spines; preopercle without double serrated edge; caudal fin rounded .... *Lates* Cuvier and Valenciennes.

2nd dorsal spine the longest; recumbent spine present before spinous dorsal fin; pectoral axil scaleless; scale sheath present at spinous dorsal base; preopercle and opercle without prominent spines; preopercle with double serrated edge; luciferous channel in frontal; caudal fin deeply forked .... *Ambassis* Cuvier and Valenciennes.

Lates Cuvier and Valenciennes, 1828

Lates Cuvier and Valenciennes, 1828: 88.

Key to species

Maxilla extends behind eye; strong spine present on lower edge of preopercle; teeth absent in tongue; lat. line scales 64-66 .... *Lates calcarifer* (Bloch).

Lates calcarifer (Bloch, 1790)

Plate 24.1

<u>Holocentrus calcarifer</u> Bloch, 1790: 100.

<u>Coius vacti</u> Hamilton-Buchanan, 1822: 96.

<u>Lates nobilis</u> Cuvier and Valenciennes, 1828: 96; Bleeker, 1849: 27.

<u>Lates calcarifer</u> Gunther, 1859: 68; Day, 1878: 779; Munro, 1955: 106; Weber and de Beaufort, 1928: 396; Fischer and Whitehead, 1974.

<u>Description</u>: Based on 4 specimens ranging in size 140.0–245.0 mm SL (170.0–290.0 mm TL).

<u>Fin formula</u>: D. VII, 1, 12; A. III, 10; P. 15; V. 1,5; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 30.21–32.41 (M = 31.83); head length 34.60–36.90 (M = 35.51); snout to D fin origin 42.24–44.68 (M = 43.67); snout to A fin origin 66.40–68.52 (M = 67.75); snout to pectoral fin origin 31.86–34.28 (M = 33.06); snout to pelvic fin origin 35.72–37.08 (M = 36.73); base D fin 36.82–40.48 (M = 39.38); base A fin 12.68–15.16 (M = 13.67); pectoral fin length 15.72–17.68 (M = 16.12); pelvic fin length 18.80–20.16 (M = 19.59); longest D spine (3rd) 17.10–20.23

(M = 18.36); longest A spine (3rd) 7.32-8.12 (M = 7.34); least depth of caudal peduncle 11.98-14.18 (M = 12.65).

In percent of head length: snout length 20.42-23.60 (M = 21.83); orbit diameter 11.82-14.08 (M = 12.64); least width of interorbital space 13.46-15.20 (M = 14.94).

Body elongate, laterally well compressed. Head pointed, dorsal profile concave, a steep ascent to dorsal fin origin. Mouth slightly oblique and large. Lower jaw very strong, slightly bigger than upper jaw. Maxillary tip reaches well behind eye. A strong spine present on preopercle, its vertical limb with three notches. A small spine on opercle. Gill rakers on first arch (3-4) + 8 = 11-12. Some of the rakers are found as rudimentary. Villiform teeth in jaws, triangular patch on vomer. Lateral line get branched at caudal base. Dorsal spine stout. Soft dorsal, anal and pectoral fins tips rounded. Caudal fin rounded.

Scales: Lateral line scales 62-64; in transverse series 16-18. Scales present all over the body including head, opercle and cheek, absent on snout and interorbital. Scale sheaths are visible at soft dorsal, anal, caudal, pectoral and pelvic fins base.

Colour: Dorsal profile greenish, ventral profile silvery. Scales on dorsal profile are mottled with minute brown spots thus imparting a brownish tinge. Head silvery. Dorsal, anal and pelvic fins very black. Pectoral fin colourless.

Distribution: Persian Gulf to Southern China, Japan, New Guinea, Malay Archipelago, North Australia, Sri Lanka and India: east and west coasts.

Other materials examined: ZSI Nos. Cat. 125 (179.0 mm SL), 1718 (178.0 mm SL) India, F. Day Coll.

Ambassis Cuvier and Valenciennes, 1828

Ambassis Cuvier and Valenciennes, 1828: 175.
Chanda Hamilton-Buchanan, 1822: 103.
Parambassis Bleeker, 1874: 102.
Pseudambassis Bleeker, 1876: 292.

Key to species

1. Interopercle serrated; orbital ring denticulated in its lower and posterior margin; lat. line continuous; no spines in the posterior superior angle of orbit .... 2.

Interopercle not serrated; no denticulation in the orbital margin; lat. line continuous or interrupted;

spine or spines present in the posterior superior angle of orbit .... 3.

2. Body depth 31.09–34.37% in SL; depth at caudal peduncle 10.16–13.15% in SL; serrations of the horizontal lower margin of interopercle are nearly confined around its angle; lat. line scales 39–41 ... . <u>Ambassis dayi</u> Bleeker.

Body depth 38.57–46.15% in SL; depth at caudal peduncle 13.33–17.94% in SL; serrations of the horizontal lower margin of interopercle complete; lat. line scales 33–35 .... <u>Ambassis thomassi</u> Day.

3. Lat. line continuous; a single prominent spine present on the posterior superior angle of orbit; gill rakers on first arch 26–29; lat. line scales 31–36 ... . <u>Ambassis commersoni</u> Cuvier.

Lat. line interrupted; four small spines present on the posterior superior angle of the orbit; gill rakers on first arch 31–38; lat. line scales 29–35 .... <u>Ambassis gymnocephalus</u> Lacepede.

<u>Ambassis dayi</u> Bleeker, 1874:
<u>Plate 24.2</u>

<u>Ambassis dayi</u> Bleeker, 1874: 95; Day, 1878: 54; 1889: 487; Munro, 1955: 107; Jhingran, 1982: 30.

__Description:__ Based on 25 specimens ranging in size 33.0–140.0 mm SL (42.0–179.0 mm TL).

__Fin formula:__ D. VII, 1,10; A. III, 9–10; P. 11–12; V. 1,5; C. 24.

Body measurements expressed in percent of standard length: greatest body depth 30.09–34.37 (M = 32.00); head length 37.09–42.42 (M = 39.30); snout to D fin origin 46.01–48.64 (M = 46.88); snout to A fin origin 59.09–65.76 (M = 63.07); snout to pectoral fin origin 34.95–38.70 (M = 36.35); snout to pelvic fin origin 38.27–42.42 (M = 39.93); base D fin 34.89–38.54 (M = 36.75); base A fin 18.27–21.81 (M = 19.79); pectoral fin length 23.65–27.43 (M = 25.67); pelvic fin length 18.27–22.97 (M = 20.13); longest D spine (2nd) 22.49–28.78 (M = 24.97); longest A spine (2nd) 13.55–17.10 (M = 15.31); least depth of caudal peduncle 10.16–13.15 (M = 11.79).

In percent of head length: snout length 27.63–32.25 (M = 29.68); orbit diameter 24.50–29.03 (M = 26.90); least width of interorbital space 18.05–22.58 (M = 21.34).

Body elongate, snout pointed. Notch above orbit on upper surface with a gradual ascent to the dorsal fin origin. Mouth oblique, maxillary tip reaches upto anterior one fourth of eye, lower jaw slightly greater than upper jaw. Orbit margin serrated in the lower and posterior margin. Double edged preopercle serrated. Serrations of the horizontal lower margin of interopercle are nearly confined around its angle. Gill rakers on first arch (7-8) + (18-19) = 25-27. Two rows of teeth on upper and lower jaws, the outer row slightly enlarged. A single row of teeth on palate. Lateral line continuous. Caudal fin deeply forked.

Scales: Lateral line scales 39-41, in transverse series 15-16. Scales present all over the body including preopercle and opercle. Scales sheaths are visible at dorsal, anal and caudal fin bases. Axillary scale present on pelvic fin axis. Scales absent on snout and interorbital space.

Colour: Dorsal profile greenish, ventral profile bright silvery. Preopercle and opercle silvery with slight pink reflection. Two oval silvery blotches above opercle. Snout tip black. Silvery band along the midline of the body. Dorsal fin and upper lobe of caudal fin pale green. Pectoral axis silvery. Other fins colourless.

Distribution: Sri Lanka, Malabar coast of India and now from Southern most Vembanad lake.

<u>Remarks</u>: Day (1878) stated that in *A. dayi* the interopercle is serrated only in its posterior half of lower limb but in the present studies it is observed that the interopercle angle is serrated both horizontally and vertically. There is a remarkable difference in the number of lateral and transverse scales in the present observation and those given by Day (1878). Kurup and Samuel (1979) reported an abnormal specimen of *A. dayi* from Punnamuda region of Vembanad lake.

Ambassis thomassi Day, 1870

Plate 24.3

Ambassis thomassi Day, 1870: 369; 1889: 486.

<u>Description</u>: Based on 20 specimens ranging in size 30.0–73.0 mm SL (41.0–96.5 mm TL).

<u>Fin formula</u>: D. VII, I, 10–11; A. III, 10–11; P. 11–13; V. I, 5; C. 24.

Body measurements expressed in percent of standard length: greatest body depth 38.57–46.15 (M = 42.90); head length 38.23–43.33 (M = 40.81); snout to D fin origin 48.71–52.77 (M = 50.84); snout to A fin origin 61.42–66.66 (M = 64.02); snout to pectoral fin origin 35.29–39.99 (M = 37.63); snout to pelvic fin origin 39.21–43.33 (M = 41.60); base D fin 37.77–42.42

(M = 40.11); base A fin 19.70–25.64 (M = 22.64); pectoral fin length 27.39–31.81 (M = 29.15); pelvic fin length 23.28–28.43 (M = 25.62); longest D spine (2nd) 27.39–35.29 (M = 29.71); longest A spine 16.43–24.34 (M = 20.72); least depth of caudal peduncle 13.33–17.94 (M = 15.36).

In percent of head length: snout length 23.07–30.76 (M = 27.04); orbit diameter 24.99–31.25 (M = 27.79); least width of interorbital space 21.15–26.92 (M = 23.80).

Body oval, laterally well compressed. Snout pointed, a distinct notch above orbit on upper surface with a steep ascent to dorsal fin origin. Mouth oblique, maxillary reaches upto anterior one fourth of eye, lower jaw longer. Orbit margin serrated in its lower and posterior margin. Double edged preopercle serrated. Interopercle fully serrated in its horizontal margin and posterior angle. Gill rakers on first arch (7–8) + (15–18) = 22–26. An outer enlarged row of teeth in both jaws, inner row small. Teeth present on palate. Lateral line continuous. Caudal fin deeply forked.

Scales: Lateral line scales 33–35; in transverse series 13–15. Scales present all over the body including preopercle and opercle. Scale sheaths are visible at dorsal, anal and caudal fins base. Axillary scale present on pelvic fin axis. Scales absent on snout and interopercle.

Colour: Dorsal profile greyish green, ventral profile bright silvery. Preopercle and opercle silvery bright. A silvery band along the midline of the body. Scales on dorsal profile are marked basaly by brown spots, thus imparting a brownish tinge. Membrane between 2nd to 4th dorsal spines black distally. Soft dorsal, anal and caudal fins dusky. Other fins colourless.

Distribution: Freshwaters of Canara, Cochin and now from southern most region of Vembanad lake.

Other materials examined: ZSI Nos. 818-823 (50.0-117.0 mm SL) history unknown, F. Day Coll. It appears that Day's materials at ZSI composed of both A. thomassi and A. dayi.

Ambassis commersoni Cuvier and Valenciennes, 1828
Plate 25.1

Ambassis commersonii Cuvier and Valenciennes, 1828: 176; Bleeker, 1849: 30; Gunther, 1859: 223; Day, 1878: 52.

Ambassis commersoni Weber and de Beaufort, 1929: 406; Munro, 1955: 107; Jhingran, 1982: 30.

Ambassis ambassis Fowler, 1905: 300; Chaudhuri, 1923: 715.

Description: Based on 25 specimens ranging in size 69.0-107.0 mm SL (120.0-140.0 mm TL).

Fin formula: D. VII, 1, 8-10; A. III, 9-10; P. 14-15; V. I,5; C. 24-26.

Body measurements expressed in percent of standard length: greatest body depth 34.57-40.34 (M = 37.41); head length 37.34-40.62 (M = 38.75); snout to D fin origin 45.62-47.95 (M = 46.47); snout to A fin origin 63.68-68.47 (M = 65.68); snout to pectoral fin origin 33.33-36.44 (M = 34.94); snout to pelvic fin origin 36.36-39.75 (M = 38.66); base D fin 35.48-39.32 (M = 37.25); base A fin fin 20.40-23.36 (M = 22.06); pectoral fin length 27.45-31.97 (M = 28.71); pelvic fin length 19.10-22.50 (M = 21.23); longest D spine (2nd) 24.01-27.95 (M = 26.40); longest A spine (3rd) 15.42-20.00 (M = 18.25); least depth of caudal peduncle 12.10-14.49 (M = 13.27).

In percent of head length: snout length 24-24-27.94 (M = 25.97); orbit diameter 23.60-28.07 (M = 25.56); least width of interorbital space 20.58-24.32 (M = 22.45).

Body oblong, compressed. Snout pointed, a slight concavity above orbit on upper surface. Head triangular, mouth oblique. Maxillary does not reach behind anterior border of eye, lower jaw slightly greater than upper jaw. Orbital margin not serrated. Double edged preopercle serrated in both limbs. Interopercle not serrated. A single prominent spine on the posterior superior angle of the orbit. Gill rakers on first arch (9–10) + (18–20) = 27–30. Villiform teeth in jaws. Teeth present on vomer, palatine and tongue. Lateral line continuous. Caudal fin deeply forked.

Scales: Lateral line scales 31–33; in transverse series 11–13. Scales present all over the body including cheek and nape. Scale sheath are visible at dorsal, anal and caudal fin bases. Axillary scale present at pelvic fin axis.

Colour: Dorsal profile slightly green, ventral profile shining silvery with purple reflections. Very bright silvery band along the midline of the body. Preopercle and opercle silvery. Scales on dorsal profile are mottled with small brown spots. Membrane between 2nd to 4th dorsal spines black distally. Caudal fin slightly yellowish. Other fins colourless.

Distribution: Madagascar to East coast of Africa, Mauritius, Seychelles, Red Sea, Philippines, Japan, Sri Lanka, North Australia and India: east and west coasts.

Other materials examined: ZSI Nos. 837–839 (71.0–86.0 mm SL) 842 (82.0 mm SL) Madras, F. Day Coll.

Ambassis gymnocephalus (Lacepede, 1802)

Plate 25.2

Lutianus gymnocephalus Lacepede, 1802: 216.

Ambassis Dussumieri Cuvier and Valenciennes, 1828: 181; Bleeker, 1849: 30.

Ambassis dussumieri Gunther, 1859: 225.

Ambassis gymnocephalus Bleeker, 1874: 99; Day, 1878: 54; Fowler, 1905: 501; Weber and de Beaufort, 1929: 412; Munro, 1955: 107; Jhingran, 1982: 30.

Description: Based on 25 specimens ranging in size 27.0–62.0 mm SL (35.0–81.0 mm TL).

Fin formula: D. VII, I, 9; A. III, 9–10; P. 14–15; V. I,5; C. 26.

Body measurements in percent of standard length: greatest body depth 31.25–36.36 (M = 34.19); head length 31.48–36.66 (M = 34.74); snout to D fin origin 42.64–47.50 (M = 44.17); snout to A fin origin 63.15–67.18 (M = 65.60); snout to pectoral fin origin 30.55–35.18 (M = 32.51); snout to pelvic fin origin 36.29–43.75 (M = 39.36); base D fin 32.35–37.50 (M = 35.73); base A fin 19.23-24.99 (M = 21.50); pectoral fin length 27.67-30.88 (M = 29.51); pelvic fin length 18.51-22.22 (M = 20.07); longest D spine (2nd) 20.75-26.66 (M = 22.60); longest A spine (2nd) 16.07-19.99 (M = 17.14); least depth of caudal peduncle 13.46-17.18 (M = 15.00).

In percent of head length: snout length 26.08-30.00 (M = 27.90); orbit diameter 27.02-33.33 (M = 29.48); least width of interorbital space 26.31-32.35 (M = 28.81).

Body oblong, compressed. Snout pointed, slight concavity above orbit on upper surface. Mouth oblique, maxillary does not reach upto anterior border of eye, lower jaw slightly greater than upper jaw. Orbital margin not serrated. Double edged preopercle serrated in both limbs. Interopercle not serrated. Four prominent spines on posterior superior angle of orbit. Gill rakers on first arch (9-11) + (22-25) = 31-36. Villiform teeth on jaws, vomer and palatine. Lateral line interrupted at 8-9th scale. Caudal fin deeply forked.

Scales: Lateral line scales 29-31, in transverse series 9-10. Scales present all over the body including cheek and opercle. Scale sheaths are visible at dorsal, anal and caudal fins base. Axillary scale present at pelvic fin axis.

Colour: Body bright silvery with pinkish reflections. Scales of dorsal profile are mottled with minute brown spots, imparting brownish tinge. A bright silvery band along the midline of the body. Membrane between 2-4th dorsal spines black distally. Soft dorsal and anal dusky. Caudal fin tip black. Other fins colourless.

Distribution: East Coast of Africa, Red Sea, Japan, Philippines, China, North coast of Australia, Malay Archipelago, Sri Lanka and India: east and west coasts.

Other materials examined: ZSI Nos. F 1173/2 (46.0 mm SL) F 1176/2 (49.0 mm SL) Pondicherry 24.12.1956, A.G.K.Menon Coll.

2.4.24. FAMILY : SERRANIDAE

Characters of taxonomic value: Body robust or elongated. Mouth large. Maxilla tip broad, Villiform or conical teeth in bands in jaws, inner series enlarged, a few canine teeth in front. Gill membrane free from isthmus. Scales often ctenoid, embedded in the skin. Two slit-like nostrils on each side. Preopercle edge serrated. Opercle with 1-3 weak flat spines. Lateral line complete. A single dorsal fin, 7-12 strong spines. 3 spines in anal fin. Pelvic fin with 1 spine and 5 rays. Caudal peduncle comparatively deep, caudal fin rounded or truncate.

A comprehensive revision of fishes of the family Serranidae is very urgently needed since the taxonomy of this group is still unsatisfactory. Among the 13 known genera of the family Serranidae (Fischer and Whitehead, 1974), fishes of the genus Epinephelus was only represented in the study area. Day (1878) reported 31 species from India under the genus Serranus Cuvier, which was placed in the family Percidae. Weber and de Beaufort (1931) described 38 species under the genus Epinephelus from Indo-Australian Archipelago and Munro (1955) reported 14 species from Sri Lanka waters. 3 species were listed from Eastern Indian Ocean and Western Central Pacific (Fischer and Whitehead, 1974). Jones and Kumaran (1964) reported one new distributional record from the seas around India and also described 13 species from Laccadive Archipelago (Jones and Kumaran, 1980).

Key to genus

Dorsal with 11 spines; anal with 7-9 soft rays; lat. line scale more than 80; preopercle moderately serrated, lower edge without antrose spines; canine teeth present; no distinct enlarged canines on sides of mandible; palatines toothed; caudal fin rounded .... Epinephelus Bloch.

Epinephelus Bloch, 1790

Epinephelus Bloch, 1790: 33.

Key to species

Body depth 27.85-31.25% in SL; dorsal with 14-15 soft rays; gill rakers 11-14; opercular spines more or less equidistant; last dorsal spine nearly equal to third dorsal spine; maxilla tip nearly reaching to posterior margin of eye; body is having 4-5 black oblique interrupted cross bands; reddish brown spots on head, body and fins ... . Epinephelus tauvina (Forsskal).

Epinephelus tauvina (Forsskal, 1775)
Plate 26.1

Perca tauvina Forskal, 1775: 39.
Serranus maculosus Cuvier and Valenciennes, 1828: 332.
Serranus diacanthus Gunther, 1859: 11[illegible].
Serranus salmoides Day, 1878: 2[illegible].
Epinephelus tauvina Jordan and Evermann, 1902: 341;
Weber and de Beaufort, 1931: 6[illegible]; Munro, 1950: 114;
Fischer and Whitehead, 1974.

Description: Based on 25 specimens ranging in size 51.0-172.0 mm SL (64.0-213.0 mm TL).

Fin formula: D. XI, 14–15; A. III, 8–9; P. 19; V. I, 5; C. 18.

Body measurements expressed in percent of standard length: greatest body depth 27.85–31.25 (M = 29.89); head length 39.35–43.84 (M = 41.24); snout to D fin origin 38.14–42.06 (M = 38.89); snout to A fin origin 69.28–73.91 (M = 71.64); snout to pectoral fin origin 35.18–40.76 (M = 37.97); snout to pelvic fin origin 38.82–44.28 (M = 41.43); base D fin 51.42–55.38 (M = 53.39); base A fin 14.91–16.29 (M = 15.66); pectoral fin length 21.29–24.78 (M = 22.94); pelvic fin length 17.10–20.63 (M = 18.71); longest D spine (5th) 10.94–14.28 (M = 11.81); longest A spine (3rd) 7.94–11.11 (M = 9.01); least depth of caudal peduncle 10.71–12.74 (M = 11.34);

In percent of head length: snout length 22.72–27.38 (M = 25.39); orbit diameter 15.78–18.82 (M = 16.41); least width of interorbital space 12.50–15.50 (M = 14.01).

Body slightly elongated. Snout pointed. Mouth terminal, lower jaw projecting. Cleft of mouth oblique. Maxilla tip nearly reaching to posterior margin of eye. Interorbital space concave. Anterior nostril with a flap. Hind margin of preopercle serrated, lower angle with prominent spinules. Opercle with 3 flat spines, nearly equidistant. Gill rakers on first arch (3–4) + (8–10) =

11-14. Jaws with two series of inwardly directed pointed conical teeth, outer row of small canines. Lateral line arched, reaching to half of caudal fin. Ventral fin close nearer. Caudal fin rounded.

Scales: Lateral line scales 88-92; in transverse series 36-42. Cycloid scales on head excluding snout and interorbital space. Elongated ctenoid scales on body, fins base and fins.

Colour: Dark brown with 4-5 dark oblique interrupted cross bands. Head, body and fins with reddish brown round spots. Pelvic fins very blackish. Other fins dark brownish.

Distribution: Red Sea, East coast of Africa, Persian Gulf, China, Formosa, Japan, Philippines, Hawaiian Islands, Australia, Sri Lanka and coasts of India.

Other materials examined: ZSI No. F 1178/2 (185.0 mm SL) Madras, A. K. Menon Coll.

Remarks: Munro (1955) reported 10 gill rakers on lower first gill arch of E. tauvina and Fischer and Whitehead (1974) noted 27-30 gill rakers. But in the present study 8-10 gill rakers were only observed. Similarly, a higher number of dorsal fin rays (15-16) were reported (Fischer and Whitehead, 1974) but in the present observation the dorsal fin rays ranged from 14-15.

2.4.25. <u>FAMILY : THERAPONIDAE</u>

<u>Characters of taxonomic value</u>: Body oblong-ovate and compressed. Snout blunt. Mouth terminal and protractile. Teeth villiform or conical, in bands in jaws, outer series often enlarged. Teeth on vomer and palate present or absent. Gill membrane united or separated from isthmus. Scales ctenoid. Two nostrils on each side. Preopercle strongly serrated. Opercle with 2 flat spines. Lateral line complete. Single dorsal fin with 12-14 strong spines. Anal fin with 3 spines. Pelvic fin with one spine and 5 rays. Caudal fin forked.

Of the 3 genera known (Fischer and Whitehead, 1974) under this family, fishes of the genus <u>Therapon</u> was only represented in the Vembanad lake. Day (1878) reported 6 species from India, Weber and de Beaufort (1931) described 9 species from Indo-Australian Archipelago, Munro (1955) noted one species from Sri Lanka waters, Fischer and Whitehead (1974) listed 8 species from Eastern Indian Ocean and Western Central Pacific and Jones and Kumaran (1980) reported 3 species from Laccadive Archipelago.

<u>Key to genus</u>

outer series nearly conical; gill membrane free from isthmus .... *Therapon* Cuvier.

Therapon Cuvier, 1817

Therapon Cuvier, 1817: 295.
Mesopristes Bleeker, 1845: 327.
Eutherapon Fowler, 1904: 527.

Key to species

Body depth 32.35–37.50% in SL; 13–15 scale rows above lateral line; lat. line scales 87–96; preopercle serrated, moderately enlarged serrations at the angle; vomer and palatines toothed; three brownish downwardly curved lateral bands; a black blotch on spinous dorsal ... . *Therapon jarbua* (Forsskal).

Therapon jarbua (Forsskal, 1775)
Plate 26.2

Sciaena jarbua Forskal, 1775: 50.
Therapon servus Gunther, 1859: 278.
Therapon (*Datina*) *jarbua* Bleeker, 1873: 377.
Therapon jarbua Day, 1878: 69; Fowler, 1928: 211; Weber and de Beaufort, 1931: 147; Munro, 1955: 116; Fischer and Whitehead, 1974.

Description: Based on 25 specimens ranging in size 31.0–101.0 mm SL (38.0–121.0 mm TL).

Fin formula: D. XI, 10; A. III, 8; P. 12-13; V. I, 5; C. 18.

Body measurements expressed in percent of standard length: greatest body depth 32.35-37.50 (M = 34.55); head length 33.67-39.50 (M = 36.24); snout to D fin origin 39.79-44.44 (M = 41.94); snout to A fin origin 69.80-72.22 (M = 70.16); snout to pectoral fin origin 32.22-38.69 (M = 34.83); snout to pelvic fin origin 39.18-45.55 (M = 44.36); base D fin 47.52-50.94 (M = 48.82); base A fin 16.83-19.35 (M = 17.58); pectoral fin length 16.66-19.44 (M = 17.79); pelvic fin length 20.83-24.19 (M = 22.97); longest D spine (4th) 16.12-19.71 (M = 18.44); longest A spine (3rd) 9.72-12.26 (M = 11.16); least depth of caudal peduncle 11.11-13.33 (M = 12.55).

In percent of head length: snout length 25.00-29.62 (M = 28.29); orbit diameter 20.00-23.52 (M = 22.45); least width of interorbital space 23.52-28.30 (M = 26.42).

Body oblong and compressed. Cleft of mouth slightly oblique. Hind end of maxilla nearly reaching to anterior margin of eye. Interorbital space flat. Anterior nostril with a flap. Gill rakers on first arch (6-7) + (9-11) = 15-18. Teeth in jaws in villiform band, outer series enlarged. Vomer and palatine toothed. Preopercle serrated, two spinules at lower angle. Opercle with two flat spines, the lower one very pungent. Lateral line slightly arched anteriorly, reaching to base of caudal fin. Caudal fin slightly forked.

Scales: Lateral line scales 87-96; in transverse series 39-42. Scales small, present on body on head excluding snout and interorbital space. Scales present at the base of paired and unpaired fins and also on caudal and anal fins.

Colour: Silvery with brown tinge. 3 brownish downwardly curved lateral bands, first one starting from the origin of dorsal and ends below the middle of soft dorsal, second one from nape to end of soft dorsal and third one from opercle to tip of caudal fin. A black blotch between 3rd and 6th dorsal spines. Distal margins of 9th and 10th dorsal spine, 2-4th and last 3 rays of soft dorsal blackish. Caudal fin with 4 oblique black lines, the lobes tipped with black. Pectoral fin pinkish. Middle rays of pelvic and anal fins yellowish.

Distribution: East Africa, Red Sea, China, Taiwan, Japan, Fiji, Indonesia, Philippines, Australia, Sri Lanka and coasts of India including Laccadives.

Other materials examined: ZSI Nos. 1952 (88.0 mm SL), 1954 (94.0 mm SL) 1955 (120.0 mm SL) 1956 (96.0 mm SL) Madras, F. Day Coll.

2.4.26. FAMILY : SILLAGINIDAE

Characters of taxonomic value: Body elongate and tapering. Head slightly depressed and conical. Mouth terminal, maxillary concealed below preorbital. Vertical limb of preopercle serrated, lower part of preopercle bent inwards to meet the other side. Opercle with a small sharp spine. Lateral line almost straight. Jaw teeth villiform, vomerine teeth present. Two dorsal fin, 10-13 slender spines on first dorsal fin, one spine and 16-27 rays in the second dorsal fin. Anal with 2 weak spines and 14-26 rays. Caudal fin truncate or slightly emarginate.

Day (1878) described 3 species of fishes of the genus Sillago Cuvier from Indian waters and Weber and de Beaufort (1931) added three more species from Indo-Australian Archipelago. The occurrence of S. chondropus Bleeker in Indian waters was first reported by Palekar and Bal (1955). Mckay (1976) in his very recent revision on Sillaginid fishes of India, reported 5 species under two genera which includes the description of a new species from the backwaters of Kerala. Dutt and Sujatha (1980) recorded 7 species of fishes of the family Sillaginidae from Indian waters.

Key to genus:

head not very depressed; eyes normal (not very small); swimbladder present .... *Sillago* Cuvier.

Sillago Cuvier, 1817

Sillago Cuvier, 1817: 258; Bleeker, 1874: 63.

Key to species

Swimbladder with only one post coelomic extension and no antero-lateral or anterior tubular extensions; 5 rows of black spots on second dorsal fin .... *Sillago vincenti* McKay.

Swimbladder with two very distinct post coelomic extensions, two anteriorly directed extensions and an antero-lateral convoluted tube; vertical black streaks on second dorsal fin .... *Sillago sihama* (Forsskal).

Sillago vincenti McKay, 1976
Plate 27.1

Sillago vincenti McKay, 1976: 373.

Description: Based on 14 specimens ranging in size 9[illegible].[illegible]–21[illegible].[illegible] mm SL (1[illegible]4.0–246.0 mm TL).

Fin formula: D. XI, I, 22–23; A. II, 23–24; P. 1[illegible]–16; V. 6; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 16.08–19.44 (M = 17.54); head length 27.88–29.33 (M = 28.16); snout to D_1 fin origin 33.56–35.96 (M = 34.60); snout to D_2 fin origin 53.33–56.66 (M = 54.90); snout to A fin origin 56.11–59.52 (M = 56.66); snout to pectoral fin origin 28.52–30.05 (M = 29.19); snout to pelvic fin origin 31.54–34.80 (M = 32.85); base D_1 fin 17.12–20.29 (M = 18.92); base D_2 fin 33.33–38.25 (M = 35.38); base A fin 33.52–37.50 (M = 35.13); pectoral fin length 14.75–16.92 (M = 15.63); pelvic fin length 13.98–16.15 (M = 15.14); longest D spine 19.04–23.33 (M = 20.82); least depth of caudal peduncle 6.25–7&77 (M = 6.82).

In percent of head length: snout length 37.03–42.85 (M = 40.05); orbit diameter 17.50–22.85 (M = 20.13); least width of interorbital space 20.00–23.33 (M = 22.04).

Body elongated, snout pointed. Head somewhat depressed and triangular. Interorbital space broad. Mouth terminal and small. Preopercle serrated in its vertical limb, a backwardly directed small spine on operculam. 'U' shaped structure on the snout. Gill rakers on first arch 3+ (6–8) = 9–11. Lateral line complete, extends upto middle of caudal fin. Teeth villiform, present in jaws and vomer. Spines are delicate and flexible, first 3 spines of 1 dorsal fin rather longer. Pelvic fin without thickened club-like first ray. Caudal fin slightly emarginate.

__Scales:__ Lateral line scales 76–84; in transverse series 15–17. The scales of the interorbital space, opercle and cheek are cycloid. Ctenoid scales present all over the body including pectoral axis and caudal fin base. Scales absent on snout.

__Colour:__ Dorsal profile silvery with golden reflection including head, ventral profile white with pinkish tinge. Tip of spinous dorsal fin black, soft dorsal is having five rows of black spots. Pectoral fin base, distal margins of pelvic and anal fins yellowish. Caudal fin dusky.

__Distribution:__ Estuarine waters of Kerala.

__Remarks:__ Mckay (1975) described this new species from the collections of FAO DANIDA expert consultation programme at CMFRI Cochin. __S. vincenti__ is very similar to __S. sihama__ in most of the external characters and can be distinguished only by checking the colour of soft dorsal and the structure of the swimbladder. Besides, the vertebral counts, dorsal and anal fin ray counts, lateral line scale numbers were found to be overlapping in these two species (Mckay, 1976). The holotype of this species was examined.

<u>Sillago sihama</u> (Forsskal, 1779)
<u>Plate 27.2</u>

<u>Atherina sihama</u> Forskal, 1775: 70.
<u>Platycephalus sihama</u> Bloch and Schneider, 1801: 60.
<u>Sillago acuta</u> Bleeker, 1849: 61.
<u>Sillago sihama</u> Gunther, 1860: 243; Day, 1878: 265; Fowler, 1928: 235; Weber and de Beaufort, 1931: 172; Munro, 1955: 121; Fischer and Whitehead, 1974; Mckay, 1976: 381.

<u>Description</u>: Based on 20 specimens ranging in size 66.0–265.0 mm SL (77.0–300.0 mm TL).

<u>Fin formula</u>: D. XI, I, 22; A. II, 22–23; P. 14; V. 6; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 16.19–19.24 (M = 17.67); head length 28.69–30.43 (M = 29.04); snout to D_1 fin origin 34.00–36.00 (M = 35.62); snout to D_2 fin origin 54.27–56.98 (M = 55.78); snout to A fin origin 56.06–60.71 (M = 57.68); snout to pectoral fin origin

29.82–32.47 (M = 31.14); snout to pelvic fin origin 31.34–35.47 (M = 33.53); base D_1 fin 16.00–19.04 (M = 18.09); base D_2 fin 32.72–36.90 (M = 34.56); base A fin 31.81–36.01 (M = 33.94); pectoral fin length 14.00–16.52 (M = 15.17); pelvic fin length 13.24–15.47 (M = 14.59); longest D spine 15.15–20.75 (M = 18.37); least depth of caudal peduncle 5.76–7.57 (M = 6.54).

In percent of head length: snout length 38.69–42.00 (M = 40.58); orbit diameter 18.47–23.68 (M = 20.04); least width of interorbital space 17.39–21.05 (M = 19.78).

Body elongated. Snout pointed. Head somewhat depressed and triangular. Interorbital space broad. Mouth terminal and small. Preopercle serrated in its vertical limb, a backwardly directed spine on opercle. 'U' shaped structure on the snout. Gill rakers on first arch 2–3 + 6–8 = 8–11. Lateral line complete, extends upto middle of caudal fin. Teeth villiform, as bands in jaws, semicircular band in vomer. Spines are delicate and flexible, first few dorsal spines rather longer. Pelvic fin without thickened club-like first ray. Caudal fin slightly emarginate.

Scales: Lateral line scales 74–78, in transeverse series 16–17. The scales of interorbital space, opercle and cheek cycloid. Ctenoid scale present all over the body including pectoral axis and caudal fin base. Scales absent on snout.

Colour: Greyish brown above with golden reflections, ventral profile silvery with purple reflection. Snout tip black. Tip of spinous dorsal black, vertical black streaks on soft dorsal fin. Caudal fin dusky. Distal margins of ventral and anal fins yellowish.

Distribution: Japan, Red Sea, Aden, East Africa, Zanzibar, Coast of Natal, Madagascar, Mauritius, Seychelles, Malayan Peninsula, Bangkok, China, Formosa, Philippines, North Australia, Sri Lanka, India: both east and west coasts including Andaman and Nicobar islands.

Other materials examined: ZSI Reg. Dup. Cat. 66 (120.00 mm SL) Andamans, Dup. Cat. 404 (195.0 mm SL) Akyab, 1836 (211.0 mm SL) Madras, 2109 (209.0 mm SL) Madras, F. Day Coll.

2.4.27. FAMILY : CARANGIDAE

Body rhomboid, oblong or elongate and slender. Mouth slightly protractile. Jaws with villiform bands of teeth; teeth present on vomer, palate and pterygoides. Gill membrane free from isthmus. Scales cycloid, rounded, lanceolate or needle-shaped. Lateral line usually arched anteriorly, becoming straight posteriorly with scutes, but wanting in some species. Two dorsal fins, spinous dorsal fin short based with 5-8 spines, often preceded by a procumbent spine, soft dorsal with a long base. Anal fin usually preceded by two detached spines, separated from rest of the fins. Pelvic fin with one spine and 5 rays. Caudal fin deeply forked.

A brief review of the literature shows that the first detailed account of Indian Carangids was by Day (1878) who described 38 species from Indian waters and many of the genera were raised to families by subsequent workers. Weber and de Beaufort (1931) reported 53 species under 11 genera from Indo-Australian Archipelago and there is the occurrence of 36 species in Sri Lanka waters (Munro, 1955). Misra (1959) listed 24 species from the collections of Zoological Survey of India, Calcutta. Fischer and Whitehead (1974) listed 65 species under 20 genera from Eastern Indian Ocean and Western Central Pacific. There is the occurrence of 17 species in Laccadive Archipelago (Jones and Kumaran, 1980).

New species of Carangid fishes has been described by Chu and Cheng (1958) and Williams (1961). Many new distributional records from the seas around India have been reported and the recent important records of interest are those of Jones and Kumaran (1966), Reuben (1967, 1968), Luther (1971), Sreenivasan (1975, 1976) and Dutt and

Shameem (1976). Other important studies on systematics of this group of fishes are those of Smith (1967a, 1967b; 1967c, 1968, 1970). Talwar (1969a), Smith (1972, 1973), Smith and Staiger (1973), Venkataramani and Ramaiyan (1977), Williams and Venkataramani (1978) and Williams et al. (1980). Recently Venkataramani (1979) conducted a detailed taxonomic investigation on all available Carangid fishes of Porto Novo waters and described 29 species under 13 genera, which include 2 new distributional records from the Bay of Bengal and other two records from Indian seas.

Key to genera

1. Lat. line with scutes; pectoral fin long and falcate .... 2.

Lat. line without scutes; pectoral fin short and not falcate .... 3.

2. 8-9 and 7-8 detached finlets behind soft dorsal and anal; eye covered with adipose eyelid except a median slit .... *Megalaspis* Bleeker.

No detached finlets behind soft dorsal and anal; adipose eyelid not fully covering eye except a median slit .... 3.

3. Body without visible scales, embedded in skin;

spinous dorsal with less than 7 spines and not connected by membrane; anterior dorsal and anal rays filament lime .... *Alectis* Rafinesque.

Body with small visible scales, not embedded in skin; spinous dorsal with 7-8 spines, connected by a membrane; anterior dorsal and anal rays not filament like .... 4.

4. No deep groove on abdomen; teeth present in both jaws; adipose tissue covering the eye leaving anterior half of eye exposed .... a,b and c.

a) Jaws with single series of uniform villiform teeth; scutes prominent posteriorly; breast scaled .... *Alepes* Swainson.

b) Jaws with villiform teeth in bands, widest anteriorly, outer rows often enlarged; scutes not prominent; breast scaled or naked .... *Carangoides* Bleeker.

c) Upper jaw with two series of teeth, the outer series slightly enlarged; lower jaw with a single series of teeth; scutes prominent; breast scaled or naked .... *Caranx* Lacepede.

5. Body slender; soft dorsal and anal with semidetached finlets posteriorly, not falcate; scales

lanceolate or needle like and partly embedded in skin .... *Scomberoides* Lacepede.

Body deep; soft dorsal and anal without semidetached finlets posteriorly, strongly falcate; scales circular .... *Trachinotus* Lacepede.

Megalaspis Bleeker, 1851

Megalaspis Bleeker, 1851: 248.

This genus contains only the following species.

Megalaspis cordyla (Linnaeus, 1758)
Plate 28.1

Scomber cordyla Linnaeus, 1758: 298.
Caranx rottleri Gunther, 1860: 424; Day, 1878: 213.
Megalaspis cordyla Wakiya, 1924; Fowler, 1928: 143; Weber and de Beaufort, 1931: 193; Munro, 1955: 124; Fischer and Whitehead, 1974; Venkataramani, 1979: 164.

Description: Based on 12 specimens ranging in size 73.0–181.0 mm SL (86.0–210.0 mm TL).

Fin formula: D. I, VIII; I, 10; 8–9; A. II; I, 9–10; 7–8; P. 1,20; V. 1,5; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 24.85–28.76 (M = 26.19); head

length 25.13–28.48 (M = 26.07); snout to D_1 fin origin 31.36–37.64 (M = 32.92); snout to D_2 fin origin 46.15–52.05 (M = 48.09); snout to A fin origin 53.37–58.90 (M = 56.28); snout to pectoral fin origin 25.56–29.67 (M = 27.07); snout to pelvic fin origin 29.55–35.44 (M = 32.60); base D_1 fin 12.85–15.06 (M = 13.83); base D_2 fin 14.08–17.80 (M = 15.05); base A fin 12.49–16.43 (M = 13.96); pectoral fin length 25.27–28.45 (M = 26.09); pelvic fin length 12.02–13.73 (M = 12.57); height of 3D spine 9.46–11.64 (M = 10.14); CLL 14.55–17.12 (M = 15.73); SLL 57.14–62.13 (M = 62.92); least depth of caudal peduncle 2.52–3.42 (M = 2.92).

In percent of head length: snout length 26.31–28.57 (M = 27.68); orbit diameter 22.22–28.88 (M = 24.72); least width of interorbital space 25.80–28.88 (M = 26.37).

Body oblong-elongate and compressed, posteriorly tapering. Snout pointed. Mouth terminal, lower jaw prominent. Cleft of mouth oblique, hind tip of maxilla broad and reaching to vertical below middle of eye. Interorbital space elevated. Adipose eyelid well developed and nearly reaching to pupil. Gill rakers on first arch (10–13) + (21–22) = 31–35. Villiform teeth in bands in upper jaw, vomer, palate and tongue, in a single series in lower jaw. Lateral line strongly arched anteriorly, becoming straight below 5th-6th dorsal spine. Pectoral fin reaching to below middle of soft dorsal. 8-9 and 7-8 finlets on posterior part of soft dorsal and anal fins respectively. Caudal fin deeply forked.

Scales: Present on body except breast and absent on head excluding postorbital area.

Colour: Bluish-green above, silvery below. A black spot on posterior edge of opercle. Dorsal and anal fins dusky black, other fins grey.

Distribution: Red Sea, Natal, Madagascar, South and East Africa, Hawaiian Islands, Sri Lanka and coasts of India.

Other materials examined: ZSI No. F 1119/2 (193.0 and 221.0 mm SL) Pondicherry, A.G.K. Menon Coll.

Alectis Rafinesque, 1815

Alectis Rafinesque, 1815: 88.

Key to species

Orbit diameter less than suborbital depth; gill rakers on first arch (8-9) + 24 .... *Alectis indicus* (Ruppell).

__*Alectis indicus*__ (Ruppell, 1828)

__Plate 28.2__

__*Scyris indicus*__ Ruppell, 1828: 128.

__*Scyris indica*__ Cuvier and Valenciennes, 1833: 145; Fowler, 1928: 151.

__*Caranx gallus*__ Gunther, 1860: 455; Day, 1878: 224.

__*Alectis indicus*__ Barnard, 1925-27: 550; Smith, 1965: 219; Fischer and Whitehead, 1974:, Venkataramani, 1979: 154.

__*Alectis indica*__ Weber and de Beaufort, 1931: 271; Munro, 1955: 125.

__Description__: Based on 2 specimens, 79.0 and 131.0 mm SL (100.0 and 161.0 mm TL).

Body measurements expressed in percent of standard length: greatest body depth 67.93-77.21 (M = 72.57); head length 36.64-40.50 (M = 38.57); snout to D_1 fin origin 51.13-58.01 (M = 54.57); snout to D_2 fin origin 64.81-69.46 (M = 67.13); snout to A_2 fin origin 51.90-55.69 (M = 53.79); snout to pectoral fin origin 36.64-36.70 (M = 36.67); snout to pelvic fin origin 30.15-32.26 (M = 31.21); base D_1 fin 12.21-16.45 (M = 14.33); base D_2 fin 53.43-54.43 (M = 53.93); base A_2 fin 45.56-45.80 (M = 45.68); pectoral fin length 35.44-36.99 (M = 36.21); pelvic fin length 53.43-54.43 (M = 53.93);

height of 3D spine 3.81-4.43 (M = 4.12); CLL 29.77-33.54 (M = 31.66); SLL 36.10-38.54 (M = 37.62); least depth of caudal peduncle 4.58-5.06 (M = 4.82).

In percent of head length: snout length 30.00, orbit diameter 25.00, least width of interorbital space 18.75.

Body rhomboid, deep and well compressed. A strong ascent from snout to dorsal fin origin with a concavity above eye, strong descent from dorsal origin to caudal peduncle. Snout pointed. Mouth terminal, lower jaw very prominent. Cleft of mouth oblique, hind tip of maxilla reaching to vertical below anterior margin of eye. Interorbital space elevated. Adipose eyelid rudimentary. Gill rakers on first arch (8-9) + 24 = 32-33. Villiform teeth in band in jaws, also on vomer, palate and tongue. Lateral line strongly arched anteriorly, becoming straight below 10th-11th dorsal ray, with feeble scutes on caudal peduncle. Pectoral fin long, reaching to below 11th-12th dorsal ray. Anterior rays of soft dorsal and anal fins filamentous, pelvic fin elongated and reaching to caudal fin, the later deeply forked.

<u>Scales</u>: Minute, inconspicuous and embedded in skin.

<u>Colour</u>: Silvery with yellow tinge. 4-5 broad vertical black bands in young ones. Upper edge of opercle with

a black spot. Filamentous rays of dorsal, anal and pelvic fins black. Other fins colourless.

<u>Distribution</u>: Red Sea, East coast of Africa, Madagascar, Hawaiian Islands, Formosa, Australia, Sri Lanka and coasts of India.

<u>Other materials examined</u>: ZSI Nos. 263–265 (39.0–157.0 mm SL) Madras, F. Day Coll.

<u>*Alepes* Swainson, 1839</u>

<u>*Alepes*</u> Swainson, 1839: 200.

<u>Key to species</u>

Gill rakers on first arch (12–13) + (29–33); scutes 43–46; straight part of lat. line originates below 2nd–3rd soft dorsal ray .... <u>*Alepes djeddaba*</u> (Forsskal).

<u>*Alepes djeddaba* (Forsskal, 1775)</u>
<u>Plate 29.1</u>

<u>*Scomber djeddaba*</u> Forskal, 1775: 56.

<u>*Caranx djeddaba*</u> Ruppel, 1828: 97; Gunther, 1860: 432; Day, 1889: 153.

<u>*Caranx* (*Selar*) *djeddaba*</u> Weber and de Beaufort, 1931: 214.

<u>*Alepes djeddaba*</u> Fischer and Whitehead, 1974; Venkataramani, 1979: 106.

Description: Based on 25 specimens ranging in size 50.0–137.0 mm SL (64.0–167.0 mm TL).

Fin formula: D. I, VIII; I, 22–24; A. II; I, 19–21; P. I, 18–20; V. I, 5; C. 20–22.

Body measurements expressed in percent of standard length: greatest body depth 29.99–33.08 (M = 32.15); head length 27.00–30.38 (M = 29.31); snout to D_1 fin origin 33.65–36.76 (M = 34.60); snout to D_2 fin origin 48.17–51.47 (M = 50.35); snout to A_2 fin origin 54.76–57.35 (M = 56.76); snout to pectoral fin origin 28.57–31.61 (M = 29.89); snout to pelvic fin origin 34.67–37.79 (M = 35.31); base D_1 fin 13.44–16.66 (M = 14.54); base D_2 fin 38.00–42.25 (M = 40.40); base A_2 fin 34.00–37.03 (M = 35.81); pectoral fin length 25.92–30.25 (M = 28.04); pelvic fin length 11.00–13.23 (M = 12.09); height of 3 D spine 9.87–11.97 (M = 11.06); CLL 21.63–23.52 (M = 22.65); SLL 49.99–55.95 (M = 53.66); least depth of caudal peduncle 4.00–5.63 (M = 4.68).

In percent of head length: snout length 25.86–29.41 (M = 27.39); orbit diameter 24.00–28.57 (M = 26.44); least width of interorbital space 24.24–28.57 (M = 26.30).

Body oblong and compressed. Mouth terminal, lower jaw slightly longer. Gape of mouth oblique, hind tip of maxilla reaching to nearly vertical below anterior margin of eye. Interorbital space elevated. Adipose eyelid absent on anterior half of eye. Gill rakers on first arch (12-13) + (29-33) = 41-46. Lower part of gill opening without furrow. Villiform teeth in jaws in a single series. Fine teeth on vomer, palate and tongue. Anterior part of lateral line arched, becoming straight below 2nd-3rd dorsal ray. Pectoral fin long, reaching to below 7th-8th dorsal ray. Anterior rays of soft dorsal and anal high. Caudal fin deeply forked.

Scales: Present on body including breast, absent on head excluding cheek and upper part of operclo. Scale sheath at the base of soft dorsal and anal fins.

Colour: Greenish above, silvery below. A black spot on upper opercular margin. Spinous dorsal fin black. Soft dorsal margin fringed with black. Caudal fin yellowish, tip black. Other fins yellowish.

Distribution: Red Sea-Natal, Madagascar, East Africa, Ryukyu Islands, Philippines, Australia and coasts of India.

Other materials examined: ZSI Nos. 32 (184.0 mm SL) Malabar, F 266 (268.- mm SL) Pakistan, F. Day Coll.

Carangoides Bleeker, 1851

Carangoides Bleeker, 1851: 248.

Key to species

Breast naked laterally; gill rakers on first arch (12–13) + (3 –33); scutes 28–32; soft dorsal fin lobe with a black blotch distally .... *Carangoides praeustus* (Bennett).

Carangoides praeustus (Bennett, 1830)
Plate 29.2

Caranx praeustus Bennett, 1830: 689; Gunther, 1860: 436.

Caranx ire Cuvier and Valenciennes, 1833: 57; Day, 1878: 22 .

Carangoides praeustus Bleeker, 1851: 363; Munro, 1955: 126; Venkataramani, 1979: 142.

Caranx (*Carangoides*) *Praeustus* Weber and de Beaufort, 1931: 224.

Description: Based on 5 specimens ranging in size 99. –158.0 (121.0–191.0 mm TL).

Fin formula: D. I, VIII; I, 23–24; A. II; I, 19–20; P. I, 18; V. I,5; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 31.69–35.35 (M = 33.02); head length 28.10–30.80 (M = 29.29); snout to D_1 fin origin 32.70–35.85 (M = 34.35); snout to D_2 fin origin 51.63–54.54 (M = 52.74); snout to A_2 fin origin 57.51–60.12 (M = 58.98); snout to pectoral fin origin 29.41–30.37 (M = 29.86); snout to pelvic fin origin 36.31–40.25 (M = 38.67); base D_1 fin 14.55–15.65 (M = 15.28); base D_2 fin 37.34–40.40 (M = 38.97); base A_2 fin 33.86–35.85 (M = 34.85); pectoral fin length 22.40–23.41 (M = 22.85); pelvic fin length 13.31–14.14 (M = 13.77); height of 3D spine 10.75–12.33 (M = 11.32); CLL 34.34–35.75 (M = 35.03); SLL 36.00–42.42 (M = 38.00); least depth of caudal peduncle 4.54–5.55 (M = 4.85).

In percent of head length: snout length 30.23–34.09 (M = 31.84), orbit diameter 22.72–25.53 (M = 23.90); least width of interorbital space 27.06–32.90 (M = 30.13).

Body oblong and compressed. Snout pointed. Mouth terminal, gape of mouth horizontal, hind tip of maxilla reaching to vertical below anterior margin of eye. Interorbital space convex. Adipose eyelid broader posteriorly than anteriorly. Gill rakers on first arch (12–13) + (30–33) = 42–46. Villiform teeth in band in jaws, the outer row enlarged in upper jaw. Teeth in bands on palate and tongue, as a semilunar patch on vomer anteriorly and as a narrow band posteriorly. Lateral line arched anteriorly, becoming straight below 11th-12th dorsal ray. Pectoral fin long, reaching to below 2nd soft dorsal ray. Caudal fin deeply forked.

Scales: Present on body excluding breast (from origin of pelvic fin to opercular flap). Cheek and upper part of opercle scaly. Soft dorsal and anal fins with basal scaly sheath.

Colour: Brownish-black above, silvery below. Ventral part of head black. Soft dorsal fin lobe with a black blotch, other fins yellowish.

Distribution: Philippines, Riuw Archipelago, Java, Sumatra, Celebes, Singapore, Sri Lanka and coasts of India.

Other materials examined: ZSI Cat. No. 178 (117.0 mm SL) Ganjam, F. Day Coll.

Caranx Lacepede, 1802

Caranx Lacepede, 1802: 60.

Key to species

Breast fully scaled; gill rakers on first arch (6-7) + (16-18); anal with 14-16 rays .... Caranx sexfasciatus Quoy and Gaimard.

<u>*Caranx sexfasciatus*</u> Quoy and Gaimard, 1824

Plate 30.1

<u>*Caranx sexfasciatus*</u> Quoy and Gaimard, 1824: 358; Munro, 1955: 128; Fischer and Whitehead, 1974; Venkataramani, 1979: 144.

<u>*Caranx hippos*</u> Day, 1878: 216.

<u>Description</u>: Based on 25 specimens ranging in size 40.0–183.0 mm SL (48.0–223.0 mm TL).

<u>Fin formula</u>: D. I, VIII; I, 19–20; A. II; I, 14–16; P. I, 18–19; V. I, 5; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 36.50–41.58 (M = 38.99); head length 31.09–33.59 (M = 32.71); snout to D_1 fin origin 38.13–42.85 (M = 40.08); snout to D_2 fin origin 56.33–61.72 (M = 58.70); snout to A_2 fin origin 58.73–62.31 (M = 60.17); snout to pectoral fin origin 30.45–33.12 (M = 31.68); snout to pelvic fin origin 33.54–38.02 (M = 36.32); base D_1 fin 16.90–20.00 (M = 18.14); base D_2 fin 35.21–38.75 (M = 36.83); base A_2 fin 30.95–34.21 (M = 32.32); pectoral fin length 28.98–33.74 (M = 31.03); pelvic fin length 12.87–15.30 (M = 14.10); height of 2D spine 11.70–15.07 (M = 13.44); CLL 27.50–32.50 (M = 29.86); SLL 39.68–44.94 (M = 41.68); least depth of caudal peduncle 4.54–5.62 (M = 4.89).

In percent of head length: snout length 25.88-30.95 (M = 30.03); orbit diameter 23.80-26.15 (M = 24.13); least width of interorbital space 24.07-28.94 (M = 27.45).

Body oblong and moderately compressed. Mouth terminal, lower jaw slightly oblique, hind tip of maxilla reaching to vertical below middle of eye. Interorbital space elevated. Adipose eyelid broader posteriorly than anteriorly. Gill rakers on first arch (6-7) + (16-18) = 22-25. Upper jaw with an outer row of conical teeth and an inner band of fine teeth, a single row of conical teeth in lower jaw. Fine teeth in bands on vomer and palate. Anterior portion of lateral line strongly arched, becoming straight below 5th-6th dorsal ray with scutes posteriorly. Pectoral fin long, reaching below 8th dorsal ray. Anterior rays of soft dorsal and anal fins with falcate lobes. Caudal fin deeply forked.

Scales: Present on body with fully scaled breast, absent on head excluding cheek and postorbital area. Scale sheath at the base of soft dorsal and anal fins.

Colour: Yellowish above, silvery below. A small black spot on upper angle of opercle. Spinous dorsal, soft dorsal lobe and forked margin of caudal fins blackish. Other fins yellowish. Juveniles with broad vertical black bands.

Distribution: East Africa to Red Sea, Natal, Madagascar, Hawaiian Islands, Sri Lanka and coasts of India.

Other materials examined: ZSI No. 8288 (174.0 mm SL) Burma, F. Day Coll.

Scomberoides Lacepede, 1802

Scomberoides Lacepede, 1802: 60.

Key to species

Hind end of maxilla reaching to vertical below slight beyond posterior margin of eye; gill rakers on first arch (3-4) + (9-11); 4-8 vertically oblong black blotches intersects the lat. line; dorsal fin lobe uniformly pigmented .... Scomberoides tala (Cuvier).

Hind end of maxilla reaching to vertically below middle of eye; gill rakers on first arch (7-8) + (17-19); indistinct vertically oblong lateral blotches, the anterior one intersects lat. line; dorsal fin lobe densily pigmented .... Scomberoides tol (Cuvier).

Scomberoides tala (Cuvier, 1831)
Plate 30.2

Chorinemus tala Cuvier in Cuvier and Valenciennes, 1831:

377; Day, 1878: 231; Weber and de Beaufort, 1931: 281; Munro, 1955: 130.

Chorinemus toloo Cuvier in Cuvier and Valenciennes, 1831: 377; Day, 1878: 130.

Scomberoides tala Smith-Vaniz and Staiger, 1973: 199; Fischer and Whitehead, 1974; Venkataramani, 1979: 176.

Description: Based on 6 specimens ranging in size 154.0-204.0 mm SL (186.0-254.0 mm TL).

Fin formula: D. I, VII; I, 19-20; A. II; I, 18; P. I, 17; V. I, 5; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 30.39-32.35 (M = 31.44); head length 22.15-22.79 (M = 22.54); snout to D_1 fin origin 30.68-32.36 (M = 31.63); snout to D_2 fin origin 53.40-55.49 (M = 54.46); snout to A_2 fin origin 50.64-52.60 (M = 51.21); snout to pectoral fin origin 23.01-23.52 (M = 23.17); snout to pelvic fin origin 26.22-27.59 (M = 26.77); base D_1 fin 18.46-20.23 (M = 19.19); base D_2 fin 40.19-42.77 (M = 41.26); base A_2 fin 41.47-45.09 (M = 43.02); pectoral fin length 13.29-13.72 (M = 13.49); pelvic fin length 9.65-11.03 (M = 10.61); height of 3D spine 3.43-5.51 (M = 4.38); CLL 9.74-10.78 (M = 10.30); SLL 69.48-74.99 (M = 71.27); least depth of caudal peduncle 4.82–5.63 (M = 5.29).

In percent of head length: snout length 24.35–26.08 (M = 25.24); orbit diameter 21.51–26.09 (M = 23.98); least width of interorbital space 25.64–27.95 (M = 27.24).

Body elongate and well compressed. Snout blunt. Mouth terminal, lower jaw longer. Cleft of mouth oblique, hind end of maxilla reaching to vertical below slightly beyond posterior margin of eye. Interorbital space convex. Adipose eyelid rudimentary. Gill rakers on first arch (3–4) + (9–11) = 12–15. Upper jaw with a single series of teeth, two series in lower jaw of which the outer row directed outwards. Canine teeth on symphysis. Longitudinal bands on palatine, pterygoid and tongue, as a triangular patch on vomer. Lateral line with a slight arch anteriorly and wavy. Pectoral fin small, reaching to below 4th dorsal spine. Soft dorsal and anal fins high anteriorly with semidetached finlets posteriorly. Caudal fin deeply forked.

Scales: Lanceolate, present on body including breast, absent on head.

Colour: Greyish blue above, silvery below. 4–8 vertically oblong dark blotches intersects the lateral line. Dorsal fin lobe dusky black. Forked margin of caudal fin fringed with black. Inner axil of pectoral fin black. Other fins colourless.

Distribution: Sumatra, Java, Celebes, Sri Lanka and coasts of India.

Other materials examined: ZSI Nos. 1847 (226.0 mm SL) Andamans, 1848: (131.0 mm SL) Madras, F. Day Coll.

Scomberoides tol (Cuvier, 1831)

Plate 30.3

Chorinemus tol Cuvier in Cuvier and Valenciennes, 1831: 385; Weber and de Beaufort, 1931: 283; Munro, 1955: 130.

Chorinemus moadetta Day, 1878: 230.

Scomberoides tol Smith-Vaniz and Staiger, 1973: 209; Fischer and Whitehead, 1974; Venkataramani, 1979: 178.

Description: Based on 14 specimens ranging in size 57.0–147.0 mm SL (68.0–180.0 mm TL).

Fin formula: D. I, VII; I, 19–20; A. II; I, 18–19; P. I, 16–18; V. I, 5; C. 20–22.

Body measurements expressed in percent of standard length: greatest body depth 26.31–29.41 (M = 28.16); head length 22.44–26.47 (M = 24.96); snout to D_1 fin origin 29.37–33.08 (M = 31.42); snout to D_2 fin origin

51.29–53.16 (M = 52.07); snout to A_2 fin origin 49.99–54.76 (M = 52.80); snout to pectoral fin origin 23.12–26.47 (M = 25.46); snout to pelvic fin origin 28.82–31.01 (M = 30.34); base D_1 fin 18.58–21.92 (M = 19.03); base D_2 fin 38.96–42.35 (M = 40.70); base A_2 fin 39.70–42.85 (M = 41.02); pectoral fin length 12.94–15.44 (M = 14.57); pelvic fin length 11.39–14.28 (M = 1[illegible].48); height of 3D spine 5.75–8.33 (M = 6.81); CLL 8.84–12.35 (M = 10.39); SLL 68.23–71.42 (M = 69.82); least depth of caudal peduncle 4.76–6.32 (M = 5.53).

In percent of head length: snout length 28.57–32.14 (M = 29.85); orbit diameter 21.21–26.08 (M = 23.34); least width of interorbital space 25.[illegible]–30.55 (M = 27.50).

Body elongated and well compressed. Snout blunt. Mouth terminal, lower jaw longer. Gape of mouth oblique, hind tip of maxilla reaching to vertical below middle of eye. Interorbital space convex. Adipose eyelid slightly developed. Gill rakers on first arch (7–8) + (17–19) = 24–27. Teeth in upper jaw villiform posteriorly and caniform anteriorly, lower jaw with two rows. Patch of teeth on vomer, palate and tongue. Lateral line wavy, slightly arched anteriorly, becoming straight below the last dorsal spine. Pectoral fin small, reaching to below

3rd dorsal spine. Soft dorsal and anal fins high anteriorly with semidetached finlets posteriorly. Caudal fin deeply forked.

Scales: Needle shaped, present on body including breast, absent on head.

Colour: Bluish above, silvery below. Small indistinct black oval blotches in lateral series, anterior one intersects lateral line. Soft dorsal fin lobe dusky black. Anal fin slightly yellowish. Other fins colourless.

Distribution: Red Sea, South Africa, Madagascar, Natal coast, Sri Lanka and coasts of India.

Other materials examined: ZSI Nos. 12 (181.0 mm SL), 1595 (179.0 mm SL) Madras, F. Day Coll.

Trachinotus Lacepede, 1802

Tachinotus Lacepede, 1802: 79.

Key to species

Body depth 52.94–57.92% in SL, without blotches near the lat. line; gill rakers on first arch 6+(8–9) ... . *Trachinotus blochii* (Lacepede).

Trachinotus blochii (Lacepede, 1802)

Plate 31.1

Scomber falcatus Forskal, 1775: 57.

Caesiomorus bloghii Lacepede, 1802: 95.

Trachinotus ovatus Gunther, 1860: 481; Fowler, 1928: 151:

Trachynotus ovatus Day, 1878: 234.

Trachinotus blochii Weber and de Beaufort, 1931: 286; Munro, 1955: 130; Smith, 1965:223; Fischer and Whitehead, 1974; Venkataramani, 1979: 181.

Description: Based on 7 specimens ranging in size 68.0–123.0 mm SL (90.0–163.0 mm TL).

Fin formula: D. I, VI; I, 19–20; A. II, I, 16–17; P. I, 17–18; V. I, 5; C. 18.

Body measurements expressed in percent of standard length: greatest body depth 52.94–57.72 (M = 54.83); head length 29.00–30.35 (M = 30.20); snout to D_1 fin origin 43.09–49.10 (M = 45.87); snout to D_2 fin origin 61.99–64.70 (M = 63.67); snout to A_2 fin origin 62.19–67.64 (M = 64.69); snout to pectoral fin origin 30.0–31.61 (M = 30.54); snout to pelvic fin origin 38.50–41.91 (M = 39.65); base D_1 fin 17.99–19.11 (M = 18.60); base D_2 fin 37.49–41.05 (M = 38.88); base A_2 fin 33.33–36.00 (M = 34.40); pectoral fin length 20.50–21.99

pelvic fin length 12.19–13.23 (M = 12.70); height of 3D spine 6.69–7.35 (M = 7.05); least depth of caudal peduncle 8.53–9.00 (M = 8.78).

In percent of head length: snout length 24.44–27.02 (M = 25.87); orbit diameter 24.32–28.88 (M = 26.01); least width of interorbital space 39.70–44.18 (M = 42.14).

Body nearly oval and strongly compressed. Snout blunt. Mouth subterminal, upper jaw prominent. Cleft of mouth oblique, hind tip of maxilla reaching to vertical below anterior margin of eye. Lips thick and fleshy. Interorbital space convex. Adipose eyelid rudimentary. Gill rakers on first arch 6+(8–9) = 14–15. Villiform teeth in jaws, vomer and palatines. Lateral line wavy, slightly arched anteriorly. Soft dorsal and anal fins high and falcate. Pectoral fin small, nearly reaching to below 3rd–4th dorsal spine. Caudal fin deeply forked.

Scales: Very small scales present on body including breast, absent on head excluding behind eye.

Colour: Silvery above, golden yellow below. Distal half of soft dorsal, anal and caudal fins blackish. Other fins yellowish.

Distribution: Red Sea, East coast of Africa, Malaya, Indonesia, Philippines, China, Japan, Australia, Samoa, New Hebrides, Sri Lanka and coasts of India including Laccadive Archipelago.

Other materials examined: ZSI Nos. 25-27 (99.0-213.0 mm SL) Madras and Port Blair, 10852 (136.0 mm SL) Mergui, Anderson Coll.

2.4.28. FAMILY : LEIOGNATHIDAE

The systematics and distribution of Leiognathid fishes of Vembanad lake has presented by Kurup and Samuel (1981c). 9 species of silver-belly fishes under 3 genera viz. *Secutor insidiator*, *S. ruconius*, *Leiognathus splendens* (Cuvier), *L. equulus* (Forsskal), *L. bindus* (Valenciennes), *L. daura* (Cuvier), *L. berbis* (Valenciennes), *L. brevirostris* (Valenciennes) and *Gazza minuta* (Bloch) were recorded from the lake. Characters of taxonomic value and brief review on various taxonomic studies of the family Leiognathidae, key to the genera and species of the lake, brief description of the 9 species, notes on occurrence and abundance in the lake and geographic distribution of the 9 species were presented (Kurup and Samuel, 1981c - Appendix 6).

2.4.29. FAMILY : LUTJANIDAE

Characters of taxonomic value: Body oblong and compressed. Mouth terminal and protractile. Cleft of mouth horizontal or oblique. Maxilla tip broader posteriorly, reaching to or beyond the level of the eye. Preopercle usually serrated. Small ctenoid scales present all over the body and head except on the snout, pre and post orbital regions. Two nostrils on each side. Canine teeth present in jaws. Palate and vomer is having patch of small teeth. Lateral line complete. Dorsal with 10-12 spines, anal with 3 spines and pelvic with one spine. Caudal fin truncate, emarginate or slightly forked.

The taxonomy of this group is still unsatisfactory as stated by Fischer and Whitehead (1974) who listed 15 genera under this family from Eastern Indian Ocean and Western Central Pacific. Of the 15 known genera, fishes of the single genus Lutjanus alone was represented in the study area. A perusal of the literature regarding fishes of the genus Lutjanus of the Indo-Pacific area show that Day (1878) described 30 species from Indian waters, Weber and de Beaufort (1936) described 31 species from Indo-Australian Archipelago, Munro (1955) reported 19 species from Sri Lanka waters and Fischer and

Whitehead (1974) listed 28 species from Eastern Indian Ocean and Western Central Pacific.

Key to genus

Scale sheath present at soft dorsal and anal fins base; preopercle with scales; vertical and horizontal margins of preopercle serrated, a distinct notch in its vertical limb ventrally; eyes not at mid-level of head behind tip of snout; caudal fin emarginate, truncate or slightly forked .... Lutjanus Bloch.

Lutjanus Bloch, 1790

Lutianus Bloch, 1790: 108.

Diacope Cuvier, 1828: 360.

Mesoprion Cuvier and Valenciennes, 1828: 441.

Genyoroge Cantor, 1850: 994.

Neomaenis Girard, 1859: 18.

Hypoplites, Evoplites, Proamblys Gill, 1862: 236.

Bennettia, Parkia Fowler, 1904: 524.

Loxolutjanus Fowler, 1931: 165.

Key to species

1. Scales on head beginning above middle of eye; scales above the lat. line parallel to it, scales below the lat. line in horizontal pattern .... 2.

Scales on head beginning behind the eye; scales above the lat. line parallel and/or obliquely ascending to dorsal profile; scales below lat. line in horizontal pattern .... 3.

2. Body depth 37.63–41.31% in SL; head profile slightly convex; an oval dark blotch on lat. line .... Lutianus johni (Bloch).

3. Scales between the lat. line and spinous dorsal parallel, obliquely ascending to dorsal profile between lat. line and soft dorsal rays; body depth 34.37–37.20% in SL; head profile slightly convex; body reddish brown and devoid of blotch .... Lutianus argentimaculatus (Forsskal).

Scales above the lat. line obliquely ascending to the dorsal profile or the predorsal scales may be parallel to it; head profile concave or convex; body golden yellowish or brownish; a distinct black blotch present on the lat. line posteriorly .... 4.

4. Body depth less than 40.0% in SL, with longitudinal bands, no transverse bands .... 5.

Body depth more than 40.0% in SL, without longitudinal band, with transverse bands ....6.

5. Scales above the lat. line are parallel

pre-dorsally, rest of the scales are obliquely ascending to dorsal profile; head profile convex; dorsal rays 13; vomerine teeth as an arrow head patch with posterior elongate projection; golden yellow horizontal lines on the body; greater part of the black blotch below the lat. line .... Lutianus fulviflamma (Forskal).

Scales above the lat. line obliquely ascending to dorsal profile; head profile concave; dorsal rays 14; vomerine teeth as a triangular patch with posterior projection; upper 3 brown bands obliquely ascending, lower ones are nearly horizontal; greater part of the black blotch above the lat. line .... Lutianus russelli (Bleeker).

6. Scales above lat. line obliquely ascending to dorsal profile; head profile slightly convex; 3 transverse black bands of which the first band across the dorsal origin is very distinct; a pearly white spot at the centre of black blotch .... Lutjanus rivulatus (Cuvier).

Lutianus johni (Bloch, 1792)

Plate 31.2

Anthias johni Bloch, 1792: 113.

Coius catles Hamilton-Buchanan, 1822: 90.

Mesoprion johni Cantor, 1850: 995; Gunther, 1859: 200.

Mesoprion johnii Day, 1878: 42.

Lutianus johnii Day, 1878: 42.

Lutianus johnii Day, 1889: 476; Fowler, 1931: 90.

Lutianus johni Barnard, 1925: 1925; Weber and de Beaufort, 1936: 244; Fischer and Whitehead, 1974.

Lutianus johni Munro, 1955: 135.

Description: Based on 25 specimens ranging in size 47.0–133.0 mm SL (57.0–163.0 mm TL).

Fin formula: D. X, 14; A. III, 8; P. 16; V. I, 5; C. 16.

Body measurements expressed in percent of standard length: greatest body depth 37.63–41.39 (M = 38.94); head length 38.06–42.66 (M = 40.71); snout to D fin origin 39.16–45.66 (M = 43.77); snout to A fin origin 63.80–73.64 (M = 71.89); snout to pectoral fin origin 35.18–41.48 (M = 38.17); snout to pelvic fin origin 42.59–49.46 (M = 45.04); base D fin 47.31–52.86 (M = 49.59); base A fin 14.17–16.21 (M = 15.13); pectoral fin length 24.99–30.65 (M = 27.70); pelvic fin length 24.21–26.12 (M = 24.81); longest D spine (4th) 13.76–17.11 (M = 15.04); longest A spine (2nd) 14.16–16.95 (M = 15.08); least depth of caudal peduncle 11.66–14.01 (M = 12.46).

In percent of head length: snout length 29.33–33.33 (M = 31.54); orbit diameter 20.72–25.64 (M = 22.43); least width of interorbital space 15.45–19.69 (M = 17.08).

Body deep and compressed. Head profile convex, cleft of mouth horizontal. Maxilla reaching to well behind vertical below anterior margin of eye. Interorbital space flat, eyes covered with the membrane. Horizontal and vertical margins of the preopercle finely denticulated, a faint notch at its vertical limb ventrally. Rudimentary gill rakers present in vertical and horizontal limbs of gill arch. Well developed gill rakers on first arch (2–3) + (7–10) = 9–13. Outer row of teeth in the jaw are canines, inner rows of minute teeth. Triangular patch of teeth on vomer with its posterior margin concave, patch of small teeth in palate. Lateral line convex, reaching to half of caudal fin. Caudal fin slightly emarginate.

__Scales:__ Lateral line scales 47–53; in transverse rows 20–23. Scales above the lateral line are parallel to it, scales below the lateral line are horizontal.

Scales present all over the body and head excluding on snout and preorbital regions. Scale sheath is visible at soft dorsal, anal, caudal, pectoral and pelvic fins base.

<u>Colour</u>: Dorsal profile deep yellowish, ventral profile light coloured. Scales on the body are having a black spot at its centre, thus imparting longitudinal black lines. An oval black blotch on the lateral line below the junction of spinous and soft portion of the dorsal fin. Fins yellowish, its margins fringed with red colour.

<u>Distribution</u>: Eastern Indian Ocean, Western Central Pacific, coasts of Southern Africa, Natal, Malay Archipelago, Madagascar, China, Philippines, Australia, Sri Lanka and India: both east and west coasts.

<u>Lutianus argentimaculatus</u> (Forsskal, 1775)
Plate 31.3

<u>Sciaena argentimaculata</u> Forsskal, 1775: 47.
<u>Diacope argentimaculata</u> Cuvier and Valenciennes, 1828: 432.
<u>Mesoprion gembra</u> Gunther, 1859: 193.
<u>Lutianus argentimaculatus</u> Day, 1878: 37; Weber and de Beaufort, 1936: 246; Fischer and Whitehead, 1974.
<u>Lutianus argentimaculatus</u> Jordan and Evermann, 1902: 344; Munro, 1955: 135.

__Description:__ Based on 12 specimens ranging in size 104.0–159.0 mm SL (127.0–214.0 mm TL).

__Fin formula:__ D. X, 14; A. III, 8–9; P. 16; V. I, 5; C. 18.

Body measurements expressed in percent of standard length: greatest body depth 34.37–37.20 (M = 35.42); head length 38.05–40.15 (M = 39.40); snout to D fin origin 42.45–44.37 (M = 43.49); snout to A fin origin 68.55–72.11 (M = 70.41); snout to pectoral fin origin 35.22–38.23 (M = 36.55); snout to pelvic fin origin 40.29–43.38 (M = 41.65); base D fin 46.85–5.47 (M = 49.60); base A fin 13.46–16.28 (M = 14.89); pectoral fin length 26.92–31.13 (M = 28.73); pelvic fin length 21.25–23.44 (M = 22.20); longest D spine (4th) 12.50–15.53 (M = 13.59); longest A spine (2nd) 9.89–12.98 (M = 11.06); least depth of caudal peduncle 12.01–13.55 (M = 12.55).

In percent of head length: snout length 31.70–35.18 (M = 33.37); orbit diameter 18.79–22.31 (M = 20.54); least width of interorbital space 17.07–19.44 (M = 18.81).

Body oblong and not well compressed. Head profile nearly convex. Cleft of the mouth slightly oblique.

Maxilla reaching to vertical below anterior margin of eye. Interorbital space flat, eyes covered with the membrane. Horizontal and vertical margins of the preopercle finely denticulated, a distinct notch on vertical limb ventrally. Rudimentary gill rakers present in horizontal and vertical limbs of gill arch. Well developed gill rakers on first arch, 2+7 = 9. Outer row of jaw teeth canine, inner rows in patches. Teeth on vomer in triangular patch, on palate as an elongated patch. Lateral line convex, reaching to half of caudal fin. Caudal fin truncate.

Scales: Lateral line scales 49-53; in transverse series 20-22. Scales above the lateral line are parallel to it below the spinous dorsal base, but obliquely ascending below the soft dorsal rays. Scale rows below the lateral line horizontal. Scales present all over the body and head except on snout, pre and postorbital regions. Scale sheath is seen at soft dorsal, anal, caudal, pectoral and pelvic fins base.

Colour: Body uniformly reddish-brown. Scales of the body are having distinct brown spots at its centre, thus imparting longitudinal lines. The dorsal interspinal membrane rose-red in its distal half. Soft dorsal, anal, caudal and pelvic fins blackish in its distal half. Pectoral fin colourless.

Distribution: From Natal coast to East coast of South Africa, Australia, Madagascar, Zanzibar, Red Sea, China, Riukiu Islands, Formosa, Philippines, Sri Lanka and India: both east and west coasts.

Lutianus fulviflamma (Forsskal, 1775)
Plate 32.1

Sciaena fulviflamma Forskal, 1775: 45.

Mesoprion fulviflamma Bleeker, 1852: 553; Gunther, 1859: 201.

Lutianus fulviflamma Day, 1878: 41; Fowler, 1922: 31; Weber and de Beaufort, 1936: 270; Fischer and Whitehead, 1974.

Lutianus fulviflamma Jordan and Evermann, 1902: 343; Munro, 1955: 136.

Description: Based on 20 specimens ranging in size 51.0-124.0 mm SL (60.5-157.0 mm TL).

Fin formula: D. X, 13; A. III, 8-9; P. 14-16; V. I, 5; C. 18-20.

Body measurements expressed in percent of standard length: greatest body depth 32.52-38.33 (M = 34.77); head length 37.20-41.66 (M = 38.86); snout to D fin origin 39.04-43.33 (M = 41.14); snout to A fin origin 69.41–73.21 (M = 71.72); snout to pectoral fin origin 34.95–39.38 (M = 37.05); snout to pelvic fin origin 43.02–50.00 (M = 48.16); base D fin 45.09–50.00 (M = 47.81); base A fin 13.20–15.00 (M = 14.57); pectoral fin length 24.50–29.94 (M = 27.27); pelvic fin length 20.00–23.52 (M = 21.55); longest D spine (4th) 13.33–17.64 (M = 14.83); longest A spine (2nd) 11.76–15.68 (M = 12.08); least depth of caudal peduncle 12.62–13.33 (M = 12.91).

In percent of head length: snout length 25.71–30.43 (M = 28.53); orbit diameter 21.79–26.56 (M = 24.06); least width of interorbital space 17.94–20.00 (M = 18.92).

Body oblong. Head profile well convex. Cleft of mouth nearly horizontal. Maxilla ends behind the level of the anterior margin of eye. Interorbital space convex, eyes covered with the membrane. Horizontal and vertical margins of preopercle finely denticulated, a faint notch on vertical limb ventrally. Rudimentary gill rakers present in horizontal and vertical limbs of gill arch. Well developed gill rakers on first arch (1–3) + (7–8) = 8–11. Outer row of teeth in jaws canine, small teeth in band in its inner side. Vomerine teeth as an arrow head patch with a posterior elongation, palatine teeth as an oval patch. Lateral line convex, reaching to half of caudal fin. Caudal fin slightly forked.

Scales: Lateral line scales 47-50; in transverse series 19-22. Scales above the lateral line are parallel to it anteriorly (pre-dorsal scales), and then appearing as obliquely ascending to dorsal profile. Scales below lateral line horizontal. Scales present all over the body including on head except snout, pre and postorbital region. Scale sheath is visible at soft dorsal, anal, caudal, pectoral and pelvic fins base.

Colour: Dorsal profile yellowish-brown, silvery ventrally. A black oval blotch on lateral line below the last dorsal spines and first dorsal rays, greater part of it is below the lateral line. 4-5 golden yellow horizontal bands from opercle to caudal peduncle. Dorsal and anal fins slightly brown. Other fins yellowish.

Distribution: East coast of Africa, Madagascar, Red Sea, Seychelles, Siam, Hongkong, Formosa, Philippines, Fiji, Tahiti, Australia, Sri Lanka and India: both east and west coasts.

Lutianus russelli (Bleeker, 1849)

Plate 32.2

Mesoprion Russelli Bleeker, 1849: 41.

Mesoprion russelli Day, 1867: 701.

Lutianus russelli Seale, 1906: 43; Jordan and Thompson, 1911: 450; Munro, 1955: 136.

Lutjanus russelli Weber and de Beaufort, 1936: 272; Fischer and Whitehead, 1974.

Description: Based on 9 specimens ranging in size 42.0–128.0 mm SL (52.0–153.0 mm TL).

Fin formula: D. X, 14; A. III, 8; P. 14–15; V. I, 5; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 34.45–37.96 (M = 36.29); head length 35.93–40.47 (M = 38.60); snout to D fin origin 36.52–42.59 (M = 41.21); snout to A fin origin 67.18–72.47 (M = 69.91); snout to pectoral fin origin 30.43–37.96 (M = 35.70); snout to pelvic fin origin 41.66–44.95 (M = 44.43); base D fin 45.94–48.80 (M = 46.96); base A fin 13.04–16.66 (M = 15.23); pectoral fin length 20.86–25.92 (M = 23.65); pelvic fin length 18.26–23.80 (M = 21.36); longest D spine (4th) 11.30–15.27 (M = 13.98); longest A spine (2nd) 10.00–14.28 (M = 11.29); least depth of caudal peduncle 10.86–13.42 (M = 12.66).

In percent of head length: snout length 27.58–32.14 (M = 32.09); orbit diameter 21.80–26.47 (M =

2?.90); least width of interorbital space 15.47-18.47 (M = 17.56).

Body deep and oblong. Head profile very concave. Cleft of mouth horizontal, maxilla reaching to vertical below anterior margin of eye. Interorbital space slightly concave, eyes covered with the membrane. Horizontal and vertical margins of the preopercle finely denticulated, a very distinct notch on the vertical limb ventrally. Rudimentary gill rakers present in the horizontal and vertical limb of gill arch. Well developed gill rakers on first arch (1-2) + (5-7) = 6-9. Inner jaw teeth small and in bands, outer row of canine teeth. Vomerine teeth in a triangular patch with a narrow posterior prolongation. Elongated patch of teeth in palate. Lateral line convex, reaching to half of caudal fin. Caudal fin slightly forked.

Scales: Lateral line scales 46-49; in transverse series 21-24. Scales above the lateral line are obliquely ascending to the dorsal profile. Scales below the lateral line horizontal. Scales present all over the body including on head except on snout, pre and postorbital regions. Scale sheath is visible at soft dorsal, anal, caudal pectoral and pelvic fins base.

Colour: Dorsal profile golden yellow, ventral profile silvery. A black oval blotch on lateral line below the 1-8 soft dorsal rays, greater part of it above the lateral line. 6-8 brown bands on the body, 3-4 bands are obliquely raising to dorsal profile, the 4th one terminating at the black blotch, rest of the bands of ventral profile nearly horizontal. Distal half of dorsal, anal and pectoral fins brownish. Other fins yellowish.

Distribution: South African coasts, Madagascar, Zanzibar, Malay Archipelago, Japan, Philippines, Solomon Islands, New South Wales, Australia, Sri Lanka and India: both east and west coasts.

Lutianus rivulatus (Cuvier and Valenciennes, 1828)
Plate 32.3

Diacope rivulata Cuvier and Valenciennes, 1828: 414.
Genyoroge rivulata Gunther, 1859: 182.
Genyoroge caeruleopunctata Day, 1870: 679.
Lutianus rivulatus Bleeker, 1873: 81; Day, 1878: 37; Fowler, 1928: 202; Weber and de Beaufort, 1936: 287.
Lutianus rivulatus Seale and Bean, 1908: 243; Munro, 1955: 136.

Description: Based on 4 specimens ranging in size 69.0-105.0 mm SL (85.0-119.0 mm TL).

<u>Fin formula</u>: D. X, 14; A. III, 8–9; P. 16; V. I, 5; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 42.85–44.92 (M = 43.88); head length 41.42–43.47 (M = 42.44); snout to D fin origin 42.75–43.57 (M = 43.16); snout to A fin origin 72.85–75.36 (M = 74.10); snout to pectoral fin origin 40.71–42.02 (M = 41.36); pelvic fin origin 48.57–52.17 (M = 50.37); base D fin 52.89–53.87 (M = 53.23); base A fin 15.71–19.56 (M = 17.64); pectoral fin length 25.71–29.71 (M = 27.71); pelvic fin length 25.00–28.26 (M = 26.63); longest D spine (4th) 15.21–15.71 (M = 15.46); longest A spine (2nd) 13.76–15.00 (M = 14.38); least depth of caudal peduncle 13.04–13.57 (M = 13.30).

In percent of head length: snout length 27.58–32.52 (M = 29.30); orbit diameter 22.41–24.13 (M = 23.96); least width of interorbital space 17.27–21.05 (M = 19.08).

Body oblong and deep. Head profile convex. Cleft of mouth nearly horizontal, maxilla reaching to vertical below anterior margin of eye. Interorbital space slightly concave, eyes covered with the membrane. Horizontal and vertical margins of preopercle finely denticulated, a distinct notch on the vertical limb ventrally.

Rudimentary gill rakers present in horizontal and vertical limbs of gill arch. Well developed gill rakers on first arch, (1-2) + (7-8) = 8-10. Inner side of the jaw is having very small teeth, outer row of canine teeth present. Vomerine teeth as a triangular patch, an elongated patch of teeth on palate. Lateral line convex, reaching to half of caudal fin. Caudal fin slightly forked.

Scales: Lateral line scales 44-47; in transverse series 26-27. Scales above the lateral line obliquely ascending to dorsal profile. Scales below the lateral line horizontal. Scales present all over the body including on head except on snout, pre and postorbital regions. Scale sheath is present at soft dorsal, anal, caudal, pectoral and pelvic fins base.

Colour: Body greyish-brown. Head is having irregular blue line, in fresh specimens. An oval black blotch on the lateral line below the 4-7th dorsal rays, its centre is having a pearly white spot. Major portion of the blotch is below the lateral line. Body scales are having a pearly white spot. Three vertical cross bands, a distinct one across the dorsal fin origin, the second one at 5-6th dorsal spine an the third indistinct one at the end of spinous dorsal. Dorsal and anal fins brownish with black margin. Caudal fin is having blue tinge in fresh condition. Other fins colourless.

Distribution: South Africa, Natal coast, Madagascar, Zanzibar, Red Sea, Solomon Islands, Japan, China, Formosa, Philippines, Samoa, Australia, Sri Lanka and India: west coast.

2.4.30. FAMILY : GERREIDAE

Characters of taxonomic value: Body oblong or oval and compressed. Snout pointed. Mouth terminal, downwardly protractile. Fine teeth in jaws, none on vomer and palate. Gill membrane free from isthmus. Scales cycloid, present on head, body and unpaired fins base. Lateral line complete. Single long dorsal fin with 9-10 spines and 10-15 rays. Anal fin with 2-6 spines and 1.-13 rays. Pectoral fin long and pointed. Pelvic fin with an elongated axillary scale. Caudal fin deeply forked.

Of the two genera known under this family (Fischer and Whitehead, 1974), fishes of the genus Gerres was only represented in the study area. Day (1878) recorded 8 species of Gerres from Indian waters and Weber and de Beaufort (1931) reported 18 species from Indo-Australian Archipelago. 5 species of silver-biddies were recorded from Sri Lanka waters (Munro, 1955). Fischer and Whitehead (1974) listed 25 species from Eastern Indian Ocean and Western Central Pacific and also mentioned that the given list is incomplete and contains many doubtful species, so the family is in badly need of an urgent revision. Venkataraman and Badrudeen (1975) reported *Gerres macrocanthus* Bleeker from the coast of Peninsular India for the first time.

Key to genus

Anal fin with 2-4 spines and 7-10 rays, shorter than soft part of dorsal fin .... *Gerres* Cuvier.

Gerres Cuvier, 1829

Gerres Cuvier, 1829: 164.
Diapterus Ranzani, 1840: 340.
Catochaenum Cantor, 1849: 1037.

Key to species

1. Second dorsal spine greatly elongated, usually greater than depth of body; lat. line scales 43-46; gill rakers 10-12; bluish-black spots in lateral series .... *Gerres filamentosus* Cuvier.

Second dorsal spine not elongated; lat. line scales less than 43; gill rakers 9–11; no bluish black spots in lateral series .... 2.

2. Body depth 43.17–47.88% in SL; second dorsal spine 21.47–22.42% in SL; gill rakers 9; lat. line scales 40–42, in transverse series 16–17; body without vertical black cross bars; dorsal and anal fins with black distal margin .... _Gerres abbreviatus_ Bleeker.

Body depth 37.64–42.63% in SL; second dorsal spine 16.47–19.18% in SL; gill rakers 9–11; lat. line scales 34–36, in transverse series 12–14; body with 4–5 vertical black cross bars; 2–5th dorsal spine black distally; anal, lower lobe of caudal and pelvic fins yellowish .... _Gerres setifer_ Hamilton-Buchanan.

Gerres filamentosus Cuvier, 1829

Plate 33.1

Gerres filamentosus Cuvier, 1829: 188; Bleeker, 1850: 10; Gunther, 1859: 345; Day, 1878: 98; Fowler, 1928: 226; Fischer and Whitehead, 1974.

Gerres punctatus Cuvier, 1830: 430; Weber and de Beaufort, 1931: 349.

Gerres (Pertica) filamentosus Fowler, 1904: 530.

Pertica filamentosa Munro, 1955: 143.

Description: Based on 25 specimens ranging in size 91.0–171.0 mm SL (115.0–214.0 mm TL).

<u>Fin formula</u>: D. IX, 10; A. III, 7; P. 16; V. I, 5; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 42.85–47.61 (M = 45.01); head length 31.32–33.55 (M = 32.45); snout to D fin origin 42.85–46.90 (M = 44.90); snout to A fin origin 69.02–72.38 (M = 70.85); snout to pectoral fin origin 32.72–35.54 (M = 33.64); snout to pelvic fin origin 39.31–42.77 (M = 41.27); D base length 49.09–52.30 (M = 50.90); A base length 14.28–17.10 (M = 15.45); pectoral fin length 33.59–38.07 (M = 36.30); pelvic fin length 20.42–23.60 (M = 22.17); longest D spine (2nd) 46.01–56.03 (M = 52.25); longest A spine (2nd) 12.17–14.41 (M = 13.47); least depth of caudal peduncle 11.50–13.18 (M = 12.06).

In percent of head length: snout length 30.00–33.33 (M = 32.55); orbit diameter 30.95–34.09 (M = 33.09); least width of interorbital space 32.14–36.98 (M = 35.00).

Body oblong. Mouth protractile. Maxilla nearly reaching to below anterior margin of eye. Mandible strongly concave. Interorbital space nearly flat. A steep ascent from snout to dorsal fin origin. Two nostrils on each side, close together and the anterior one with a fleshy flap. Gill rakers very small, on first arch (3-5) + (7-8) = 10-12. Small teeth in jaws. Lateral line arched, reaching to caudal fin base. Pelvic fin with an elongated axillary scale. Caudal fin forked.

Scales: Lateral line scales 43-46; in transverse series 17-19. Scales present on body and head excluding snout. Scale sheath at dorsal and anal fins base high. Caudal fin base with scales.

Colour: Silvery bright with bluish tinge in fresh condition. 4-5 rows of bluish-black spots in lateral series on dorsal profile. Snout tip black. Elongated dorsal spine black. Soft dorsal, anal and caudal fins with dusky margins. Pelvic fin slightly yellowish. Pectoral fin hyaline.

Distribution: Red Sea, East and South Africa, Indonesia, China, Philippines, Taiwan, Japan, New Britain, Australia, Sri Lanka and coasts of India including Laccadives Archipelago.

Other materials examined: ZSI No. 1576/2 (88.0 mm and 90.0 mm SL) Madras, A.G.K. Menon Coll.

Remarks: Fowler (1928) and Fischer and Whitehead (1974) had synonymised _S. macracanthus_ under _S. filamentosus_.

Fowler (1928) stated that G. macracanthus was evidently based on immature specimens of G. filamentosus with dark vertical bands. Weber and de Beaufort (1931) considered G. macracanthus as a separate species. Venkataraman and Badrudeen (1975) differentiated G. macracanthus from G. filamentosus in the shape of post-cranio dorsal profile, predorsal distance, lateral and transverse scale counts and colour pattern.

Gerres abbreviatus Bleeker, 1850

Plate 33.2

Gerres abbreviatus Bleeker, 1850: 11; Gunther, 1859: 345; Day, 1878: 97; Fowler, 1928: 224; Weber and de Beaufort, 1931: 344; Munro, 1955: 147; Fischer and Whitehead, 1974.

Description: Based on 2 specimens, 136.0 mm and 142.0 mm SL (178.0 and 180.0 mm TL).

Fin formula: D. IX, 10-11; A. III, 7; P. 14; V. I, 5; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 43.17-47.88 (M = 45.52); head length 33.82-35.56 (M = 34.69); snout to D fin origin 45.58-46.83 (M = 46.20); snout to A fin origin 71.83-73.16 (M = 72.49); snout to pectoral fin origin 33.08–34.50 (M = 33.79); snout to pelvic fin origin 41.17–42.25 (M = 41.71); base D fin 50.00–54.57 (M = 52.28); base A fin 16.54–16.91 (M = 16.72); pectoral fin length 37.50–39.43 (M = 38.46); pelvic fin length 22.79–22.88 (M = 22.83); longest D spine (2nd) 21.47–22.42 (M = 21.94); longest A spine (2nd) 16.19–16.54 (M = 16.36); least depth of caudal peduncle 13.23–13.38 (M = 13.30).

In percent of head length: snout length 30.43–30.69 (M = 30.56); orbit diameter 30.69–34.78 (M = 32.73); least width of interorbital space 34.78–36.63 (M = 32.70).

Body oval and deep. Mouth downwardly protractile. Maxilla nearly reaching to below anterior margin of eye. Mandible strongly concave. Interorbital space slightly convex. A strong ascent from snout to dorsal fin origin. Two nostrils on each side, close together, the anterior one with a fleshy flap. Gill rakers on first arch 1+8 = 9. Fine teeth in jaws. Lateral line arched, reaching to caudal fin base. Pelvic fin with an elongated axillary scale. Caudal fin deeply forked.

Scales: Lateral line scales 40–42; in transverse series 16–17. Scales present on body and head excluding snout.

High scaly basal sheath at dorsal and anal fins base. Caudal fin base with scales.

Colour: Silvery, dorsal profile with bluish tinge in fresh condition. Snout tip black. Distal margin of dorsal, anal and caudal fins black. Other fins colourless.

Distribution: Formosa, Philippines, North Australia, Sri Lanka and coasts of India including Andamans.

Other materials examined: ZSI No. 392 (129.0 mm SL) Madras, F. Day Coll.

Gerres setifer (Hamilton-Buchanan, 1822)
Plate 33.3

Chanda setifer Hamilton-Buchanan, 1822: 105.
Gerres lucidus Cuvier and Valenciennes, 1830: 477; Jones and Kumaran, 1980: 316.
Gerres setifer Day, 1878: 97; Weber and de Beaufort, 1931: 358; Fischer and Whitehead, 1974.
Gerreomorpha setifer Munro, 1955: 147.

Description: Based on 20 specimens ranging in size 56.0-95.0 mm SL (70.0-121.0 mm TL).

Fin formula: D. IX, 10; A. III, 7; P. 14; V. I, 5; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 37.64–42.63 (M = 39.42); head length 29.17–33.33 (M = 30.87); snout to D fin origin 40.00–43.25 (M = 41.25); to A fin origin 66.66–71.60 (M = 68.46); snout to pectoral fin origin 29.41–33.57 (M = 31.41); snout to pelvic fin origin 38.97–42.42 (M = 40.55); base D fin 46.42–52.75 (M = 49.53); base A fin 13.39–17.32 (M = 15.50); pectoral fin length 29.41–33.92 (M = 31.04); pelvic fin length 20.13–24.10 (M = 22.38); longest D spine (2nd) 16.47–19.16 (M = 17.99); longest A spine (2nd) 14.70–18.60 (M = 16.50); least depth of caudal peduncle 11.76–13.39 (M = 12.48).

In percent of head length: snout length 27.45–31.81 (M = 29.54); orbit diameter 31.37–36.95 (M = 34.03); least width of interorbital space 33.33–36.84 (M = 35.14).

Body oblong. Mouth protractile. Maxilla reaching to slightly beyond the anterior margin of eye. Mandible concave. Interorbital space nearly flat. The two nostrils situated closely, anterior one with a flap. Gill rakers on first arch (2–4) + 7 = 9–11. Jaws having small teeth. Lateral line arched, reaching to caudal fin base. Pelvic fin with an elongated axillary scale. Caudal fin well forked.

Scales: Lateral line scales 34-36; in transverse series 12-14. Scales present on body and head excluding snout. Scale sheath at dorsal and anal fins base very high. Caudal base with scales.

Colour: Silvery-grey with 4-5 vertical black cross bars on dorsal profile. Ventral profile silvery. Tip of snout dark. Membrane between 2-5th dorsal spine black distally. Anal, lower lobe of caudal and pelvic fins yellowish. Pectoral fin colourless.

Distribution: Hongkong, Indonesia, Sri Lanka and coasts of India including Laccadive Archipelago.

Other materials examined: ZSI Nos. 10767 (70.0 mm SL) 10768 (75.0 mm SL) Mergin Archipelago, J. Anderson Coll.

2.4.31. FAMILY : POMADASYIDAE

Characters of taxonomic value: Body oblong or ovoid and moderately compressed. Snout nearly pointed. Mouth terminal. Lips thick. Hind edge of maxilla hidden when mouth closed. Conical teeth in jaws, palate toothless.

Chin with two pores and longitudinal groove or 6 pores and no groove. Gill membrane free from isthmus. Scales ctenoid. Lateral line complete. Posterior margin of preopercle serrated. Opercle with an indistinct spine. Single dorsal fin with 9-15 spines and 12-26 rays. Anal fin with 3 spines and 7-9 rays. Pelvic fin with one spine and 5 rays. Caudal fin truncate.

Of the three known genera under this family Pomadasyidae (Fischer and Whitehead, 1974), fishes of the genus *Pomadasys* and *Plectorhynchus* were represented in the Vembanad lake. Day (1878) reported 9 species under each genus from Indian waters and placed them in the family Percidae. Weber and de Beaufort (1936) described 6 species under the genus *Pomadasys* and 12 species under *Plectorhynchus* from the Indo-Australian Archipelago. Munro (1955) created a separate family for each genus and reported 5 species under the family Pomadasyidae and 7 species under the family Plectorhynchidae from Sri Lanka waters. Smith (1962) made a resume of all known species of Gaterinidae from Indo-Pacific area. 9 species under *Pomadasys* and 8 species under *Plectorhynchus* were listed from Eastern Indian Ocean and Western Central Pacific (Fischer and Whitehead, 1974).

Key to genera

Body oblong; mouth moderate; chin with 2 pores and a longitudinal groove; 4–8 scale rows above lat. line; dorsal and anal spines very strong .... *Pomadasys* Lacepede.

Body ovoid; mouth small; chin with 6 pores and no groove; 10–19 scale rows above lat. line; dorsal and anal spines weak .... *Plectorhynchus* Lacepede.

Pomadasys Lacepede, 1803

Pomadasys Lacepede, 1803: 515.
Pristipomus (Cuvier) Oken, 1817: 1182.
Pristipoma Cuvier and Valenciennes, 183 : 243.

Key to species

Body depth 34.33–38.97% in SL; upper profile of head convex; 4–6 scale rows above lat. line; flanks with longitudinal brownish-black lines; dorsal fin with 3 rows of brownish-black spots .... *Pomadasys hasta* (Bloch).

Pomadasys hasta (Bloch, 1790)
Plate 34.1

Lutianus hasta Bloch, 1790: 109; Lacepede, 1802: 229.

Pristipoma hasta Cuvier and Valenciennes, 1830: 247; Bleeker, 1850: 20; Gunther, 1859: 289; Day, 1878: 73.

P. madasya hasta Bleeker, 1876: 28; Fowler, 1931: 313; Weber and de Beaufort, 1936: 402; Munro, 1955: 148; Fischer and Whitehead, 1974.

Description: Based on 19 specimens ranging in size 100.0–127.0 mm SL (121.0–153.0 mm TL).

Fin formula: D. XII, 14; A. III, 7; P. 16; V. I, 5; C. 18.

Body measurements expressed in percent of standard length: greatest body depth 34.83–38.97 (M = 37.58); head length 35.43–37.61 (M = 36.50); snout to D fin origin 41.50–44.76 (M = 42.65); snout to A fin origin 68.69–70.87 (M = 70.12); snout to pectoral fin origin 33.45–35.71 (M = 34.39); snout to pelvic fin origin 37.19–40.00 (M = 38.34); base D fin 50.00–53.04 (M = 52.06); base A fin 11.90–13.52 (M = 12.66); pectoral fin length 27.55–31.42 (M = 29.39); pelvic fin length 23.00–25.23 (M = 24.12); longest D spine (3rd) 17.14–18.89 (M = 17.61); longest A spine (2nd) 16.94–20.95 (M = 18.32); least depth of caudal peduncle 10.19–11.79 (M = 10.95).

In percent of head length: snout length 28.94–31.11 (M = 30.38); orbit diameter 22.22–26.38 (M = 24.90); least width of interorbital space 20.25–23.80 (M = 22.16).

Body oblong and compressed. Cleft of mouth horizontal, hind end of maxilla nearly reaching to vertical below anterior margin of eye. Eye covered with the membrane. Interorbital space nearly flat. Two nostrils close together, the anterior one more prominent. 2 pores on chin and a longitudinal groove behind it. Preopercle margin denticulated, coarsely serrated at the angle. Gill rakers on first arch (5–6) + (10–12) = 15–18. Teeth in bands on jaws, outer row enlarged. Lateral line arched anteriorly, reaching to caudal peduncle. Axillary scale present at pelvic fin base. Caudal fin truncate.

Scales: Lateral line scales 45–47; in transverse series 16–17. Scales present all over the body including on opercle, preopercle, cheek and interorbital space. Scales absent on snout. Scale sheath is present at the bases of paired and unpaired fins.

Colour: Body silvery with pinkish tinge in fresh condition. Each scale of the dorsal profile has a brownish-black spot and the spots together appear as interrupted longitudinal brownish-black lines. Dorsal fin with 3 rows of brownish-black spots. Distal margin of spinous dorsal membrane black. Anal and caudal fins dusky black. Other fins yellowish.

Distribution: East Africa, Taiwan, Red Sea, Madagascar, China, Formosa, Philippines, Australia, Sri Lanka and coasts of India.

Plectorhynchus Lacepede, 1802

Plectorhynchus Lacepede, 1802: 134.
Diagramma Cuvier, 1815: 360.

Key to species

Body depth 44.37-48.96% in SL; D. XIII-XIV, 15-16; body dark brown with reddish tinge, devoid of brownish lateral bands; distal margins of soft dorsal, anal and caudal fins white .... Plectorhynchus nigrus (Cuvier and Valenciennes).

Plectorhynchus nigrus (Cuvier and Valenciennes, 1830)
Plate 34.2

Pristipoma nigrum Cuvier and Valenciennes, 1830: 258.
Diagramma crassispinum Ruppell, 1837: 125; Bleeker, 185?: 26; Gunther, 1859: 319; Day, 1878: 78.

Plectorhinchus nigrus Fowler, 1931: 233.

Plectorhynchus crassispina Weber and de Beaufort, 1936: 410.

Pseudopristipoma nigra Munro, 1955: 15[illegible].

Plectorhynchus nigrus Fischer and Whitehead, 1974.

Description: Based on 5 specimens ranging in size 123.0–151.0 mm SL (142.0–186.0 mm TL).

Fin formula: D. XIII–XIV, 15–16; A. III, 7; P. 17; V. I, 5; C. 18.

Body measurements expressed in percent of standard length: greatest body depth 44.37–48.96 (M = 46.55); head length 33.10–35.09 (M = 34.11); snout to D fin origin 43.08–46.26 (M = 44.32); snout to A fin origin 69.10–75.49 (M = 72.10); snout to pectoral fin origin 32.52–34.76 (M = 33.23); snout to pelvic fin origin 35.36–41.39 (M = 37.94); base D fin 59.34–66.89 (M = 63.15); base A fin 13.81–14.56 (M = 14.15); pectoral fin length 20.19–21.37 (M = 20.76); pelvic fin length 24.39–26.20 (M = 25.49); longest D spine (4th) 16.55–19.65 (M = 18.29); longest A spine 15.56–19.91 (M = 17.89); least depth of caudal peduncle 11.58–12.06 (M = 11.80).

In percent of head length: snout length 32.29-35.71 (M = 34.30); orbit diameter 24.52-29.76 (M = 27.46); least width of interorbital space 26.04-28.57 (M = 27.32).

Body slightly oval and compressed. Mouth terminal and small. Cleft of mouth horizontal, lips thick. A steep ascent from snout to dorsal fin origin. Hind end of maxilla do not reach to the vertical below anterior margin of eye. Interorbital space convex. Two nostrils on each side, just in front of eye. 6 pores on chin. Preopercle margin serrate. Gill rakers on first arch (7-8) + (18-19) = 25-27. Jaws having minute teeth in bands. Lateral line arched anteriorly, extends to caudal fin base. Axillary scale present at pelvic fin base. Caudal fin slightly emarginate.

__Scales:__ Lateral line scales 58-62; in transverse series 28-31. Scales present all over the body and head excluding snout. Scale sheath visible at soft dorsal, anal, caudal, pectoral and pelvic fins base.

__Colour:__ Body brownish black with reddish tinge in fresh condition. Dorsal, anal and caudal fins brownish black, their distal margins light coloured. Distal half of pelvic fin blackish. Pectoral fin greyish.

Distribution: Red Sea, East coast of Africa, Madagascar, China, Philippines, Indonesia, Australia, Siam, Sri Lanka and coasts of India including Laccadives.

2.4.32. FAMILY : LETHRINIDAE

Characters of taxonomic value: Body oblong and moderately compressed. Snout nearly pointed. Mouth terminal, slightly protractile. Lips thick. Maxilla tip broad. Anterior teeth conical with a few canines, posterior teeth molar-like or lanceolate. Palate toothless. Gill membrane free from isthmus. Scales ctenoid. Two nostrils on each side. Lateral line complete. Single dorsal fin with 10 spines and 8-1 rays. Anal fin with 3 spines and 8 rays. Caudal fin slightly forked.

This group really requires a revision. There is only a single genus *Lethrinus* under this family (Weber and de Beaufort, 1936; Fischer and Whitehead, 1974). Day (1873) placed the genus *Lethrinus* under the family Sparidae and reported 7 species from Indian waters. Weber and de Beaufort (1936) described 14 species from Indo-Australian Archipelago. 10 species were described from Sri Lanka waters (Munro, 1955) and 39 species were listed from Eastern Indian Ocean and Western Central Pacific (Fischer and Whitehead, 1974). Other new distributional reports of Lethrinid fishes from the seas around India were those of Silas and Toor (1961, 1962), Toor (1972) and Jones and Kumaran (1980).

<u>Lethrinus</u> Cuvier, 1829

<u>Lethrinus</u> Cuvier, 1829: 182.
<u>Lethrinella</u> Fowler, 1904: 529.
<u>Lethrinichthys</u> Jordan and Thompson, 1912: 558.

<u>Key to species</u>

Body depth 34.82–37.50% in SL; five scale rows above lat. line; second dorsal spine not prolonged; hind nostril nearer to tip of snout than to hind margin of head; a black blotch in between the pectoral fin and lat. line; indistinct hexagonal cross bars on body .... <u>Lethrinus microdon</u> (Cuvier and Valenciennes).

<u>Lethrinus microdon Cuvier and Valenciennes, 1830</u>
<u>Plate 34.3</u>

<u>Lethrinus microdon</u> Cuvier and Valenciennes, 1830: 295; Weber and de Beaufort, 1936: 436; Munro, 1955: 159; Fischer and Whitehead, 1974.
<u>Lethrinella microdon</u> Smith, 1959: 293; Silas and Toor, 1961: 209; Jones and Kumaran, 1980: 335.
<u>Lethrinus rostratus</u> Day, 1878: 134 nec Cuvier and Valenciennes).

Description: Based on 18 specimens ranging in size 56.0–112.0 mm SL (70.0–141.0 mm TL).

Fin formula: D. X, 8–9; A. III, 8; P. 12; V. I, 5; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 34.82–37.50 (M = 37.04); head length 33.87–38.88 (M = 35.41); snout to D fin origin 40.00–43.05 (M = 41.77); snout to A fin origin 64.13–68.62 (M = 65.59); snout to pectoral fin origin 33.50–40.17 (M = 35.00); snout to pelvic fin origin 39.56–47.32 (M = 41.25); base D fin 46.15–48.21 (M = 46.73); base A fin 16.50–18.62 (M = 17.48); pectoral fin length 25.00–28.00 (M = 26.54); pelvic fin length 19.23–22.58 (M = 20.83); longest D spine (3rd) 10.32–14.28 (M = 11.76); longest A spine (3rd) 9.50–11.11 (M = 10.30); least depth of caudal peduncle 10.00–13.33 (M = 11.51).

In percent of head length: snout length 42.02–46.03 (M = 44.05); orbit diameter 26.66–29.41 (M = 28.01); least width of interorbital space 25.00–29.41 (M = 27.21).

Body oblong. Snout pointed. Mouth slightly oblique. Maxilla does not reaching to vertical below anterior margin of eye. Interorbital space nearly flat. Anterior nostril with a fleshy flap. Gill rakers on first arch (4-5) + (4+5) = 8-10. Anterior teeth of jaws canine, posterior teeth conical. Lateral line arched, reaching to caudal fin base. Axillary scale present at pelvic fin axis. Caudal fin slightly forked.

Scales: Lateral line scales 44-50; in transverse series 19-21. Scales present all over the body including on operclе and postorbital region. Scales absent on snout, interorbital space, preopercle and cheek. Scale sheath is visible at anal, caudal, pectoral and pelvic fins base.

Colour: Body greenish brown. Lower part of head slightly pinkish. A distinct black blotch is present in between the lateral line and pectoral fin. Indistinct hexagonal vertical cross bars are seen on the body. Dorsal, anal, caudal and pelvic fins reddish brown in fresh condition. Pectoral fin colourless.

Distribution: Red Sea, Zanzibar, Indonesia, Philippines, Marianas, Marshall Islands, Sri Lanka, coasts of India including Laccadives.

2.4.33. FAMILY : SPARIDAE

Characters of taxonomic value: Body oblong, deep and moderately compressed. Mouth small, terminal and slightly protractile. Maxilla tip exposed. Jaws contain distinct rows of canine, molar-like and conical teeth, palate toothless. Gill membrane free from isthmus. Scales cycloid or minutely ctenoid, absent on suborbital region and snout. Two nostrils on each side. Lateral line continuous. Single dorsal fin with 10-13 spines and 10-15 rays. Anal fin with 3 spines. Pectoral long and pointed, pelvic fin with one spine and 5 rays. Caudal fin slightly forked.

The taxonomy of this group is still incomplete and requires urgent revision as suggested by Fischer and Whitehead (1974). Day (1878) recognized 7 genera under this family from Indian waters, but many of his genera have raised to families by subsequent workers. Weber and de Beaufort (1936) presented only a single genus under the family Sparidae from Indo-Australian Archipelago and described 5 valid species. Munro (1955) reported 4 species under 3 genera from Sri Lanka waters. Fischer and Whitehead (1974) listed 6 genera and 12 species from Eastern Indian Ocean and Western Central Pacific.

Key to genera

No elongated spine in dorsal fin, second anal spine longest and strongest .... Mylio (Commerson) Lacepede.

Mylio (Commerson) Lacepede, 1802

Mylio (Commerson) Lacepede, 1802: 70.

Key to species

Body depth 45.03–47.76% in SL; lat. line scales 47–50, tr. scales 19–20; canine teeth present in front part of jaws; no spot along the scale rows and at pectoral axis; soft dorsal, anal and caudal fins with black margins .... *Mylio berda* (Forsskal).

Mylio berda (Forsskal, 1775)

Plate 35.1

Sparus berda Forskal, 1775: 32; Fowler, 1933: 157; Weber and de Beaufort, 1936: 470.

Chrysophrys berda Cuvier and Valenciennes, 1830: 113; Day, 1878: 140.

Chrysophrys hasta Gunther, 1859: 490.

Acanthopagrus berda Munro, 1955: 161.

Mylio berda Fischer and Whitehead, 1974.

Description: Based on 5 specimens ranging in size 131.0–173.0 mm SL (169.0–221.0 mm TL).

Fin formula: D. XI, 12; A. III, 9–10; P. 13; V. I, 5; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 45.03–47.76 (M = 46.53); head length 31.50–32.08 (M = 31.72); snout to D fin origin 41.90–43.65 (M = 42.81); snout to A fin origin 71.64–72.25 (M = 71.88); snout to pectoral fin origin 32.83–35.83 (M = 33.95); snout to pelvic fin origin 37.31–40.17 (M = 38.54); base D fin 55.22–58.01 (M = 56.33); base A fin 16.41–18.70 (M = 17.29); pectoral fin length 39.69–41.79 (M = 41.03); pelvic fin length 26.86–27.16 (M = 27.03); longest D spine (4th) 16.76–19.02 (M = 17.77); longest A spine (2nd) 19.65–24.04 (M = 22.52); least depth of caudal peduncle 12.42–13.43 (M = 13.06).

In percent of head length: snout length 32.55–34.93 (M = 34.11); orbit diameter 24.41–26.50 (M = 25.53); least width of interorbital space 28.91–32.11 (M = 30.80).

Body deep and compressed. Upper profile of the head oblique. A strong ascent from snout to dorsal fin origin. Mouth terminal, cleft of mouth horizontal. Maxilla reaching to vertical below middle of eye. Eye covered with the membrane, located well above from the level of mouth. Interorbital space slightly convex.

Opercle with a small spine. Gill rakers on first arch 5+9 = 14. Teeth in anterior region of the jaws are canine, followed by conical teeth and the inner most rows are molar-like. Lateral line convex, reaching to caudal peduncle. Pectoral fin reaching to anal fin origin. Caudal fin slightly forked.

Scales: Lateral line scales 47-50; in transverse series 19-20. Scales present all over the body including one opercle, preopercle, cheek and post-orbital region. Scales absent on snout and interorbital space. Scale sheath is visible at the bases of paired and unpaired fins.

Colour: Body silvery with brownish tinge in fresh condition. The scales of upper profile are mottled with black, thus imparting a black colour. Spinous dorsal membrane, margins of soft dorsal, anal and caudal fins and pelvic fin blackish. Pectoral fin yellowish.

Distribution: Red Sea, South Africa, Arabian coast, Madagascar, China, Japan, Formosa, Philippines, Australia, Sri Lanka, Pakistan and India including Andamans.

Other materials examined: ZSI Nos. 1784 (234.0 mm SL) 1786 (172.0 mm SL) F. 1789 (131.0 mm SL) Sind, Pakistan, F. Day Coll.

2.4.34. FAMILY : SCIAENIDAE

Characters of taxonomic value: Body robust and moderately compressed. Head covered with scales excluding snout. Snout bluntly rounded. Mouth terminal or inferior, large. Distal end of maxilla slightly expanded. Conspicuous pores on chin and snout. Villiform teeth in bands in jaws, outer row of upper jaw and sometimes inner row of lower jaw conical. Gill membrane free from isthmus. Scales ctenoid and cycloid. Two nostrils on each side, close to eye. Lateral line complete, extending to end of caudal fin. Swimbladder prominent, of different shape, which may be single or branched. Dorsal fin with 1 spine and 21-45 rays. Anal fin with 2 spines and 7-13 rays. Pelvic fin with 1 spine and 5 rays. Caudal fin rhomboid or truncate.

A review of the literature shows that the Sciaenid fishes of India were subjected to detailed taxonomical studies. Day (1878) recognized 4 genera of Sciaenid fishes from India and described 27 species. Weber and de Beaufort (1936) reported 34 species under 6 genera from Indo-Australian Archipelago and Munro (1955) described 17 species under 3 genera from Sri Lanka waters. Subsequently, new genera were erected by various workers notably by Chu *et al.* (1963), Trewavas (1964), Trewavas and Yazdani (1965), Mohan (1969a), Talwar (1970c) and Talwar and Joglekar (1970). Mohan (1972) classified the Sciaenid fishes of India under 14 genera and 5 sub-families and a synoptic key to the sub-families and genera were presented. Several new species were described from Indian waters (Mohan, 1969b, 1975; Talwar and Joglekar, 1969). Baba Rao and Sinha (1966), Dutt and Thankam (1968), Joglekar and Talwar (1970) and Jayaprakash (1975) reported new distributional records of Sciaenid fishes from the coasts of peninsular India. The taxonomic position of various species were resurrected notably by Yazdani (1966), Talwar and Joglekar (1968,1970,1972a, 1972b), Talwar (1969b,1970a,1970b,1970d) and Talwar and Sinha (1972). Fischer and Whitehead (1974) listed 64 species under 21 genera from the Eastern Indian Ocean and Western Central Pacific. Other monumental contributions on the systematic revision on fishes of the family Sciaenidae were those of Trewavas (1962, 1964,1965,1971, 1977) and Chu *et al.* (1963).

Key to genera

1. Swimbladder carrot-shaped, with more than 15 pairs of arborescent appendages .... 2.

Swimbladder hammer-shaped, with 12-14 pairs of arborescent appendages .... 3.

2. Anterior pair of swimbladder appendage branching behind the transverse septum and not entering head; anal spine moderate, 9.65–11.48% in SL; barbels absent .... 4.

Anterior pair of swimbladder appendage branching in the head behind the skull; anal spine moderate, 9.8–14.35% in SL; barbel or barbels present ... . 5.

4. Soft dorsal ray 2[illegible]–24; lower jaw with a row of enlarged teeth; dorsal and caudal fins usually with black spots .... Protonibea Trewavas.

5. Soft dorsal rays 27–28; lower jaw with small uniform teeth; anal spine 12.80–14.35% in SL; a median tapering mental barbel; a black band across nape .... Dendrophysa Trewavas.

Soft dorsal rays 24–25; lower jaw with a distinct row of enlarged teeth; anal spine 9.80–14.10% in SL; a pair of mental barbels; anal, pectoral and pelvic fins deep yellowish .... Daysciaena Talwar.

3. Anterior pair of swimbladder appendage arising from the front of hammer-shaped swimbladder and branching in the head; mental pores 3 pairs .... Johnius Bloch.

Protonibea Trewavas, 1971

Protonibea Trewavas, 1971: 458; 1977: 363.

A single species is known, *Protonibea diacanthus*.

Protonibea diacanthus (Lacepede, 1802)
Plate 33.2

Lutjanus diacanthus Lacepede, 1802: 240.
Johnius diacanthus Cantor, 1850: 1049; Fowler, 1928: 115; Munro, 1955: 153.
Sciaena diacanthus Gunther, 1860: 290; Day, 1878: 189.
Pseudosciaena diacanthus Bleeker, 1874: 27; Weber and de Beaufort, 1936: 515.
Nibea diacanthus Lin, 1938: 544; Chu, Lo and Wu, 1963: 52; Mohan, 1972: 93.
Protonibea diacanthus Trewavas, 1971: 458; Fischer and Whitehead, 1974.

Description: Based on 5 specimens ranging in size 124.0–273.0 mm SL (154.0–328.0 mm TL).

Fin formula: D. X, I, 22–24; A. II, 7; P. 16; V. I, 5; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 27.58–31.61 (M =

29.08); head length 32.96–34.67 (M = 33.91); snout to D fin origin 36.77–40.32 (M = 38.[illegible]); snout to A fin origin 66.30–67.24 (M = 66.81); snout to pectoral fin origin 30.76–34.67 (M = 32.37); snout to pelvic fin origin 32.25–36.69 (M = 34.41); base D spines 21.29–22.90 (M = 22.27); base D rays 32.39–37.91 (M = 34.79); base A fin 8.87–9.67 (M = 9.36); pectoral fin length 21.06–21.77 (M = 21.46); pelvic fin length 16.66–19.31 (M = 18.38); longest D spine (3rd) 13.79–14.83 (M = 14.[illegible]9); longest A spine (2nd) 8.65–10.48 (M = 9.87); least depth of caudal peduncle 9.[illegible]7–9.67 (M = 9.48).

In percent of head length: snout length 23.33–26.74 (M = 25.02); orbit diameter 16.11–21.15 (M = 19.54); least width of interorbital space 19.44–22.09 (M = 21.17).

Body rather slender and slightly elongated. Snout pointed. Mouth terminal, cleft of mouth oblique. Upper jaw prominent, hind end of maxilla reaching beyond the level of posterior margin of eye. Interorbital space convex. The posterior nostril more prominent. Snout is having 8 pores. 5 pairs of mental pores. Gill rakers on first arch (3–4) + (6–8) = 9–12. The teeth are well differentiated in size in both jaws. Swimbladder with 20 pairs of lateral appendages, the anterior pair branches in a fan-like manner. Lateral line arched anteriorly, becomes straight below 12th dorsal ray. Axillary scale present at pelvic fin axil. Caudal fin rhomboid.

Scales: Lateral line scales 65-70; in transverse series 18-22. Cycloid scales present on anterior most region of snout and fins. Ctenoid scales on other parts of body and head including at fins base.

Colour: Dorsal profile brownish, ventral profile silvery. 4-5 dark distinct cross bands on dorsal profile. Dorsal and caudal fins and upper profile of the body with black round spots of varying sizes. Spinous dorsal, caudal, anal and pelvic fins blackish. Pectoral fin dusky black.

Distribution: East Indies, Malay Peninsula, Mozambique, China, Sri Lanka and coasts of India.

Other materials examined: ZSI Nos. F 7302/2 (186.0 mm SL) Cochin, F 7303/2 (166.0 and 161.0 mm SL) West Bengal, Talwar Coll.

Dendrophysa Trewavas, 1964

Dendrophysa Trewavas, 1964: 110.

Umbrina (part) Cuvier, 1817: 297.

A single species is known, Dendrophysa russelli.

Dendrophysa russelli (Cuvier, 1830)

Plate 36.1

Umbrina russelli Cuvier, 1830: 178; Day, 1878: 183.

Sciaena indica Fowler, 1933: 410.

Sciaena russelli Weber and de Beaufort, 1936: 544; Lin, 1938: 373; Munro, 1955: 153.

Dendrophysa russelli Trewavas, 1964: 110; Mohan, 1972: 92; Fischer and Whitehead, 1974.

Description: Based on 25 specimens ranging in size 74.0–127.0 mm SL (90.0–157.0 mm TL).

Fin formula: D. X, I, 27–28; A. II, 7; P. 14–15; V. I, 5; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 29.72–32.45 (M = 31.69); head length 31.04–33.78 (M = 32.13); snout to D fin origin 34.92–37.83 (M = 36.46); snout to A fin origin 66.26–71.25 (M = 69.26); snout to pectoral fin origin 30.15–34.09 (M = 32.66); snout to pelvic fin origin 37.09–41.22 (M = 39.04); base D spines 21.87–25.19 (M = 23.47); base D rays 32.84–37.71 (M = 35.21); base A fin 9.20–12.28 (M = 10.33); pectoral fin length 19.31–21.89 (M = 20.77); pelvic fin length 18.11–22.50 (M = 19.91); longest D spine (3rd) 14.17–17.32 (M =

15.38); longest A spine (2nd) 12.80-14.35 (M = 13.42); least depth of caudal peduncle 10.4-12.04 (M = 10.48).

In percent of head length: snout length 26.82-29.54 (M = 27.80); orbit diameter 22.22-25.00 (M = 29.04); least width of interorbital space 22.22-26.66 (M = 24.28).

Body oblong and compressed. Snout rounded, overhangs lower jaw. Mouth slightly inferior. Cleft of mouth horizontal. Upper jaw prominent, hind end of maxilla reaching to middle of eye. Interorbital space convex. Posterior nostril more prominent. Snout is having 2 median and 3 paired pores. 5 mental pores. A median tapering mental barbel with a median pore at its base. Gill rakers on first arch (5-6) + (6-7) = 11-13. Teeth in upper jaw villiform, the outer row slightly enlarged. Uniform small teeth in lower jaw. Swimbladder with 15-16 pairs of lateral appendages, the anterior pair branching under the skull. The posterior pair parallel to the tubular end of bladder. Lateral line arched anteriorly, becomes straight below 12th dorsal fin ray. Pelvic fin with axillary scale, first ray filament like. Caudal fin rhomboid.

Scales: Lateral line scales 48-50; in transverse series 15-16. Cycloid scales at the anterior most region of snout below opercle and fins, elsewhere ctenoid.

Colour: Body silvery, dorsal profile with purple tinge in fresh condition. A black band across nape. Opercle golden yellow. Spinous dorsal fin black, rays blackish distally. Other fins feebly yellowish. Dark spot at inner pectoral axil.

Distribution: Coasts of India and eastwards to Kwangtung.

Other materials examined: ZSI Reg. F 7321/2 (126-161 mm SL; 4 ex.) Vellar estuary, Talwar, Coll.

Dendrophysa Talwar, 1970

Dendrophysa Talwar, 1970: 193.

A single species is known, Dendrophysa albida.

Dendrophysa albida (Cuvier, 1830)
Plate 36.2

Corvina albida Cuvier, 1830: 93; Bleeker, 1872: 142; Day, 1865: 54.

Sciaena albida Day, 1878: 188.

Johnius coibor Fowler, 1933: 378; Munro, 1955: 154.

Pseudosciaena coibor (nec Hamilton) Weber and de Beaufort, 1936: 517.

Dendrophysa hooghliensis Sinha and Rao, 1969: 77.

Daysciaena albida Talwar, 1970: 191; Fischer and Whitehead, 1974; Trewavas, 1977: 372.

Description: Based on 25 specimens ranging in size 56.0–520.0 mm SL (84.0–600.0 mm TL).

Fin formula: D. IX, I, 24–25; A. II, 7; P. 16; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 27.21–30.21 (M = 28.73); head length 29.16–33.33 (M = 31.56); snout to D fin origin 35.00–38.46 (M = 37.03); snout to A fin origin 66.45–71.42 (M = 68.76); snout to pectoral fin origin 29.03–33.33 (M = 30.98); snout to pelvic fin origin 31.15–34.61 (M = 33.18); base D spines 20.28–23.07 (M = 21.81); base D rays 35.70–37.75 (M = 37.09); base A fin 8.43–10.49 (M = 9.43); pectoral fin length 19.44–21.79 (M = 20.66); pelvic fin length 16.77–20.31 (M = 18.89); longest D spine (3rd) 12.30–16.98 (M = 15.24); longest A spine (2nd) 9.90–14.10 (M = 12.50); least depth of caudal peduncle 8.07–9.89 (M = 9.12).

In percent of head length: snout length 21.56–26.92 (M = 24.54); orbit diameter 14.42–20.00 (M = 17.06); least width of interorbital space 22.11–27.61 (M = 24.38).

Body oblong and moderately compressed. Snout rounded. Mouth terminal, cleft of mouth oblique. Upper jaw overlapping lower jaw. Hind end of maxilla reaching slightly beyond the middle of eye. Interorbital space flat. The posterior nostril more prominent. 8 pores present on snout. Five pores present at mandibular symphysis. A pair of small mental barbels present. Two indistinct spines on opercle. Gill rakers on first arch (4–6) + (8–9) = 12–15. A row of enlarged teeth in each jaw, outer series in upper jaw and inner series in lower jaw. Small villiform teeth also present in jaws. Swimbladder with 17–18 pairs of lateral appendages, the anterior most pair branching in the head. Posterior pair of appendage are free and tubular. Lateral line arched anteriorly, becomes straight below 10–11 dorsal fin rays. Caudal fin rhomboid.

Scales: Lateral line scales 63–68; in transverse series 22–23. Anterior most region of snout and fins having cycloid scales, ctenoid scales present on other parts of body and head including fins base.

Colour: Body silvery with pinkish tinge in fresh condition. Bluish blotch on opercle. Spinous dorsal blackish. Soft dorsal and upper half of caudal fins dotted black in its distal half. Belly and anal, lower half of caudal, pectoral and pelvic fins yellowish in every fresh specimens. Dark spot at inner pectoral axil.

Distribution: Only positively known from the coasts of India.

Other materials examined: ZSI Nos. 989 (179.0 mm SL) Madras, F. Day Coll; F 7320/2 (125.0-180.0 mm SL, 6 eg.) Cochin, Talwar Coll.

Johnius Bloch, 1793

Johnius Bloch, 1793: 132.
Bola Hamilton, 1822: 73.

Key to sub-genus

Upper teeth not widely spaced, lower teeth in a band, uniform in size or with a few inner slightly enlarged; mouth ventral or subterminal; lower gill rakers 5-10 .... _Johnius_ Bloch.

Key to species

Soft dorsal rays 27-30; snout slightly projecting; 2nd anal spine 10.81-14.13% in SL; barbels absent; 12-14 pairs of swimbladder appendages; lower gill rakers 8-10; ctenoid scales present on occiput and body excluding chest; fins blackish .... _Johnius_ (_Johnius_) _belangerii_ (Cuvier).

Johnius (*Johnius*) *belangerii* (Cuvier, 1830)
Plate 36.3

Corvina belangerii Cuvier, 1830: 120.
Johnius belengeri Bleeker, 1845: 523; Cantor, 1850: 1047; Fowler, 1933: 382.
Sciaena belangeri Day, 1876: 191.
Johnius belangerii Fischer and Whitehead, 1974; Trewavas, 1977: 413.

Description: Based on 15 specimens ranging in size 93.0–128.0 mm SL (113.0–160.0 mm TL).

Fin formula: D. IX, I, 27–3 ; A. II, 7; P. 16; V. I, 5; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 30.55–31.52 (M = 30.99); head length 29.50–31.52 (M = 30.43); snout to D fin origin 33.15–34.50 (M = 34.27); snout to A fin origin 65.40–70.33 (M = 67.16); snout to pectoral fin origin 27.77–31.10 (M = 29.94); snout to pelvic fin origin 32.43–37.63 (M = 35.30); base D spines 19.35–22.31 (M = 20.47); base D rays 39.84–42.34 (M = 42.00); base A fin 9.83–11.94 (M = 10.63); pectoral fin length 17.11–20.24 (M = 18.66); pelvic fin length 18.27–21.48 (M = 19.65); longest D spine (3rd) 14.83–16.79 (M = 15.47); longest A spine (2nd) 10.81–14.13 (M = 11.58); least depth of caudal peduncle 9.67–10.86 (M = 10.32).

In percent of head length: snout length 27.27-30.30 (M = 28.94); orbit diameter 21.05-26.56 (M = 23.38); least width of interorbital space 25.86-29.98 (M = 26.96).

Body oblong and moderately compressed. Snout rounded and slightly projecting in front of upper jaw. Mouth subterminal, cleft of mouth horizontal. Hind end of maxilla reaching to middle of eye. Interorbital space convex. Posterior nostril prominent. Snout is having 5 marginal pores and 3 rostral pores. Mental pores 5. Gill rakers on first arch 4+ (8-10) = 12-14. Outer teeth in upper jaw larger and curved, inner teeth small and in bands. Teeth in lower jaw uniform and small. Swimbladder with 12-14 pairs of lateral appendages, the anterior most pair entering in head. Lateral line arched anteriorly, becomes straight below 12-13 dorsal rays. Axillary scale present at pelvic fin axis. Caudal fin rhomboid.

<u>Scales</u>: Lateral line scales 5[illegible]-54; in transverse series 16-18. Cycloid scale present at anterior most region of snout, chest and fins. Ctenoid scales on other parts of body and head including fins base.

<u>Colour</u>: Body silver with bronzy tinge. Opercle with a black blotch. Dorsal, anal, caudal and distal half of pelvic fins blackish. Pectoral fin grey. Preserved specimens uniformly brown.

Distribution: South East Asia to China and Japan, Persian Gulf, Eastern coast of Australia and coasts of Indian Peninsula.

Other materials examined: ZSI Nos. 970 (106.0 mm SL) 973-976 (99.0-146.0 mm SL, 4 ex.) Bombay, F. Day Coll.

2.4.35. FAMILY : MULLIDAE

Characters of taxonomic value: Body elongate, slightly compressed, covered with large ctenoid scales. Underside of the head and belly flat. Mouth horizontal, slightly protrusible, subterminal and a pair of barbels on the chin. Uniseriate or multiseriate teeth in jaws, present or absent in vomer and palate. Lateral line entire, the sensory tubes branched. Two short dorsal fins, separated from each other, the first with 7-8 spines. Anal fin with one or two spines. Pelvic fin with one spine and five rays and an axillary scale present. Gill membrane free from isthmus. Caudal fin deeply forked.

A brief review on the literature shows that Day (1878) recorded 14 species of Goat fishes under 3 genera from the seas around India. Subsequently, Weber and de Beaufort (1931) described 25 species under 3 genera from Indo-Australian Archipelago and Munro (1955) reported 13 species from Sri Lanka waters. Fishes of the family Mullidae were subjected to revisions in different areas of the world notably by Snyder (1907) from the shores of Japan, Herre and Montalban (1928) from Philippines and Lachner (1954,1960) from the Indo-Pacific area, Marshall and Marianas Islands. Apart from Day's (1878) account, other new distributional records of goat fishes from Indian seas were those of Jones and Kumaran (1965,1967) and Thomas (1967). A critical taxonomic study of the fishes of the family Mullidae was done by Thomas (1969) who described 19 species under 3 genera from the seas around India. Fischer and Whitehead (1974) listed 27 species under 4 genera from the Eastern Indian Ocean and Western Central Pacific.

Key to genera

Villiform bands of teeth present in jaws, vomer and palatine; no spine on opercle; stripes present on dorsal fins .... *Upeneus* Cuvier.

A single row of stout, blunt and widely inter-spaced teeth on both jaws; palate devoid of teeth; spine present on opercle .... *Parupeneus* Bleeker.

Upeneus Cuvier (1829)

Upeneus Cuvier in Cuvier and Valenciennes, 1829: 448.

Hypeneus Agassize, 1846: 19[illegible].

Upeneoides Bleeker, 1849: 64.

Fischer and Whitehead (1974) proposed two sub-genera under this genus.

Key to sub-genus

5–7 vertical scale rows between the interdorsal fins; 12 vertical scale rows from post second dorsal fin to caudal peduncle; grey or black stripes on dorsal fins; stripes on caudal fin usually more in upper lobe than lower .... _Upeneus_.

Key to species

First dorsal with 8 spines, the first spine minute; preorbital scales absent .... 1 and 2.

1. Snout length 34.[illegible]–37.4[illegible]% in HL; gill rakers 24–27; 2 yellow longitudinal bands along sides; no dark oblique band on caudal fin .... _Upeneus_ (_Upeneus_) _sulphureus_ Cuvier.

2. Snout length 33.33–34.52% in HL; gill rakers 26–28; 4 golden yellow longitudinal bands along sides; 4–6 dark oblique bands on each lobe of caudal fin .... _Upeneus_ (_Upeneus_) _vittatus_ Lacepede.

Upeneus (Upeneus) sulphureus Cuvier, 1829

Plate 37.1

Upneus sulphureus Cuvier in Cuvier and Valenciennes, 1829: 450; Bleeker, 1875: 4; Weber and de Beaufort, 1931: 364; Fowler, 1933: 33 ; Smith, 1949: 229; Munro, 1955: 163; Lachner, 1960: 4; Thomas, 1969: 17.

Upeneoides sulphureus Bleeker, 1849: 63; Gunther, 1859: 398; Day, 1876: 12 ; Fowler, 1928: 115.

Upeneoides vittatus Fowler, 1925: 246.

Upeneus (Upeneus) sulphureus Fischer and Whitehead, 1974.

Description: Based on 4 specimens ranging in size 75.0–93.5 mm SL (96.0–118.0 mm TL).

Fin formula: D. VII; 1, 8; A. I, 7; P. 14; V. I, 5; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 23.99–27.30 (M = 26.78); head length 29.31–29.62 (M = 29.41); snout to D_1 fin origin 39.33–39.65 (M = 39.51); snout to D_2 fin origin 66.66–66.84 (M = 66.70); snout to A fin origin 67.33–68.50 (M = 67.83); snout to pectoral fin origin 29.99–31.03 (M = 30.56); snout to pelvic fin origin 32.66–33.95 (M = 33.41); base D_1 fin 13.58–14.94 (M = 14.27); base D_2 fin 12.34–13.66 (M = 12.89); base A fin 9.77–12.66 (M = 11.03); pectoral fin length 20.85–22.22 (M = 21.58); pelvic fin length 17.11–17.90 (M = 17.39);

barbel length 18.66–19.75 (M = 19.17); longest D spine (3rd) 19.78–22.66 (M = 21.02); least depth of caudal peduncle 10.49–11.22 (M = 1[illegible].32).

In percent of head length: snout length 34.00–37.40; orbit diameter 24.90–27.45 (M = 26.22); least width of interorbital space 27.27–29.41 (M = 28.73).

Body elongated. Mouth subterminal, maxilla reaching to slightly behind preorbital margin. Barbels reaching to ventral margin of opercle. Snout pointed. Interorbital space nearly flat. Gill rakers on first arch (5–8) + (15–19) = 20–27. Villiform bands of teeth in vomer, palate and jaws. Lateral line extends to caudal fin base. First dorsal spine very small. Caudal fin deeply forked.

Scales: Lateral line scales 31–34; in transverse series 9–10. Ctenoid scales present all over the body including interorbital space. Scales absent in the preorbital region, opercle and preopercle. Scales below the dorsal fins and anal fin slightly elongated.

Colour: Dorsal profile yellowish, dull white below. Head with slight red reflection. 3 longitudinal yellow bands, one above the lateral line and two below. First dorsal fin with two dark horizontal stripes, its lip blackish. Caudal fin margin black. Other fins colourless.

Distribution: East Africa, Red Sea, East Indies, Philippines, Fiji Islands, northern coasts of Australia, coasts of China, Japan, Sri Lanka and India: east and west coasts.

Upeneus (Upeneus) vittatus Lacepede, 1801
Plate 37.2

Upeneus vittatus Lacepede, 1801: 382; Cuvier in Cuvier and Valenciennes, 1829: 448; Bleeker, 1875: 6; Weber and de Beaufort, 1931: 365; Fowler, 1932: 10; Smith, 1949: 228; Munro, 1955: 163; Lachner, 1960: 5; Thomas, 1969: 23.

Upeneoides vittatus Bleeker, 1849: 63; Gunther, 1859: 397; Day, 1878: 120; Fowler, 1927: 259.

Upeneoides caeruleus Day, 1868: 194.

Upeneus (Upeneus) vittatus Fischer and Whitehead, 1974.

Description: Based on 4 specimens ranging in size 91.0–96.0 mm SL (114.0–120.0 mm TL).

Fin formula: D. VIII, I, 7; A. I, 6; P. 15; V. I, 5; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 25.27–25.92 (M = 25.59); head length 27.36–30.76 (M = 29.06); snout to D_1

fin origin 38.00–40.65 (M = 39.32); snout to D_2 fin origin 60.48–64.58 (M = 62.53); snout to A fin origin 60.48–64.13 (M = 62.30); snout to pectoral fin origin 27.84–31.31 (M = 29.57); snout to pelvic fin origin 31.20–34.61 (M = 32.90); base D_1 fin 13.73–14.38 (M = 14.30); base D_2 fin 12.08–12.96 (M = 12.52); base A fin 9.89–9.60 (M = 9.74); pectoral fin length 21.12–21.42 (M = 21.27); pelvic fin length 15.84–17.03 (M = 16.43); barbel length 15.38–16.32 (M = 15.85); longest D spine (3rd) 19.68–21.42 (M = 20.55); least depth of caudal peduncle 10.08–10.43 (M = 10.25).

In percent of head length: snout length 33.33–35.71 (M = 34.52); orbit diameter 23.21–26.31 (M = 24.76); least width of interorbital space 24.99–29.82 (M = 27.40).

Body elongated, dorsal profile slightly convex. Mouth subterminal, maxilla reaching to below anterior border of orbital margin. Barbels reaching behind the hind margin of preopercle. Interorbital space flat. Gill rakers on first arch 8+(18–20) = 26–28. Villiform bands of teeth in jaws, oval patch in vomer and on elongate band in palate. Lateral line extends upto caudal fin base. First dorsal spine very small.

Caudal fin deeply forked.

Scales: Lateral line scales 34-35; in transverse series 10. Ctenoid scales present all over the body including interorbital space. Scales absent on preorbital region, opercle and preopercle. Scales at bases of dorsal and anal fins slightly elongated.

Colour: Dorsal profile golden yellow, pale white below. Head slightly pinkish. Four golden yellow longitudinal bands along sides, two of them above lateral line and other below it. Dorsal fin with three horizontal stripes, the upper most blackish and others dusky. Caudal fin with 4-5 black cross bars on upper lobe and 3-4 black cross bars on the lower lobe. Other fins colourless.

Distribution: Island group of Oceania to low Archipelago, Japan to Australia, East coast of Africa, Red Sea, Indonesia, Philippines, Sri Lanka and India: both east and west coasts including Andamans.

Other materials examined: ZSI Reg. Dup. Cat. 352 (84.0 mm SL) Andamans, A.S.B. 339 (127.0 mm SL) Sind, F. Day Coll.

Remarks: Fischer and Whitehead (1974) stated that *D. vittatus* Forsskal was seemed to be a species from the Red Sea belonging to the sub-genus *Pennon*.

Parupeneus Bleeker (1868)

Parupeneus Bleeker, 1868: 344.

Key to species

Snout length 45.65–47.61% in HL; gill rakers 23–24; a golden yellow blotch on the lat. line below the interdorsal space; a black blotch behind the midpoint of caudal peduncle .... *Parupeneus indicus* (Shaw).

Parupeneus indicus (Shaw, 1803)
Plate 37.3

Mullus indicus Shaw, 1803: 614.

Upeneus malabaricus Cuvier in Cuvier and Valenciennes, 1829: 467; Bleeker, 1853: 34; Günther, 1859: 407.

Upeneus indicus Günther, 1859: 406; Day, 1878: 126; Fowler, 19[illegible]: 526.

Parupeneus malabaricus Weber, 1913: 297; Weber and de Beaufort, 1931: 395.

Parupeneus indicus Bleeker, 1875: 27; Weber and de Beaufort, 1931: 394; Munro, 1955: 164; Lachner, 1960: 7; Thomas, 1969: 55; Fischer and Whitehead, 1974.

Description: Based on 6 specimens ranging in size 77.0–104.0 mm SL (93.0–128.0 mm TL).

Fin formula: D. VIII, I, 7–8; A. I, 6; P. 14; V. I, 5; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 23.37–25.60 (M = 24.65); head length 29.87–30.28 (M = 30.00); snout to D_1 fin origin 36.36–38.46 (M = 37.33); snout to D_2 fin origin 59.14–61.53 (M = 60.13); snout to A fin origin 60.38–62.49 (M = 61.68); snout to pectoral fin origin 31.09–31.73 (M = 31.32); snout to pelvic fin origin 31.81–33.53 (M = 32.74); base D_1 fin 13.41–14.42 (M = 13.82); base D_2 fin 14.90–15.58 (M = 15.24); base A fin 10.38–12.49 (M = 11.60); pectoral fin length 20.12–21.63 (M = 20.82); pelvic fin length 20.77–24.03 (M = 2 .25); barbel length 20.12–21.15 (M = 20.46); longest D spine (3rd) 17.68–18.18 (M = 17.88); least depth of caudal peduncle 10.38–11.53 (M = 10.96).

In percent of head length: snout length 45.65–47.61 (M = 46.73); orbit diameter 20.40–22.60 (M = 21.74); least width of interorbital space 23.80–28.26 (M = 26.20).

Body oblong, dorsal profile slightly convex. Mouth subterminal, maxilla does not reaching to preorbital margin. Barbels reaching to well behind posterior border of opercle. Opercle with a weak flat spine. Interorbital space convex. Gill rakers on first arch 5+(18-19) = 23-24. A single band of teeth in jaws, none on palate and vomer. Lateral line extends upto caudal fin base. First dorsal spine very small. Caudal fin deeply forked.

__Scales:__ Lateral line scales 31-32; in transverse series 9-10. Scales present all over the body including on cheek, opercle and preopercle. Scales absent on preorbital space. Scales below dorsal fins and anal fin base triangular.

__Colour:__ Body purplish red, head rosy red, pale yellow on belly. Cheek and opercle purple. Three purple lines from snout to opercle. A golden yellow oval blotch on the lateral line below hind part of first dorsal fin to below front part of second dorsal fin. A black blotch behind the midpoint of caudal peduncle. Two horizontal yellow bands on second dorsal and anal fins. Other fins not pigmented.

__Distribution:__ Red Sea, East coast of Africa, Philippines, Southern Japan, China, Formosa, Fiji, Tonga, Micronesia, Polynesian Islands, Australia, Sri Lanka and India: both east and west coasts.

<u>Other materials examined</u>: ZSI No. Cat. 73 (193.0 mm SL) history unknown, A.S.B. Cat. 74 (97.0-137.0 mm SL, 3 eg.) Andamans, J. Anderson Coll.

2.4.36. <u>FAMILY</u>: <u>DREPANIDAE</u>

<u>Characters of taxonomic value</u>: Body rhombic, deep and strongly compressed. Mouth small, terminal and protractile into a downwardly directed tube. Tip of maxilla exposed. Bands of teeth in jaws, none on palate. Gill membrane united with isthmus. Scales medium sized and ciliated. Two nostrils on each side. Lateral line arched. Dorsal fin with 8-10 spines, first spine procumbent. Anal fin with 4 spines. Pectoral fin long and falcate. Caudal fin rounded.

Family Drepanidae is represented by a single genus <u>Drepane</u> (Fischer and Whitehead, 1974). Day (1878), Weber and de Beaufort (1936) and Munro (1955) recognised only a single valid species under the genus <u>Drepane</u>. Lele (1924) revised the genus <u>Drepane</u> and established both anatomically and morphologically the distinctness of two species. Smith (1949) also reported about the possibilities of two species under the genus <u>Drepane</u>. However, Murty (1968) conducted detailed investigations on fishes of the genus <u>Drepane</u> of Indian coasts and confirmed the validity of two species, <u>D. punctata</u> and

D. longimana. Fischer and Whitehead (1974) also listed two species from Eastern Indian Ocean and Western Central Pacific.

Drepane Cuvier and Valenciennes, 1831

Drepane Cuvier and Valenciennes, 1831: 91.

Key to species

Spinous dorsal with 9 spines, 4th spine the longest; 4–9 vertical bands of small black spots on sides .... Drepane punctata (Linnaeus).

Drepane punctata (Linnaeus, 1758)
Plate 37.4

Chaetodon punctatus Linnaeus, 1758: 273.
Drepane punctata Cuvier and Valenciennes, 1831: 132; Bleeker, 1845: 520; Gunther, 1860: 13 ; Day, 1878: 116; Fowler, 1928: 242; Weber and de Beaufort, 1936: 180; Munro, 1955: 169; Fischer and Whitehead, 1974.

Description: Based on 11 specimens ranging in size 43.–69. mm SL (55.–91.0 mm TL).

Fin formula: D. IX, 2 –21; A. III, 17–18; P. 16–17; V. I, 5; C. 2 .

Body measurements expressed in percent of standard length: greatest body depth 78.2[illegible]–84.52 (M = 81.45); head length 36.23–39.28 (M = 38.11); snout to D fin origin 69.76–74.99 (M = 72.44); snout to A fin origin 62.79–68.[illegible]2 (M = 65.4[illegible]); snout to pectoral fin origin 36.36–37.68 (M = 36.95); snout to pelvic fin origin 35.71–4[illegible].69 (M = 37.90); base D fin 67.44–74.6[illegible] (M = 72.18); base A fin 46.37–5[illegible].79 (M = 47.03); pectoral fin length 5[illegible].79–58.33 (M = 53.91); pelvic fin length 29.76–37.87 (M = 35.40); longest D spine (4th) 24.24–29.36 (M = 26.27); longest A spine (2nd) 13.[illegible]4–16.66 (M = 14.55); least depth of caudal peduncle 13.95–15.21 (M = 14.48).

In percent of head length: snout length 36.36–42.85 (M = 39.59); orbit diameter 27.27–31.66 (M = 29.7[illegible]); least width of interorbital space 24.24–28.33 (M = 27.27).

Body deep and well compressed. Head profile convex. A distinct concavity before the origin of dorsal fin. From dorsal fin origin to caudal peduncle, the body is steeply descending. Mouth terminal and downwardly protractile. Eyes covered with the membrane, located well above from the level of mouth. Two small nostrils just in front of eyes. Interorbital space convex. Gill rakers on first arch (5-6) + (1-11) = 15-17. Small pointed teeth in bands in jaws. Lateral line strongly arched, reaching to caudal peduncle. Pectoral fin long and falcate, reaching to caudal peduncle. Axillary scale present at pelvic fin base. Caudal fin rounded.

__Scales__: Lateral line scales 49-56; in transverse series 42-45. Scales present all over the body including on dorsal, anal and caudal fins and cheek. Scales absent on snout, opercle and interorbital space. Scales sheath are visible at dorsal and anal fins base.

__Colour__: Body silvery bright with a purple tinge in very fresh condition. 4-9 vertical bands of small black spots are seen on sides. Ventral profile dusky brown in preserved specimens. Margins of soft dorsal, anal and caudal fins dusky black. Pelvic fin blackish. Pectoral fin colourless.

__Distribution__: Red Sea, East coast of Africa, Madagascar, South Arabia, Persian Gulf, Malay Peninsula, China, Siam, Philippines, Australia, Sri Lanka and India: both east and west coasts including Andamans.

__Other material examined__: ZSI No. 304 (88.0 mm SL) Madras, F. Day Coll.

Remarks: Murty (1968) observed that *D. punctata* differs from its closely related species, *D. longimana* (Bloch and Schneider) in a number of anatomical characters such as air bladder structure, number of pyloric caeca and in the shape of liver. The number of pyloric caeca is two in *D. punctata* where as it is three in *D. longimana* and this character may be used in field identifications.

2.4.37. FAMILY : SCATOPHAGIDAE

Characters of taxonomic value: Body rhombic and well compressed. Mouth small, terminal and the maxillary tip is not exposed. Bands of teeth in jaws but none on vomer and palate. Gill membrane united with isthmus. Minute ctenoid adherent scales present on body and head. Two nostrils on each side. Lateral line complete. Two dorsal fins, the spinous dorsal fin with 11-12 spines and the soft dorsal fin with 16-18 rays. 4 anal spines. Pectoral fin small and rounded. Caudal fin truncate.

Family Scatophagidae is represented by a single genus *Scatophagus* (Weber and de Beaufort, 1936). Among the fishes of the genus *Scatophagus*, a single species is known from India (Day, 1878) and Sri Lanka (Munro, 1955) waters. But, Weber and de Beaufort (1936) described two species and another variety of *S. argus* from the Indo-Australian Archipelago. Smith (1949) listed two species from Southern Africa.

Scatophagus Cuvier and Valenciennes, 1831

Scatophagus Cuvier and Valenciennes, 1831: 136.
Cacodoxus Cantor, 1849: 1145.
Ephippus Bleeker, 1877: 26 (nec. Cuv. and Val.).

Key to species

Body depth 60.75-66.66% in SL; gill rakers 14-19; hind margin of soft dorsal and anal subvertical; body is having numerous greyish-black round blotches and devoid of cross-bars .... Scatophagus argus (Bloch).

Scatophagus argus (Bloch, 1788)
Plate 33.1

Chaetodon argus Bloch, 1788: 86; Linnaeus, 1788: 1248.
Scatophagus argus Cuvier and Valenciennes, 1831: 136; Bleeker, 1845: 500; Gunther, 1860: 58; Day, 1878: 114; Fowler, 1928: 242; Weber and de Beaufort, 1936: 6; Munro, 1955: 169.

Description: Based on 25 specimens ranging in size 31.0-112.0 mm SL (40.0-137.0 mm TL).

Fin formula: D. XI, 16; A. IV, 14; P. 17; V. I, 5; C. 18.

Body measurements expressed in percent of standard length: greatest body depth 6[illegible].75–66.66 (M = 64.[illegible]4); head length 3[illegible].14–38.7[illegible] (M = 35.3[illegible]); snout to D fin origin 5[illegible].8[illegible]–55.97 (M = 53.41); snout to A fin origin 67.94–72.5[illegible] (M = 7[illegible].[illegible]5); snout to pectoral fin origin 30.35–37.87 (M = 33.73); snout to pelvic fin origin 41.[illegible]7–45.52 (M = 43.94); base D fin 38.29–43.9[illegible] (M = 42.27); base A fin 32.[illegible]5–36.56 (M = 34.93); pectoral fin length 16.[illegible]7–2[illegible].96 (M = 19.19); pelvic fin length 25.58–31.9[illegible] (M = 28.59); longest D spine (4th) 19.76–25.37 (M = 23.25); longest A spine (2nd) 11.66–15.15 (M = 13.05); least depth of caudal peduncle 13.92–14.89 (M = 14.53).

In percent of head length: snout length 3[illegible].13–34.37 (M = 32.44); orbit diameter 21.81–26.92 (M = 25.25); least width of interorbital space 41.66–44.89 (M = 42.81).

Body rhombic and compressed. Head pointed. A deep concavity above the eyes and a steep ascent to dorsal fin origin. Cleft of mouth horizontal. Anterior nostril very prominent. Interorbital space slightly convex. Horizontal margin of the preopercle serrated in its lower portion, vertical margin completely serrated. Lower margin of opercle feebly serrated. Gill rakers on first arch (5-7) + (9-12) = 14-19. Jaws having pluriseriate tricuspidate teeth. Lateral line convex, reaching to caudal fin base. Soft dorsal and anal fin high and subvertical. Caudal fin truncate.

__Scales__: Lateral line scales 102-141; in transverse series 80-88. Very minute scales present all over the body and head. Scales visible at dorsal, anal, caudal and pelvic fins base.

__Colour__: Body greenish-brown, belly dull white. Upper 2/3 of the body and soft dorsal is having numerous round black blotches of varying sizes. Interspinous membrane of the dorsal fin black, soft dorsal slightly yellowish. Margins of soft dorsal, anal and caudal fins blackish. Pelvic fin dusky black. Pectoral fin colourless.

__Distribution__: Delagoa Bay, Malay Peninsula, Siam, Tonkin, South coast of China, Formosa, Philippines, Australia, New South Wales, Southern Africa, Sri Lanka and India: both east and west coasts including Andamans.

__Other materials examined__: ZSI Nos. 330 (122.0 mm SL) Madras, 334 (162.0 mm SL) Port Blair, 399 (143.0 mm SL) Akyab, F. Day Coll.

__Remarks__: Weber and de Beaufort (1936) considered __S. argus__ var __tetracanthus__ (Lacepede) as a variety of

S. argus, but Smith (1949) described *S. tetracanthus* (Lacepede) as a separate species. The intensity of colour of *S. argus* was found to be varying according to the biotope. The specimens collected from marine and brackish water habitat had a darker colour than that of specimens collected from the fresh water biotope.

2.4.38. FAMILY : NANDIDAE

Characters of taxonomic value: Body oblong and compressed. Snout pointed. Mouth terminal and protractile. Cleft of mouth oblique. Maxilla tip broader. Villiform teeth in band in jaws and palate, conical teeth in vomer and parasphenoid. Gill membrane free or united with isthmus. Scales ctenoid, often in sheaths at the base of unpaired fins. Lateral line interrupted. Single dorsal with 12-17 strong spines. Anal with 3 spines and 8-12 rays. Pectoral fin rounded. Pelvic fin abdominal with one spine and 5 rays. Caudal fin rounded.

Among the fishes of the family Nandidae, fishes of the genus *Nandus* was alone represented in the study area. A single species was known from India (Day, 1878; John, 1936) and another species was described from Indo-Australian Archipelago (Weber and de Beaufort, 1936).

<u>Key to genus</u>

Mouth large and very protractile; intermaxillary pedicel long, reaching to occiput; hind end of maxilla reaching behind posterior margin of eye; gill membrane free from isthmus; scales absent on interbranchial membrane; nostrils close to eye .... <u>Nandus</u> Cuvier and Valenciennes.

<u>Nandus</u> Cuvier and Valenciennes, 1831

<u>Nandus</u> Cuvier and Valenciennes, 1831: 481.

<u>Key to species</u>

Body depth 34.48–37.50% in SL; lateral line scales 47–53; gill rakers 9–14; body with 4 prominent oblique black interrupted cross bars; caudal peduncle with a prominent black blotch .... <u>Nandus</u> <u>marmoratus</u> Cuvier and Valenciennes.

<u>Nandus</u> <u>marmoratus</u> Cuvier and Valenciennes, 1831
Plate 38.2

<u>Nandus</u> <u>marmoratus</u> Cuvier and Valenciennes, 1831: 482; Day, 1878: 129; John, 1936: 707.

<u>Description</u>: Based on 2[illegible] specimens ranging in size 55.0–120.5 mm SL (68.0–148.0 mm TL).

<u>Fin formula</u>: D. XIII–XIV, 11–12; A. III, 8; P. 15; V. I, 5; C. 14.

Body measurements expressed in percent of standard length: greatest body depth 34.48–37.50 (M = 35.68); head length 40.00–42.72 (M = 42.03); snout to D fin origin 42.32–46.82 (M = 44.45); snout to A fin origin 72.14–78.18 (M = 75.79); snout to pectoral fin origin 39.28–42.20 (M = 40.92); snout to pelvic fin origin 43.68–47.27 (M = 45.15); base D fin 46.88–51.72 (M = 49.20); base A fin 13.3[illegible]–15.51 (M = 14.27); pectoral fin length 14.56–18.10 (M = 16.59); pelvic fin length 16.98–20.00 (M = 18.52); longest D spine (2nd) 11.18–13.69 (M = 12.50); longest A spine (2nd) 11.32–14.65 (M = 12.62); least depth of caudal peduncle 12.[illegible]8–14.28 (M = 13.31).

In percent of head length: snout length 26.78–30.98 (M = 28.61); orbit diameter 16.27–22.64 (M = 18.54); least width of interorbital space 17.[illegible]–21.73 (M = 19.[illegible]).

Body oblong. Head tapering anteriorly. Mouth large and well protractile, lower jaw projecting. Hind end of maxilla broad, reaching to slightly behind the posterior margin of eye. Interorbital space convex. Intermaxillary pedicel in a ridge, reaching to occiput and have two grooves. Two nostrils on each side and are close together. Preopercle serrated. Gill rakers stumpy with 5-6 small spines. Gill rakers on first arch (3-4) + (6-10) = 9-14. Villiform teeth in band in jaws and palate, the anterior jaw teeth rather elongated. Palatine teeth conical. Lateral line interrupted below 4th soft dorsal ray, reaching to caudal peduncle. Soft dorsal and anal fins high and nearly rounded. Caudal fin rounded.

Scales: Ctenoid scales present on head, body and fins base.

Colour: Body greenish-brown with 4 oblique black interrupted cross bars, sometimes isolating into big blotches. Three bands radiating from postorbital region, first one obliquely ascending to dorsal fin origin, second one to opercle and the third to hind end of maxilla. Caudal peduncle with a prominent black blotch. Paired and unpaired fins with rows of black spots.

Distribution: Limited to the fresh and brackish waters of India and Burma.

Other material examined: ZSI No. F 2512/1 (88.0 mm SL) Sasthamkottah lake, Kerala, A. Annandale Coll.

Remarks: The description of A. nebulosus (Gray) is more or less similar to that of A. marmoratus. A. nebulosus is in all probability a synonym of A. marmoratus.

2.4.39. FAMILY : CICHLIDAE

Characters of taxonomic value: Body oblong or oval and compressed. Mouth terminal, jaws slightly protractile. Teeth lobate in series in jaws. Gill membrane free from isthmus. Scales ctenoid. Lateral line interruped. Single long dorsal fin. Caudal fin truncate or emarginate.

Day (1878) described 3 species under the single genus from India, but Munro (1955) reported 3 species under two genera from Sri Lanka waters. Formerly there was a single genus in India but recently another genus was introduced from South Africa.

Key to genera

Anal short with 3 spines, origin from vertical below 14-15th dorsal spines; soft dorsal and anal elongated and pointed, dorsal and anal without raised basal sheaths; pectoral and pelvic elongated; single nostril on each side .... Sarotherodon Ruppell.

Anal long with more than 12 spines, origin from vertical below 5-7 dorsal spines; soft dorsal and anal high and angular, dorsal and anal with raised basal scale sheaths; pectoral and pelvic fins not elongated; two nostrils in each side .... Etroplus Cuvier and Valenciennes.

Sarotherodon Ruppell, 1852

Sarotherodon Ruppell, 1852: 251.

Remarks: The name Sarotherodon Ruppell has been used as a sub-genus of Tilapia but Trewavas (1972,1973) recognized Sarotherodon as a distinct genus.

A single species is known from India.

Sarotherodon mossambicus (Peters, 1852)
Plate 39.1

Chromis mossambicus Peters, 1852: 681.
Tilapia mossambica Munro, 1955: 176; Jones, 1962: 665.
Sarotherodon mossambicus Jones and Kumaran, 1980: 391.

Description: Based on 14 specimens ranging in size 79.0-137.0 mm SL (101.0-173.0 mm TL).

Fin formula: D. XV-XVI, 12; A. III, 10-12; P. 13-14; V. I, 5; C. 16.

Body measurements expressed in percent of standard length: greatest body depth 37.30-44.30 (M =

40.00); head length 33.98–37.34 (M = 35.43); snout to D fin origin 37.3[illegible]–41.77 (M = 38.82); snout to A fin origin 68.75–73.41 (M = 70.41); snout to pectoral fin origin 32.52–35.44 (M = 33.68); snout to pelvic fin origin 4[illegible].29–44.93 (M = 42.08); D spines base length 38.88–44.3[illegible] (= 4[illegible].61); D rays base length 15.90–17.96 (M = 16.59); base A fin 20.4[illegible]–24.24 (M = 21.96); pectoral fin length 33.33–36.7[illegible] (M = 35.27); pelvic fin length 28.82–31.25 (M = 29.31); least depth of caudal peduncle 14.28–16.45 (M = 15.17).

In percent of head length: snout length 34.72–39.56 (M = 37.28); orbit diameter 19.14–21.87 (M = 20.52); least width of interorbital space 34.17–38.46 (M = 36.00).

Body moderately elongated. Mouth terminal, lower jaw slightly prominent. Hind tip of maxilla not reaching to vertical below anterior margin of eye. Interorbital space convex. Single nostril on each side. Gill rakers on first arch (3–4) + (15 – 20) = 18–24. Trilobed teeth in series in both jaws, the outermost series very prominent. Lateral line interrupted, reaching to caudal fin base. Caudal fin truncate.

__Scales__: In lateral series 30–32; in transverse series

14-16. Scales present on body and head excluding snout. Scale sheath at the base of caudal and paired fins.

<u>Colour</u>: Greenish-brown or uniformly black. 4-5 black blotches mid-laterally. Posterior margin of opercle black. Dorsal, anal and caudal fins brown or black, fringed with red. Other fins colourless.

<u>Distribution</u>: A native of South Africa, recently introduced into tropical Indo-Pacific area.

Etroplus Cuvier and Valenciennes, 1830

Etroplus Cuvier and Valenciennes, 1830: 135.

<u>Key to species</u>

Basal scale sheath of dorsal and anal high; dorsal rays 14-15; anal rays 11-12; body with 6-8 oblique dark bands; pectoral with basal black spot ... . *Etroplus suratensis* (Bloch).

Basal scale sheath of dorsal and anal low; dorsal rays 9-10; anal rays 8; body with 3 black blotches mid-laterally; pectoral without basal black spot .... *Etroplus maculatus* (Bloch).

<u>Etroplus suratensis</u> (Bloch, 1785)

Plate 39.2

<u>Chaetodon suratensis</u> Bloch, 1785: pl. 217.

<u>Etroplus suratensis</u> Gunther, 1862: 266; Day, 1878: 415; Munro, 1955: 177.

<u>Description</u>: Based on 25 specimens ranging in size 42.0–120.0 mm SL (55.0–156.0 mm TL).

<u>Fin formula</u>: D. XVIII–XIX, 14–15; A. XII–XIII, 11–12; P. 15; V. I, 5; C. 18.

Body measurements expressed in percent of standard length: greatest body depth 54.78–60.71 (M = 57.01); head length 3 .01–36.38 (M = 33.92); snout to D fin origin 40.78–46.07 (M = 44.13); snout to A fin origin 54.32–58.33 (M = 56.12); snout to pectoral fin origin 30.70–34.31 (M = 32.57); snout to pelvic fin origin 39.13–42.15 (M = 40.93); D spines base length 47.61–52.19 (M = 49.75); D rays base length 17.64–21.05 (M = 19.70); base A fin 45.23–49.99 (M = 47.11); pectoral fin length 25.65–30.55 (M = 28.48); pelvic fin length 19.04–24.56 (M = 22.10); least depth of caudal peduncle 14.75–17.39 (M = 16.43).

In percent of head length: snout length 36.95–42.10 (M = 38.54); orbit diameter 25.00–29.16

(M = 26.50); least width of interorbital space 34.48-39.47 (= 36.39).

Body oval and compressed. Mouth terminal, lower jaw slightly prominent. Hind tip of maxilla not reaching to vertical below anterior margin of eye. Interorbital space convex. Two nostrils on each side, the posterior one prominent. Gill rakers on first arch (6-8) + (10-12) = 16-20. Jaws with trilobed teeth in series, the outermost series prominent. Lateral line interrupted. Caudal fin slightly emarginate.

Scales: In lateral series 36-38; in transverse series 21-23. Scales present on body and head excluding snout. High basal scale sheath at dorsal and anal fins. Caudal and paired fins with basal scales.

Colour: Greenish with 6-8 oblique dark bands across the body. Scales with a central pearly spot, appearing as lateral stripes. Pectoral yellowish with a basal black spot. Other fins dark leaden colour. The specimens collected from high saline areas are more dark than to specimens collected from fresh waters.

Distribution: Fresh and brackish waters of India and Sri Lanka.

Other materials examined: ZSI No. F 1257/2 (163.0 and 147.0 mm SL) Pondicherry, A.G.K.Menon Coll.

Etroplus maculatus (Bloch, 1785)

Plate 39.3

Chaetodon maculatus Bloch, 1785: pl. 427.

Etroplus maculatus Cuvier and Valenciennes, 1830: 489; Gunther, 1862: 266; Day, 1878: 415; Munro, 1955: 177.

Description: Based on 25 specimens ranging in size 37.0–65.0 mm SL (47.0–87.0 mm TL).

Fin formula: D. XVIII–XIX, 9–10; A. XIII–XIV, 8; P. 13; V. I,5; C.20.

Body measurements expressed in percent of standard length: greatest body depth 53.26–58.53 (M = 54.80); head length 34.61–39.13 (M = 36.74); snout to D fin origin 43.39–46.29 (M = 44.97); snout to A fin origin 51.44–56.75 (M = 55.50); snout to pectoral fin origin 33.34–39.02 (M = 36.14); snout to pelvic fin origin 39.62–44.44 (M = 41.94); D spines base 46.15–50.94 (M = 48.29); D rays base 13.55–15.85 (M = 15.37); base A fin 43.47–47.15 (M = 46.46); pectoral fin length 27.69–31.03 (M = 29.17); pelvic fin length 19.23–22.97 (M = 20.75); least depth of caudal peduncle 15.21–17.07 (M = 15.70).

In percent of head length: snout length 34.21–40.38 (M = 38.43); orbit diameter 24.99–28.57 (M =

27.54); least width of interorbital space 28.57–35.55 (M = 32.48).

Body oval and compressed. Mouth terminal. Hind tip of maxilla not reaching to vertical below anterior margin of eye. Interorbital space convex. Two nostrils on each side, the posterior more prominent. Gill rakers on first arch (6–8) + (8–9) = 14–17. Jaws with trilobed teeth in series, outermost series very conspicuous. Lateral line interrupted. Caudal fin slightly emarginate.

Scales: In lateral series 30–33; in transverse series 18–20. Scales present on body and head excluding snout. Scale sheath present at the base of dorsal, anal, caudal and paired fins.

Colour: Greenish-yellow with orange chromide spots on body. Scales of dorsal profile with golden yellow spots, imparting lateral stripes. Three black blotches mid-laterally, the middle one largest. Dorsal fin with rows of black spots. Anal and pelvic fins black. Other fins dusky.

Distribution: Fresh and brackish waters of India and Sri Lanka.

Other materials examined: St. No. 1088 and 1089 (57.0 and 69.0 mm SL) Madras, 1090 (61.0 mm SL) Canara, 1637

(62.0 mm SL) Madras, F. Day Coll.

2.4.40. FAMILY : MUGILIDAE

Characters of taxonomic value: Body elongated, cylindrical and slightly compressed. Snout blunt. Mouth terminal or inferior, small. Premaxilla protractile. Ciliary teeth on lips. Gill membrane free from isthmus. Scales usually cycloid, present on head and body. Axillary scales present at the base of first dorsal and pelvic fins. Lateral line absent. Adipose eyelids present or absent. Two dorsal fins, first dorsal with 4 slender spines. Pectoral fin located rather high on body. Caudal fin forked or emarginate.

Mullets in general have drawn special attention from several systematists. It is a difficult group for identification due to the morphological similarity of the species included in this family. During the fish faunal investigations Day (1878) described 27 species from the coasts of India, Weber and de Beaufort (1922) reported 24 species from Indo-Australian Archipelago, Devasundaram (1951) reported 10 species from Chilka lake and Munro (1955) accounted 13 species from Sri Lanka waters. Systematic revision on this group was conducted notably by Schultz (1946), Smith (1948), Pillay (1962a, 1962b) and Reddy (1977). Pillay (1962a,1962b) revised the Indian Mugilidae and described 9 species from this area. Fischer and Whitehead (1974) listed 28 species from Eastern Indian Ocean and Western Central Pacific. Other notable studies on Indian Mugilidae are those of Luther (1974) and Rangaswamy (1978). Sunny (1975) described 4 species from Vembanad lake.

Key to genera

1. Width of the hind end of pre-orbital always lesser than internostril space; pectoral base with blue band or spot and axillary scale; tongue completely adnate to the floor of the mouth, tip not bilobed .....2.

Width of the hind end of pre-orbital always greater than internostril space; pectoral base without blue band or spot and axillary scale; tongue not adnate, tip bilobed ....3.

2. Origin of anal slightly in advance to 2nd dorsal; tongue without teeth; hind tip of maxilla not curved down below tip of premaxilla; adipose eyelid well developed; maxilla visible slightly when mouth closed .... *Mugil* Linnaeus.

Origin of anal opposite to 2nd dorsal fin; tongue with teeth; hind end of maxilla feebly curved down below tip of premaxilla; maxilla not visible clearly when mouth closed .... Valamugil Smith.

3. Hind end of maxilla strongly curved down below tip of premaxilla; tip of maxilla clearly visible when mouth closed; pre-orbital bent and notched .... Liza Jordan and Swain.

Mugil Linnaeus, 1758

Mugil Linnaeus, 1758: 316.

Key to species

Anal with 3 spines and 8 rays; lat. scales 39–42; adipose eyelid covering most of the eye except a narrow slit on pupil; oblique blue band at pectoral base .... Mugil cephalus Linnaeus.

Mugil cephalus Linnaeus, 1758
Plate 40.1

Mugil cephalus Linnaeus, 1758: 316; Hamilton, 1822: 119; Weber and de Beaufort, 1922: 253; Munro, 1955: 92; Pillay, 1962b: 558; Fischer and Whitehead, 1974.

Mugil macrolepidotus Richardson, 1846: 249.

Mugil dobula Gunther, 1861: 42[illegible].

<u>Description</u>: Based on 17 specimens ranging in size 113.0–180.0 mm SL (145.0–225.0 mm TL).

<u>Fin formula</u>: D. IV; I, 8; A. III, 8; P. 15–16; V. I, 5; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 19.49–23.43 (M = 20.26); head length 26.12–29.54 (M = 27.63); snout to D_1 fin origin 43.37–53.16 (M = 50.97); snout to D_2 fin origin 72.03–78.57 (M = 74.43); snout to A fin origin 69.44–74.83 (M = 71.36); snout to pectoral fin origin 25.00–29.13 (M = 27.73); snout to pelvic fin origin 37.89–42.62 (M = 39.65); D_1 base length 7.32–11.97 (M = 9.18); D_2 base length 9.85–11.79 (M = 10.84); base A fin 10.23–12.89 (M = 11.48); pectoral fin length 17.32–21.85 (M = 18.46); pelvic fin length 14.88–17.77 (M = 16.36); longest D spine (1st) 9.85–11.79 (M = 10.84); longest A spine (3rd) 10.23–12.89 (M = 11.48); least depth of caudal peduncle 10.16–12.67 (M = 11.13).

In percent of head length: snout length 28.16–32.35 (M = 30.09); orbit diameter 13.97–20.58 (M = 17.43); least width of interorbital space 44.11–50.53 (M = 46.95).

Body elongate and cylindrical. Head very flattened dorsally. Cleft of mouth reaching to vertical below

anterior nostril. Lips thin, lower jaw with a symphisial knob. Maxilla tip visible slightly when mouth closed. Preorbital not bent, its tip not dialated, serrated on anterior and ventral edges. Interorbital space flat. Adipose eyelid well developed and completely covering the eye except a narrow slit on pupil. Two nostrils on each side, the anterior one rounded which is in the same line with the upper margin of eye, the posterior nostril slit-like and slightly above with the anterior.
Gill rakers on first arch (41–47) + (52–57) = 93–106. Ciliform teeth in both lips. Pectoral fin not reaching to below origin of first dorsal fin. Axillary scale present at the base of first dorsal, pectoral and pelvic fins. Caudal fin forked.

__Scales:__ In lateral series 39–42; in transverse series 12–14. Scales present on head and body. Scale sheath at the base of second dorsal, anal, caudal and paired fins.

__Colour:__ Upper profile silvery with bluish tinge, lower profile bright silvery. 5–6 lateral brown stripes on dorsal profile. Snout tip black. Pectoral axil with oblique blue band. Second dorsal and caudal fins with dusky margins. Other fins grey.

Distribution: Carolina Islands, Babuyan Islands, Java, Borneo, New Guinea, Philippines, Japan, Hawaiian Islands, Guam, Marshall Islands, Honolulu, Hongkong, Red Sea, Australia, Sri Lanka and coasts of India.

Valamugil Smith, 1948

Valamugil Smith, 1948: 341.

Key to species

1. Adipose eyelid rudimentary, slightly around rim of eye; pectoral nearly reaching to below origin of first dorsal; lat. scales 39-42 .... Valamugil seheli (Forsskal).

Adipose eyelid well developed, covering the eye except pupil; pectoral reaching to slightly or well beyond vertical below origin of first dorsal; lat. scales less than 40 .... 2.

2. Upper lip thick; pectoral reaching to slightly beyond vertical below origin of first dorsal; lat. scales 31-34; distal margin of first dorsal not black .... Valamugil cunnesius (Valenciennes).

Upper lip thin; pectoral reaching to well beyond vertical below origin of first dorsal; lat. scales

37-39; distal margin of first dorsal very blackish ... . *Valamugil speigleri* (Bleeker).

Valamugil seheli (Forsskal, 1775)

Plate 40.2

Mugil seheli Forskal, 1775: 73; Cuvier and Valenciennes, 1836: 113; Day, 1878: 355; Weber and de Beaufort, 1922: 252; Pillay, 1962: 565.

Mugil caeruleomaculatus Bleeker, 1851: 484.

Valamugil seheli Smith, 1948: 840; Munro, 1955: 92; Fischer and Whitehead, 1974.

Description: Based on 20 specimens ranging in size 68.5-133.0 mm SL (83.5-161.0 mm TL).

Fin formula: D. IV; I, 8; A. III, 9; P. 16; V. I, 5; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 23.57-25.65 (M = 24.43); head length 26.01-29.45 (= 27.63); snout to D_1 fin origin 48.17-52.87 (M = 51.62); snout to D_2 fin origin 69.56-76.43 (M = 74.46); snout to A fin origin 70.51-75.34 (M = 73.23); snout to pectoral fin origin 25.64-29.31 (M = 27.92); snout to pelvic fin origin 39.13-42.76 (M = 40.67); D_1 base length 6.42-9.22 (M = 7.53); D_2

base length 8.33–10.82 (M = 9.68); base A fin 9.77–13.13 (M = 10.51); pectoral fin length 17.94–22.33 (M = 21.9[illegible]); pelvic fin length 15.13–17.29 (M = 15.91); longest D spine (1st) 11.53–15.03 (M = 13.05); longest A spine (3rd) 7.79–10.07 (M = 8.73); least depth of caudal peduncle 10.98–12.56 (M = 12.08).

In percent of head length: snout length 26.35–28.57 (M = 27.15); orbit diameter 19.71–25.58 (M = 22.37); least width of interorbital space 41.02–45.34 (M = 43.09).

Body elongated and cylindrical. Head slightly flattened dorsally. Cleft of mouth reaching to vertical below middle of the interorbital space. Lips not thick, lower jaw with the symphysial knob. Tip of maxilla not very distinct when mouth closed. Preorbital bent, serrated in its anterior and ventral edges. Interorbital space slightly convex. Adipose eyelid rudimentary, confined to the rim of eye. Two nostrils on each side, the posterior slit-like one in the same line with the upper margin of eye, the anterior rounded one slightly below the level with posterior. Gill rakers on first arch (32–37) + (44–49) = 76–86. Fine teeth on both lips. Pectoral fin nearly reaching to vertical below the origin of first dorsal fin. Axillary scales present at the axil of first dorsal, pectoral and pelvic fins. Caudal fin forked.

Scales: In lateral series 39–42; in transverse series 11–13. Scales present on head and body. Scale sheath at the base of second dorsal, anal, caudal and paired fins.

Colour: Upper profile silvery with bluish tinge, lower profile bright silvery. Pectoral fin slightly yellowish with blue axillary spot. Caudal fin bright blue in fresh condition. Second dorsal dusky. Other fins colourless.

Distribution: Red Sea, East coast of Africa, Indonesia, Philippines, China, Fiji, Samoan Islands, Sri Lanka and coasts of India including Laccadives.

Valamugil cunnesius (Valenciennes, 1836)
Plate 40.3

Mugil cunnesius Valenciennes, 1836: 114; Day, 1878: 349; Weber and de Beaufort, 1922: 242; Pillay, 1962: 563.

Valamugil cunnesius Fischer and Whitehead, 1974.

Description: Based on 20 specimens ranging in size 55.0–121.0 mm SL (70.0–154.0 mm FL).

Fin formula: D. IV, I, 8; A. III, 9; P. 14–15; V. I, 5; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 21.35–26.38 (M = 25.25); head length 24.39–27.77 (M = 26.35); snout to D_1 fin origin 48.78–55.45 (M = 51.40); snout to D_2 fin origin 70.12–77.27 (M = 74.16); snout to A fin origin 66.16–73.46 (M = 69.46); snout to pectoral fin origin 25.20–29.28 (M = 27.28); snout to pelvic fin origin 37.60–41.81 (M = 39.40); D_1 base length 6.09–8.18 (M = 7.51); D_2 base length 10.36–12.12 (M = 10.79); base A fin length 8.78–12.19 (M = 12.49); pectoral fin length 18.46–24.75 (M = 22.48); pelvic fin length 16.52–18.91 (M = 17.44); longest D spine (1st) 13.63–17.85 (M = 15.28); longest A spine (3rd) 9.09–13.33 (M = 10.34); least depth of caudal peduncle 11.11–13.63 (M = 12.10).

In percent of head length: snout length 23.25–27.77 (M = 25.76); orbit diameter 21.66–25.80 (M = 23.99); least width of interorbital space 39.53–44.44 (M = 41.24).

Body elongate and slightly compressed. Head lightly flattened dorsally. Cleft of mouth reaching to vertical below posterior nostril. Upper lip thick. Lower lip thin with the symphysial knob. Tip of maxilla not very distinct when mouth closed. Preorbital bent, serrated the anterior and ventral edges. Interorbital space slightly convex. Adipose eyelid well developed, posterior slightly broader than anterior. Two nostrils on each side, the posterior slit-like one in the same line with the upper margin of eye, the anterior rounded and slightly below the level of posterior. Gill rakers on first arch (27-29) + (35-40) = 62-69. Ciliary teeth present on upper lip not clear on lower lip. Pectoral fin reaching to slightly beyond vertical below origin of first dorsal fin. Axillary scale present at the axil of first dorsal, pectoral and pelvic fins. Caudal fin forked.

Scales: In lateral series 31-34, in transverse series 9-10. Scales present on head and body. Scale sheath visible at the base of 2nd dorsal, anal, caudal and paired fins.

Colour: Upper profile silvery with greenish tinge, lower profile bright silvery. Pectoral fin dusky with blue axillary spot. Second dorsal and caudal fins with black margin. Other fins colourless.

Distribution: Red Sea, Abyssinia, New Guinea, Penang, Singapore, Indonesia, Shanghai, Philippines, Australia and coasts of India.

Other materials examined: ZSI Nos. 1395 (81.0 mm SL) Madras, 1411 (125.0 mm SL) Bombay, F. Day Coll.

<u>Valamugil speigleri</u> (Bleeker, 1858)
<u>Plate 41.1</u>

<u>Mugil speigleri</u> Bleeker, 1858: 279; Gunther, 1859: 435; Day, 1878: 348; Weber and de Beaufort, 1922: 241.
<u>Valamugil speigleri</u> Fischer and Whitehead, 1974.

<u>Description</u>: Based on 12 specimens ranging in size 105.0–111.0 mm SL (133.0–142.0 mm TL).

<u>Fin formula</u>: D_1 IV; D_2 I, 8; A. III, 9; P. 14; V. I, 5; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 24.32–26.85 (M = 25.94); head length 25.92–28.37 (M = 27.12); snout to D_1 fin origin 48.66–50.47 (M = 49.67); snout to D_2 fin origin 71.42–76.56 (M = 73.65); snout to A fin origin 65.27–70.53 (M = 68.70); snout to pectoral fin origin 27.31–28.82 (M = 27.97); snout to pelvic fin origin 38.38–40.47 (M = 39.73); D_1 base length 6.30–8.84 (M = 7.43); D_2 base length 9.32–12.33 (M = 11.16); base A fin 12.03–13.38 (M = 12.80); pectoral fin length 19.19–24.07 (M = 22.42); pelvic fin length 14.28–16.21 (M = 14.87); longest D spine (1st) 12.50–14.31 (M = 13.39); longest A spine 7.14–8.55 (M = 7.43); least depth of caudal peduncle 10.81–11.57 (M = 11.37).

In percent of head length: snout length 24.13-3[illegible].00 (M = 26.62); orbit diameter 21.31-25.39 (M = 23.34); least width of interorbital space 36.06-41.66 (M = 39.26).

Body elongate and slightly compressed. Head flattened dorsally. Cleft of mouth reaching to vertical below posterior nostril. Upper lip thin, lower lip with the symphysial knob. Tip of maxilla not very distinct when mouth closed. Preorbital straight, serrated in its anterior and ventral edges. Interorbital space slightly convex. Adipose eyelid well developed, posterior broader than anterior. Two nostrils on each side, the posterior slit-like one on the same line with the upper margin of eye, the anterior rounded and slightly below the level of posterior. Gill rakers on first arch (29-31) + (36-39) = 65-70. Teeth very small on both jaws. Pectoral fin reaching to well beyond vertical below origin of first dorsal. Axillary scale present at the axil of first dorsal, pectoral and pelvic fins.

<u>Scales</u>: In lateral series 37-39; in transverse series 9-10. Scales present on head and body. Scale sheath at the base of 2nd dorsal, anal, caudal and paired fins.

Colour: Silvery-green above, shining silvery below. Opercle with golden yellow spot. Distal margin of first dorsal fin very blackish. Second dorsal and caudal fins with dusky margins. Blue spot at pectoral axil. Other fins colourless.

Distribution: Malay Archipelago and coasts of India.

Other materials examined: ZSI Nos. 2130 (104.0 mm SL) 2131 (110.0 mm SL) Bombay, F. Day Coll.

Liza Jordan and Swain, 1884

Liza Jordan and Swain, 1884: 261.

Key to species

1. Cleft of mouth reaching to the level vertical below middle of internostril space; lat. scales 33-35; head tapering and not flattened anteriorly; width of upper jaw greater than internostril space; adipose eyelid feebly developed .... Liza macrolepis (Smith).

Cleft of mouth reaching to the level vertical below anterior nostril; lat. scales less than 34; head flattened anteriorly; width of upper jaw less than internostril space; adipose eyelid well developed .....2.

2. Adipose eyelid restricted to iris; lat. scales 32–33; pectoral fin 17.85–23.21% in SL .... *Liza parsia* (Hamilton).

Adipose eyelid covers the eye except pupil; lat. scales 29–31; pectoral fin 16.53–18.82% in SL ... . *Liza subviridis* (Valenciennes).

Liza macrolepis (Smith, 1849)
Plate 41.2

Mugil macrolepis Smith, 1849; Pillay, 1962: 551.
Mugil borneensis Bleeker, 1851: 201; Day, 1878: 357.
Mugil troschelii Gunther, 1861: 448.
Mugil poicillus Day, 1865: 33.
Mugil cunnamboo Day, 1865: 141.
Mugil trocheli Weber and de Beaufort, 1922: 248.
Liza macrolepis Herre, 1941: 347; Fischer and Whitehead, 1974.

Description: Based on 20 specimens ranging in size 51.0–173.0 mm SL (66.0–21[illegible] mm TL).

Fin formula: D. IV; I, 8; A. III, 9; P. 14; V. I, 5; C. 2

Body measurements expressed in percent of standard length: greatest body depth 22.66–25.40 (M = 24.51); head length 25.[illegible]–31.37 (M = 27.33); snout to D_1 fin origin

50.71–54.90 (M = 52.10); snout to D_2 fin origin 72.54–76.87 (M = 74.80); snout to A fin origin 70.51–72.83 (M = 71.77); snout to pectoral fin origin 25.32–31.36 (M = 27.56); snout to pelvic fin origin 37.76–43.14 (M = 39.25); D_1 base length 6.93–8.99 (M = 7.50); D_2 base length 7.91–10.89 (M = 9.69); base A fin 9.29–14.10 (M = 11.42); pectoral fin length 17.98–22.54 (M = 19.81); pelvic fin length 14.7[illegible]–17.98 (M = 16.42); longest D spine (1st) 12.17–14.73 (M = 13.9[illegible]); longest A spine 7.05–10.43 (M = 9.29); least depth of caudal peduncle 9.80–12.71 (M = 11.56).

In percent of head length: snout length 25.00–30.23 (M = 27.31); orbit diameter 20.83–25.00 (M = 22.54); least width of interorbital space 37.50–43.05 (M = 41.07).

Body elongate and cylindrical. Head tapering anteriorly. Cleft of mouth reaching to vertical below middle of interorbital space. Upper lip thick, lower lip thin with the symphysial knob. Maxilla tip distinct when mouth closed. Preorbital curved, serrated in its anterior and ventral edges, tip dialated and notched. Interorbital space slightly convex. Adipose eyelid feebly developed. Two nostrils on each side, the posterior slit like and in the same line with the upper margin of eye, anterior nostril oval and located slightly below the level of posterior. Gill rakers on first arch (39–44) + (48–57) = 87–101. Upper jaw with minute teeth, teeth on lower jaw not clear. Pectoral fin not reaching to vertical below origin of first dorsal. Axillary scale present at the axil of first dorsal and pelvic fins. Caudal fin slightly forked.

Scales: In lateral series 33–35; in transverse series 10–11. Scales present on head and body. Base of second dorsal, anal, caudal, pectoral and pelvic fins with scale sheath.

Colour: Olive-green above, silvery below. Second dorsal and caudal fins dusky black. Other fins grey.

Distribution: Africa, Madagascar, China, Japan, Marshall and Tuamotu, Sri Lanka, East Indies, Philippines and coasts of India.

Other materials examined: ZSI Nos. 2135 (133.0 mm) Cochin, 2136 (158.0 mm SL) and 1423 (191.0 mm SL) Bombay, 1418 (142.0 mm SL) Malabar, F. Day Coll.

Liza parsia (Hamilton, 1822)

Plate 41.3

Mugil parsia Hamilton, 1822: 215; Pillai, 1962: 553.

Mugil oligolepis Bleeker, 1853: 277.

Mugil nepalensis Gunther, 1861: 424.

Mugil olivaceus Day, 1878: 352.

Liza parsia Fischer and Whitehead, 1974.

Description: Based on 25 specimens ranging in size 56.0–153.0 mm SL (70.0–190.0 mm TL).

Fin formula: D. IV, I, 8; A. III, 9; P. 15; V. I, 5; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 23.21–29.11 (M = 25.99); head length 24.18–27.35 (M = 25.66); snout to D_1 fin origin 50.32–54.33 (M = 52.47); snout to D_2 fin origin 73.41–79.52 (M = 76.03); snout to A fin origin 69.64–74.16 (M = 71.83); snout to pectoral fin origin 25.19–32.14 (M = 26.78); snout to pelvic fin origin 38.63–43.25 (M = 39.66); D_1 base length 8.03–12.74 (M = 9.29); D_2 base length 7.84–10.71 (M = 9.61); base A fin 8.16–14.28 (M = 10.33); pectoral fin length 17.85–23.21 (M = 19.26); pelvic fin length 15.44–17.50 (M = 16.94); longest D spine (1st) 13.07–16.98 (M = 15.01); longest A spine (3rd) 7.13–10.12 (M = 9.17); least depth of caudal peduncle 10.71–12.53 (M = 12.11).

In percent of head length: snout length 25.71-31.03 (M = 30.08); orbit diameter 20.68-25.39 (M = 21.92); least width of interorbital space 42.85-45.94 (M = 44.12).

Body elongate and cylindrical. Head flattened dorsally. Cleft of mouth reaching to vertical below anterior nostril. Upper lip somewhat thick. Lower lip thin with the symphysial knob. Maxilla tip distinct when mouth closed. Preorbital serrated anteriorly and ventrally, bent down posteriorly, it tip somewhat dialated. Interorbital space flat. Adipose eyelid well developed posteriorly than anteriorly. The two nostrils on the same line with the upper margin of eye, the anterior rounded and the posterior slit-like. Gill rakers on first arch (39-42) + (47-54) = 86-96. Ciliary teeth in upper jaw. Pectoral fin not reaching to vertical below origin of first dorsal. Axillary scale present at the axil of first dorsal and pelvic fins. Caudal fin slightly forked.

<u>Scales</u>: In lateral series 32-33; in transverse series 10-11. Scales present on head and body. Scale sheath at second dorsal, anal, caudal and paired fins base.

Colour: Dorsal profile brownish-green. Ventral profile silvery white. 4-5 lateral brownish bands on dorsal profile. Golden yellow spot on opercle. Second dorsal and caudal fins with dusky margins. Other fins grey.

Distribution: Indonesia, Philippines, Thailand, Hongkong, New Guinea, Guam, Australia, Sri Lanka, Karachi and coasts of India.

Remarks: Sarojini (1953) conducted a biometric study on *L. parsia* and *L. dussumieri* Valenciennes and concluded that *L. dussumieri* is a synonym of *L. parsia*. Reddy (1977) considered *L. dussumieri* as a separate and distinct species morphologically, anatomically, osteologically, serologically and chemotaxonomically.

Liza subviridis (Valenciennes, 1836)

Plate 41.4

Mugil subviridis Valenciennes, 1836: 115; Gunther, 1861: 423; Day, 1878: 353; Weber and de Beaufort, 1922: 243.

Mugil sundanensis Bleeker, 1853: 265.

Liza subviridis Fischer and Whitehead, 1974.

Description: Based on 14 specimens ranging in size 77.0-130.0 mm SL (96.0-163.0 mm TL).

__Fin formula:__ D. IV; I, 9; A. III, 9; P. 14; V. I, 5; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 23.93–25.88 (M = 24.93); head length 25.00–26.49 (M = 25.51); snout to D_1 fin origin 49.50–54.54 (M = 51.89); snout to D_2 fin origin 73.50–77.92 (M = 75.76); snout to A fin origin 68.84–72.07 (M = 70.31); snout to pectoral fin origin 25.50–26.96 (M = 25.55); snout to pelvic fin origin 36.53–40.00 (M = 38.83); D_1 base length 8.25–11.68 (M = 9.41); D_2 base length 8.46–9.43 (M = 8.91); base A fin 8.44–11.00 (M = 10.13); pectoral fin length 18.07–20.12 (M = 18.70); pelvic fin length 16.53–18.52 (M = 17.65); longest D spine (1st) 14.62–17.53 (M = 16.80); longest A spine 8.96–11.68 (M = 9.90); least depth of caudal peduncle 10.78–13.59 (M = 12.22).

In percent of head length: snout length 26.00–29.03 (M = 28.27); orbit diameter 23.07–25.92 (M = 24.26); least width of interorbital space 41.93–46.29 (M = 43.71).

Body elongate and cylindrical. Head flattened dorsally. Cleft of mouth reaching to vertical below anterior nostril. Lips thin, lower lip with symphysial knob. Maxilla tip distinct when mouth closed. Preorbital serrated in its anterior and ventral edges, tip dialated and bent downwards. Interorbital space very flat. Adipose eyelid well developed, posteriorly broader than anteriorly. Posterior nostril slit-like, at the level of the upper margin of eye, anterior nostril rounded and slightly below the level of the posterior nostril. Gill rakers on first arch (34-38) + (44-53) = 78-91. Ciliary teeth in upper jaw, not distinct in lower jaw. Pectoral fin not reaching to vertical below origin of first dorsal fin. Axillary scale present at the axil of first dorsal and pelvic fins.

Scales: In lateral series 29-31, in transverse series 9-11. Scales present on head and body. Scales sheath at the base of 2nd dorsal, anal, caudal and paired fins.

Colour: Greyish-brown above, silvery white below. 4-6 brownish lateral bands on upper profile. Opercle with golden-yellow spot. Margins of second dorsal and caudal fins black. Other fins colourless.

Distribution: Philippines, Australia and coasts of India including Andamans.

Other material examined: ZSI No. 1421 (163.0 mm SL) Andamans, F. Day Coll.

SUB ORDER : SPHYRAENOIDEI

2.4.41. FAMILY : SPHYRAENIDAE

Characters of taxonomic value: Body elongate, sybcylindrical. Head very long, snout prolonged. Mouth horizontal, lower jaw well projecting. Gill membrane not united with isthmus. Gill rakers very short or absent. Fang like teeth in jaws and palate. Lateral line straight and extends upto caudal fin base. Scales small and cycloid. Two dorsal fins, the first with 5 spines, second located opposite to anal fin. Caudal fin forked.

Day (1878) has dealt with 4 species from Indian waters and Weber and de Beaufort (1922) have recorded 8 species from the Indo-Australian Archipelago. A comprehensive review of Barracudas of the world is still lacking. But extensive studies on the taxonomy of this group of fishes of Indian Ocean were conducted notably by Smith (1956) and Williams (1959). Talwar (1963) explained the taxonomic position of S. acutipinnis Day. Fischer and Whitehead (1974) listed 6 species from Eastern Indian Ocean and Western Central Pacific. Moreover, Sylva (1973) in his preliminary review on Barracudas of the Indian Ocean and adjacent seas, accounted 11 species.

Family Sphyraenidae is represented by a single genus.

Sphyraena Rose, 1788

Sphyraena Rose, 1788: 32; Bloch and Schneider, 1801: 109.
Agrioposphyraena Fowler, 1903: 502.
Sphyraenella Smith, 1956: 39.

Key to species

Preopercle smooth and rounded; maxilla does not reach upto the level of eye; gill rakers absent; lat. line scales 120–137; origin of dorsal behind origin of pelvic; oblique bars on the body nearly in a serpentine pattern; dorsal fin dusky .... *Sphyraena jello* Cuvier.

Sphyraena jello Cuvier, 1829
Plate 42.1

Sphyraena jello Cuvier, 1829: 349; Bleeker, 1849: 56; Günther, 1860: 337; Day, 1878: 342; Weber and de Beaufort, 1922: 220; Munro, 1955: 91; Sylva, 1973: 86; Fischer and Whitehead, 1974.

Description: Based on 20 specimens ranging in size 107.0–318.0 mm SL (120.0–376.0 mm TL).

Fin formula: D. V; II, 8–9; A. II, 8; P. 11–12; V. 6; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 11.47–13.55 (M = 12.06); head length 3[illegible].83–35.51 (M = 33.11); snout to D_1 fin origin 41.66–46.72 (M = 43.21); snout to D_2 fin origin 66.98–71.96 (M = 7[illegible].11); snout to A fin origin 7[illegible].12–74.76 (M = 73.04); snout to pectoral fin origin 3[illegible].[illegible]3–34.25 (M = 32.71); snout to pelvic fin origin 39.79–43.64 (M = 41.76); base D_1 fin 6.44–8.00 (M = 7.[illegible]7); base D_2 fin 8.80–9.94 (M = 8.83); base A fin 7.05–8.66 (M = 7.96); pectoral fin length 1[illegible].28–11.55 (M = 11.03); pelvic fin length 7.86–9.34 (M = 8.58); first dorsal spine length 8.46–9.81 (M = 9.25); D_2 fin height 12.59–15.29 (M = 13.48); A fin height 11.63–14.48 (M = 12.35); least depth of caudal peduncle 5.55–7.94 (M = 6.62).

In percent of head length: snout length 46.15–50.80 (M = 47.49); orbit diameter 1[illegible].69–15.96 (M = 14.72); least width of interorbital space 15.78–2[illegible].16 (M = 16.78).

Body elongate, slightly compressed. Snout prolonged and pointed, interorbital space with grooves. Mouth horizontal, lower jaw remarkably projecting, cleft of mouth reaches in front of eye. Posterior end of maxilla broad and rounded with a notch. Opercle with two flat spines. Preopercle smoothly rounded. Gill rakers absent.

Upper jaw with a single series of compressed teeth with two canines in its front. Lower jaw is having triangular teeth in a single series, the posterior ones slightly longer, a strong canine in its front. Canine teeth on palate. Lateral line extends upto half of caudal fin. Caudal fin forked.

Scales: Lateral line scales 120-137; in transverse series 32-36. Scales present all over the body, preopercle, opercle, dorsal, anal and caudal fins base.

Colour: Greyish brown above, silvery white below. Opercle and preopercle silvery. Oblique black bands on the body more or less united above, giving the serpentine pattern. Dorsal fin dusky. Caudal fin black. Pelvic and anal fins slightly yellowish. Pectoral fin colourless.

Distribution: It is distributed through out the Indo-Pacific area and is very common in Arabian Sea and Bay of Bengal.

Other materials examined: ZSI Nos. 2117 (330.0 mm SL) 2118 (162.0 mm SL) 2119 (290.0 mm SL) Madras, F. Day Coll.

Remarks: *S. jello* has a very good resemblance with *S. bleekeri* Williams, which is very common in the whole of the Indo-Pacific area. Prior to the description of *S. bleekeri* by Williams (1959), this was usually identified as *S. jello* and was under the impression that *S. jello* was quite common in the Indo-Pacific region. Yet there is no consistency in the identification of S. jello and S. bleekeri. So these records must be discarded except where identifications of the specimens have been confirmed in the light of William's new species (Sylva, 1973).

SUB ORDER : POLYNEMOIDEI

2.4.42. FAMILY : POLYNEMIDAE

Characters of taxonomic value: Body elongate, snout overhangs the subterminal mouth. Adipose eyelid present. Villiform teeth in jaws and palate. Lateral line reaching to caudal fin. Gill rakers free from isthmus. 2 dorsal fins, widely separated; the first with 7-8 weak spines. Anal with 2-3 spines. Pectoral fin low, in two parts, lower rays filamentous. Ventral fin thoracic. Caudal fin deeply forked.

Of the two genera known under this family, fishes of the genus Eleutheronema were alone represented in the Vembanad lake. A single species under this genus was reported from India (Day, 1878) and Sri Lanka (Munro, 1955) but Weber and de Beaufort (1922) described two species from Indo-Australian Archipelago. From the Eastern Indian Ocean and Western Central Pacific, Fischer and Whitehead (1974) also listed two species.

Key to genus

Lower lip only developed at corner of mouth; teeth extending to outer edges of jaws; 3 or 4 free pectoral filaments .... Eleutheronema Bleeker.

Eleutheronema Bleeker, 1862

Eleutheronema Bleeker, 1862: 123.

Key to species

Four free pectoral filaments .... Eleutheronema tetradactylum (Shaw).

Eleutheronema tetradactylum (Shaw, 1804)
Plate 42.2

Polynemus tetradactylus Shaw, 1804: 155; Cuvier and Valenciennes, 1829: 375; Bleeker, 1849: 57; Gunther, 1860: 329; Day, 1878: 180.

Eleutheronema tetradactylum Weber and de Beaufort, 1922: 199; Fischer and Whitehead, 1974.

Description: Based on 15 specimens ranging in size 54.0–145.0 mm SL (75.0–196.0 mm TL).

Fin formula: D. VIII, I, 14; A. III, 16; P. 17+4; V. I, 5; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 20.54–26.20 (M = 22.96); head length 28.21–32.43 (M = 29.70); snout to D_1 fin origin 34.40–37.03 (M = 35.45); snout to D_2 fin origin 57.42–61.11 (M = 59.39); snout to A fin origin 57.42–60.27 (M = 58.69); snout to pectoral fin origin 24.75–29.62 (M = 26.74); snout to pelvic fin origin 34.65–39.13 (M = 37.45); base D_1 fin 6.84–9.65 (M = 7.75); base D_2 fin 12.32–15.86 (M = 14.18); base A fin 17.09–19.44 (M = 17.92); pectoral fin length 17.20–22.75 (M = 20.12); pelvic fin length 11.82–16.66 (M = 13.36); longest D spine (2nd) 16.12–18.80 (M = 17.70); longest A spine (2nd) 8.24–10.51 (M = 8.77); least depth of caudal peduncle 10.86–13.10 (M = 11.46).

In percent of head length: snout length 16.66–22.85 (M = 18.16); orbit diameter 17.02–22.85 (M = 18.90); least width of interorbital space 17.85–22.85 (M = 20.82).

Body elongated. Snout rounded and projecting. Mouth inferior, cleft of mouth oblique. Hind end of maxilla broad and rounded, reaching far behind the posterior margin of eye. Interorbital space convex. Vertical margin of preopercle serrated. Lips absent, lower lip slightly developed near corner of mouth. Two nostrils on each side. Gill rakers on first arch (6–7) + (5–6) = 11–13.

Jaws having villiform teeth in band, as a patch in vomer, palate and pterygoid. Lateral line arched anteriorly, becomes straight below spinous dorsal. Lower pectoral with 4 filaments. Pelvic fin with axillary scale. Caudal fin deeply forked.

Scales: Lateral line scales 67-74; in transverse series 18-22. Ctenoid scales present on body and head including tip of snout, maxillaries, fins base, second dorsal, anal and caudal fins.

Colour: Dorsal profile silvery green with golden tinge, ventral profile silvery white. Opercle silvery. Distal margin of dorsal fins and upper lobe of caudal fin blackish. Lower lobe of caudal fin golden yellowish. Pectoral fin dusky black. Other fins colourless.

Distribution: North Australia, Philippines, Formosa, China, Malacca, Siam, Pinang, Sri Lanka and West coast of India.

Other materials examined: ZSI Jos. Dup. Cat. 10 (227.0 mm SL) Mergui, 8719 (111.0 mm SL) 8755 (97.0 mm SL) Burma, F. Day Coll.

Mouth terminal. Teeth in upper jaw one to several rows, in lower jaw in two to several rows. Gill membrane variably attached to the isthmus. Head usually with mucous canals. Scales ctenoid, cycloid or absent. Lateral line absent. Two dorsal fins, separate or united at their bases, first generally with 5-6 feeble spines. Pelvic fins united totally or fully separate. Caudal fin oblong, lanceolate or rounded.

The first comprehensive account of Gobiid fishes of India was that of Day (1878), who reported 90 species under 11 genera from Indian waters and many of these genera were raised to families by subsequent workers. Koumans (1941) conducted extensive studies on Indian Gobiids and reported 123 species under 57 genera which include many new genera and species. Ever since Koumans monumental work (1941), a number of new species has been described from India (Jacob and Rangarajan, 1960; Visweswara Rao, 1968,1971a-d; Rangarajan, 1970; Menon and Chatterjee, 1974, 1976; Menon and Govindan, 1976; Chatterjee, 1978; Menon and Rama Devi, 1980). Several new distributional records of Gobiid fishes of interest from Indian waters were reported by Jones and Kumaran (1965,1968,1970,1971), Mutsaddi and Bal (1973), Natarajan and Subrahmanyam (1975), Chatterjee and Siddiqi (1976), Venkateswarlu and Rama Rao (1976), Kurup and Samuel (1981a,   ) etc. Recently, Chatterjee (1978) reported 50 species from the Gangetic delta (West Bengal).

Key to genera

1. Pelvic fins not united .... 2.

Pelvic fins totally united .... 4.

2. A single spine at preopercular margin; head subcylindrical to depressed; serrated ridges on head absent .... Eleotris Bloch and Schneider.

No spine at preopercular margin ...... 3.

3. Serrated ridges on dorsal head; head flat, pointed; lower jaw very prominent; scales moderate, about 30 in lat. series, 10 in tr. series and 20-25 predorsall .... Butis Bleeker.

Serrated ridges on dorsal head absent; head slightly depressed; lower jaw prominent; scales small, about 60 in lat. series, 16-20 in tr. series and 35-40 predorsally .... Bunaka Herre.

4. Caudal fin long, pointed or lanceolate, longer than head .... 5.

Caudal fin short, obtuse, rounded or oblong, shorter than head .... 6.

5. First dorsal spine not strong or bony; teeth in lower jaw multiserial; eye not erectile above surface of head .... a and b.

a) Inner margin of shoulder girdle with fleshy cirri .... Stenogobius Bleeker.

b) Inner margin of shoulder girdle without fleshy cirri; teeth in upper jaw multiserial .... Oxyurichthys Bleeker.

6. Tongue bilobate; fleshy cirri on inner margin of shoulder girdle; gill membrane not fused together .... Awaous Cuvier and Valenciennes.

Tongue rounded, emarginate or bilobate; no fleshy cirri on inner margin of shoulder girdle .... 7.

7. Gill opening continued forward below; isthmus narrow .... 8.

Gill opening not continued forward below; isthmus broad .... 11.

8. Gill membrane fused to a free fold across isthmus .... 9.

Gill membrane not fused together to a free fold .... 10.

9. Head depressed and flat; mid-predorsum scaly; canine teeth present in both jaws .... Glossogobius Gill.

10. Caudal fin symmetrical; barbels on chin, snout and lateral head .... Gobiopsis Steindachner.

11. Head subcylindrical; scales on cheek, opercle, interopercle and postorbital region; scales in lat. series more than 50 .... Acentrogobius Bleeker.

Eleotris Bloch and Schneider, 1801

Eleotris Bloch and Schneider, 1801: 65.
Culius Bleeker, 1856: 411.

Key to species

Opercle and preopercle completely scaled; scales in lat. series 53-62, in tr. series 17-19 .... Eleotris fusca (Bloch and Schneider).

Eleotris fusca (Bloch and Schneider, 1801)
Plate 43.1

Poecilia fusca Bloch and Schneider, 1801: 453.

Eleotris brachyurus Bleeker, 1849: 20.

Eleotris fusca Gunther, 1861: 125; Day, 1878: 313; Fowler, 1928: 392; Koumans, 1953: 204; Munro, 1955: 229; Chatterjee, 1978: 58.

Description: Based on 5 specimens ranging in size 36.0–69.0 mm SL (43.0–86.0 mm TL).

Fin formula: D. VI; I, 8; A. I, 8; P. 15; V. I, 5; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 21.42–24.63 (M = 22.63); head length 3[illegible].59–34.72 (M = 3[illegible].86); snout to D_1 fin origin 4[illegible].00–43.47 (M = 41.[illegible]0); snout to D_2 fin origin 56.94–61.59 (M = 59.27); snout to A fin origin 61.11–65.71 (M = 65.1[illegible]); snout to pectoral fin origin 31.42–35.14 (M = 33.52), snout to pelvic fin origin 34.3[illegible]–42.59 (M = 37.13); D_1 base length 9.28–13.88 (M = 11.26); D_2 base length 11.94–15.94 (M = 14.31); A base length 11.94–13.38 (M = 12.93); pectoral fin length 22.22–25.71 (M = 24.43); pelvic fin length 19.[illegible]–22.2[illegible] (M = 2[illegible].70); least depth of caudal peduncle 12.5[illegible]–14.17 (M = 13.61).

In percent of head length: snout length 26.72–29.72 (M = 27.57); orbit diameter 12.[illegible]–15.[illegible] (M = 13.32); least width of interorbital space 26.08–29.54 (M = 27.98).

Body elongated, posteriorly compressed. Head depressed. Gape of mouth oblique, lower jaw prominent. Hind end of maxilla reaching to vertical below anterior margin of eye. A single downwardly curved spine at the angle of interopercle. Two nostrils on each side, the anterior nostril tubular. Interorbital space convex with longitudinal mucous canals, a number of mucous canals radiating from the supraorbital margin. Anterior margin of tongue rounded. Gill rakers on first arch 3+(6-7) = 9-10. Jaws with multiserial villiform teeth, outer row slightly enlarged. Two dorsal fins, not widely separated, height less than body depth. Pectoral fin rounded. Pelvic fins separated. Caudal fin obtusely rounded.

Scales: In lateral series 58-62; in transverse series 17-19. Scales present on body and head excluding snout. Cycloid scales on nape, breast and belly; other scales ctenoid.

Colour: Brownish. Unpaired and caudal fins with 2-3 rows of black spots. Pectoral and pelvic fins greyish-brown.

Distribution: Red Sea, East coast of Africa, Mauritius, Seychelles, Formosa, Philippines, Melanesia, Polynesia, Sri Lanka and coasts of India including Nicobar.

Other materials examined: ZSI ASB Cat. 144 (64.5 mm SL) Calcutta, F. Day Coll.

Butis Bleeker, 1874

Butis Bleeker, 1874: 304.

Key to species

Body depth 19.56–23.59% in SL; hind tip of maxilla reaching to vertical below anterior margin of eye; outer and innermost rows of jaw teeth enlarged .... Butis butis (Hamilton-Buchanan).

Butis butis (Hamilton-Buchanan, 1822)

Plate 43.2

Cheilodipterus butis Hamilton-Buchanan, 1822: 367.
Eleotris melanopterus Bleeker, 1852: 706.
Butis butis Bleeker, 1856: 412; Fowler, 1934: 157; Koumans, 1953: 306; Munro, 1955: 23.; Chatterjee, 1978: 72.
Eleotris amboinensis (nec Bleeker) Day, 1878: 316.

Description: Based on 12 specimens ranging in size 73.0–110.0 mm SL (95.0–134.0 mm TL).

Fin formula: D. VI; I, 8; A. I, 8; P. 18–20; V. I, 5; C. 20.

Body measurements expressed in percentage of standard length: greatest body depth 19.56–23.29 (M = 21.24); head length 34.56–37.17 (M = 35.67); snout to D_1 fin origin 43.00–44.56 (M = 44.13); snout to D_2 fin origin 58.71–61.53 (M = 60.54); snout to A fin origin 58.97–62.50 (M = 60.70); snout to pectoral fin origin 36.36–38.63 (M = 37.32); snout to pelvic fin origin 30.68–34.23 (M = 32.19); D_1 base length 9.17–11.93 (M = 10.77); D_2 base length 13.63–14.77 (M = 14.62); A base length 12.27–14.13 (M = 13.34); pectoral fin length 20.64–25.00 (M = 22.53); pelvic fin length 15.59–18.56 (M = 17.56); least depth of interorbital space 10.89–12.72 (M = 11.70).

In percent of head length: snout length 36.70–40.62 (M = 38.22); orbit diameter 13.11–17.85 (M = 15.00); least width of interorbital space 24.13–28.00 (M = 26.67).

Body elongated, posteriorly compressed. Head well depressed. Snout pointed. Gape of mouth oblique, lower jaw prominent. Hind end of maxilla reaching to vertical below anterior margin of eye. Two nostrils on each side, anterior one tubular. Interorbital space broad, bony crest above eye and not denticulated, rest of the space concave. Tongue spatulate. Gill rakers on first arch (3–4) + (5–8) = 8–12. Jaws with multiserial teeth, outer and inner rows enlarged and curved inwards. Two dorsal fins, not widely separated, height less than body depth. Pectoral fin obtuse. Pelvic fin not united, outer margin fringed. Caudal fin obtusely rounded.

Scales: In lateral series 27–29; in transverse series 9–10. Scales present on head and body. Cycloid scales on breast and belly, other scales ctenoid. Scales on head and body with axillaries.

Colour: Brownish-black. All fins except pectoral black. Scales with pearly white spot, thus appearing as longitudinal white lines. A prominent black spot at pectoral axil. The distal margins of paired and unpaired fins fringed with red.

Distribution: Widely distributed in the tropical Indo-West Pacific area.

Other materials examined: ZSI No. F 5277/2 (40.0 and 54.0 mm SL) Andamans, F. Day Coll.

Bunaka Herre, 1927

Bunaka Herre, 1927: 60.

Lizettea Herre, 1936: 275.

Key to species

Scales in lat. series 57, in tr. series 20; body without longitudinal broad bands .... *Bunaka gyrinoides* (Bleeker).

Bunaka gyrinoides (Bleeker, 1853)
Plate 43.3

Eleotris gyrinoides Bleeker, 1853: 272; Günther, 1861: 123.
Eleotris canarensis Day, 1878: 313.
Mauvina gyrinoides Fowler, 1928: 389.
Bunaka gyrinoides Koumans, 1953: 350; Munro, 1955: 231.

Description: Based on a single specimen, 55.0 mm SL (65.0 mm TL).

Fin formula: D. VI; I, 8; A. I, 8; P. 17; V. I, 5; C. 28.

Body measurements expressed in percent of standard length: greatest body depth 21.81; head length 32.72; snout to D_1 fin origin 43.63; snout to D_2 fin origin 58.18; snout to A fin origin 63.63; snout to pectoral fin origin 33.63; snout to pelvic fin origin 36.36; D_1 base length 1[illegible]; D_2 base length 14.54; A base length 11.81; pectoral fin length 22.72; pelvic fin length 2[illegible]; least depth of caudal peduncle 14.54.

In percent of head length: snout length 25.[illegible]; orbit diameter 13.88; least width of interorbital space

27.77.

Body elongated and posteriorly compressed. Head depressed. A deep groove from nape to origin of first dorsal fin. Concavity on occiput. Snout well depressed. Gape of mouth oblique, lower jaw prominent. Hind end of maxilla reaching to vertical below middle of eye. Two nostrils on each side, tubular. Anterior margin of tongue rounded. Interorbital space convex. Head with distinct rows of mucous canals. Gill rakers on first arch 3+7 = 10. Jaws with small multiserial teeth. Two dorsal fins, height less than body depth, second dorsal fin pointed posteriorly. Pectoral fin obtuse. Pelvic fins slender, not united. Caudal fin rounded.

Scales: In lateral series 57, in transverse series 20. Present on body and head excluding snout. Scales of head, breast and nape cycloid, other ctenoid.

Colour: Greyish-brown above, dull white below. Scales of dorsal profile mottled with small brown spots. Dorsal, anal and caudal fins dusky black. Pectoral base with a black spot.

Distribution: Indo-Australian Archipelago, Sri Lanka and India.

Stenogobius Bleeker, 1874

Stenogobius Bleeker, 1874: 317.

Key to species

Scales in lat. series 5[illegible]–[illegible]3; in tr. series 13–14; scales absent on head excluding postorbital region; a black crescentic mark on first dorsal fin .... *Stenogobius malabaricus* (Day).

Stenogobius malabaricus (Day, 1865)
Plate 43.4

Gobius malabaricus Day, 1865: 27; 1878: 293.
Stenogobius malabaricus Munro, 1955: 236.

Description: Based on 25 specimens ranging in size 31.[illegible]–91.[illegible] mm SL (38.[illegible]–12[illegible].[illegible] mm TL).

Fin formula: D. VI; I, 1[illegible]; A. I, 1[illegible]; P. 14–15; V. I, 5; C. 24.

Body measurements expressed in percent of standard length: greatest body depth 19.35–23.97 ($\bar{x}$ = 21.99); head length 23.07–27.41 ($\bar{x}$ = 24.97); snout to D_1 fin origin 32.95–37.66 ($\bar{x}$ = 34.[illegible]); snout to D_2 fin origin 51.17–57.14 ($\bar{x}$ = 53.37); snout to A fin origin 54.43–57.3[illegible] ($\bar{x}$ = 56.[illegible]3); snout to pectoral fin origin 23.33–

23.08 (M = 25.2); snout to pelvic fin origin 25.00–29.03 (M = 26.62); base D_1 fin 13.18–16.98 (M = 15.01); base D_2 fin 27.69–31.16 (M = 29.37); base A fin 26.43–29.37 (M = 27.80); least depth of caudal peduncle 9.67–13.33 (M = 11.84).

In percent of head length: snout length 25.00–31.25 (M = 28.69); orbit diameter 20.05–25.00 (M = 22.56); least width of interorbital space 15.62–20.00 (M = 18.32).

Body elongated and compressed. Snout blunt. Gape of mouth oblique, upper jaw prominent. Hind end of maxilla reaching to vertical below middle of eye. Two nostrils, the posterior one prominent. Interorbital space flat. Anterior tip of tongue bifid. Inner edge of shoulder girdle with fleshy flaps. Head with distinct mucous canals. Gill rakers rudimentary. Jaws with multiserial teeth, outermost row slightly enlarged. Two dorsals, anterior 4 spines of first dorsal filiform, greater than body depth. Height of second dorsal nearly half of body depth. Pectoral fin pointed. Pelvic fin united. Caudal fin lanceolate.

<u>Scales</u>: In lateral series 50–53; in transverse series 13–14. Scales present on body, absent on head excluding postorbital region. Scales of postorbital region, belly and breast cycloid, rest ctenoid.

<u>Colour</u>: Greenish-brown. 6-8 indistinct brown irregular blotches in lateral series. A black band descends from eye. Head with irregular brown spots. A black crescentic mark on first dorsal fin. Filiform rays of dorsal fin blackish. Dorsal, anal and caudal fins black with 3-4 rows of brown spots.

<u>Distribution</u>: Sri Lanka and West coast of India.

<u>*Oxyurichthys* Bleeker, 1860</u>

<u>*Oxyurichthys*</u> Bleeker, 1860: 44.
<u>*Pselaphias*</u> Jordan and Seale, 1906: 406

<u>Key to species</u>

1. Scales in lat. series more than 45, in tr. series 10-13; 8-12 gill rakers on first arch .... 2.

Scales in lat. series less than 45, in tr. series 6-7; 4-5 gill rakers on first arch .... 3.

2. Lat. scales 52-54; a tentacle at the posterior upper margin of eye .... <u>*Oxyurichthys tentacularis*</u> (Cuvier and Valenciennes).

Lat. scales 46-52; no tentacle at the upper margin of eye .... <u>*Oxyurichthys microlepis*</u> (Bleeker).

3. Lat. scales 26–28; a vertical black band below eye .... *Oxyurichthys nijsseni* Menon and Govindan.

Oxyurichthys tentacularis (Cuvier and Valenciennes, 1837)

Plate 44.1

Gobius tentacularis Cuvier and Valenciennes, 1837: 128; Bleeker, 1854: 434; Gunther, 1861: 48; Day, 1878: 291.

Gobius macrurus Bleeker, 1849: 35.

Oxyurichthys tentacularis Jordan and Seale, 1907: 45; Koumans, 1953: 44; Munro, 1955: 237.

Description: Based on 25 specimens ranging in size 57.0–107.0 mm SL (78.0–145.0 mm TL).

Fin formula: D. VI; I, 12; A. I, 13; P. 18–20; V. I, 5; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 15.62–19.35 (M = 17.16); head length 22.43–26.86 (M = 24.42); snout to D fin origin 29.34–34.54 (M = 31.65); snout to A fin origin 50.56–54.20 (M = 52.49); snout to pectoral fin origin 22.72–26.86 (M = 24.45); snout to pelvic fin origin 23.91–28.57 (M = 26.28); D base length 53.93–58.77 (M = 57.20);

A base length 38.58–41.57 (M = 39.76); pectoral fin length 25.23–30.71 (M = 26.92); pelvic fin length 19.64–25.45 (M = 22.22); least depth of caudal peduncle 7.85–10.74 (M = 9.35).

In percent of head length: snout length 28.57–32.00 (M = 30.18); orbit diameter 17.24–23.68 (M = 20.99); least width of interorbital space 10.86–15.38 (M = 13.08).

Body elongated and posteriorly well compressed. Dermal crest on nape. Gape of mouth oblique, lower jaw prominent. Hind end of maxilla reaching to vertical below anterior margin of eye. Two nostrils on each side, the anterior one tubular. Interorbital space concave, an open pore anteriorly. Posterior upper angle of eye with a tentacle. Gill rakers present only on vertical arch, 8–12 on first arch. A single series of curved teeth on upper jaw, lower jaw with 3 series of teeth, the anterior most prominent. Anterior rays of first dorsal fin filliform. Pectoral fin obtuse. Posterior end of second dorsal and anal fins pointed. Pelvic fins united. Caudal fin lanceolate.

<u>Scales</u>: In longitudinal series 52–54, in transverse series 10–12. Cycloid scales present behind eye, nape and anterior part of body. Ctenoid scales on body.

Colour: Dull green above, white on abdomen. Fins brownish black, fringed with red distally. First dorsal fin with 4-5 rows of black spots. A black spot at caudal peduncle. Scales of dorsal profile with black margin.

Distribution: Formosa, Samoa, Kandavu, Tonga, Fiji Islands, Society Islands, Australia, Sri Lanka and India.

Oxyurichthys microlepis (Bleeker, 1849)
Plate 44.2

Gobius microlepis Bleeker, 1849: 35; Gunther, 1861: 49; Day, 1889: 26_.

Oxyurichthys microlepis Bleeker, 1857: 434; Koumans, 1953: 41; Munro, 1955: 236.

Gobius cristatus Day, 1878: 291.

Description: Based on 25 specimens ranging in size 51.0-89.0 mm SL (70.0-125.0 mm TL).

Fin formula: D. VI, I, 12; A. I, 12-13; P. 20-22; V. I, 5; C. 24.

Body measurements expressed in percent of standard length: greatest body depth 16.45-2_.62 (M = 17.97); head lengt 22.78-25.69 (M = 24.57); snout to D fin origin 27.94-3_.76 (M = 29.48); snout to A fin origin 51.16-56.96 (M = 52.77); snout to pectoral fin origin 22.15-

26.47 (M = 24.62); snout to pelvic fin origin 23.97–28.43 (M = 26.08); D base length 55.05–60.25 (M = 58.27); A base length 37.93–42.64 (M = 39.13); pectoral fin length 23.97–30.30 (M = 26.17); pelvic fin length 18.75–23.68 (M = 21.22); least depth of caudal peduncle 8.90–10.75 (M = 9.38).

In percent of head length: snout length 27.02–32.50 (M = 31.28); orbit diameter 17.64–22.22 (M = 20.34); least width of interorbital space 11.76–16.23 (M = 14.43).

Body elongated and compressed. Dermal crest on nape. Gape of mouth oblique, lower jaw prominent. Hind end of maxilla reaching to vertical below beyond the level of anterior margin of eye. Two nostrils on each side, the anterior one tubular. Interorbital space concave, an open pore anteriorly. Gill rakers present only on vertical arch, 8–11 on first arch. A single series of curved teeth in upper jaw, lower jaw with 2–3 rows of fine teeth. Anterior rays of first dorsal fin not filiform. Posterior end of soft dorsal and anal fins pointed. Pectoral fin rather rounded. Pelvic fins united. Caudal fin lanceolate.

Scales: In lateral series 46–52; in transverse series 11–13. Cycloid scales behind eye, nape and anterior part of body, ctenoid scales on other parts of body.

<u>Colour</u>: Dull green above, reddish-brown below. 6 black blotches in lateral series, the last one on caudal peduncle. Fins reddish-brown with rows of spots. Scales of dorsal profile with black margin, dermal cresh black.

<u>Distribution</u>: East coast of Africa, Philippines, China, Japan, Indonesia, Sri Lanka and coasts of India including Minicoy.

<u>*Oxyurichthys nijsseni*</u> Menon and Govindan, 1976
Plate 44.3

<u>*Oxyurichthys nijsseni*</u> Menon and Govindan, 1976: 13;
Kurup and Samuel, 1981: 873.

<u>Description</u>: Based on 25 specimens ranging in size 30.0–82.0 mm SL (42.0–123.0 mm TL).

<u>Fin formula</u>: D. VI; I, 11; A. I, 11–12; P. 20–22; V. I, 5; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 21.27–26.36 (M = 23.48); head length 23.38–28.04 (M = 26.76); snout to D fin origin 28.22–33.33 (M = 31.00); snout to A fin origin 52.41–58.18 (M = 55.69); snout to pectoral fin origin 24.44–30.00 (M = 26.80); snout to pelvic fin origin 26.61–30.18 (M = 28.70); D base length 51.06–57.31 (M = 54.09);

A base length 30.0-36.79 (M = 33.38); pectoral fin length 27.41-32.92 (M = 29.49); pelvic fin length 20.75-26.92 (M = 24.38); least depth of caudal peduncle 11.62-13.69 (M = 12.84).

In percent of head length: snout length 34.48-40.00 (M = 37.56); orbit diameter 18.75-23.52 (M = 21.40); least width of interorbital space 15.62-2[illegible].68 (= 17.74).

Body elongated and posteriorly compressed. Dermal crest on nape absent. Gape of mouth oblique, lower jaw prominent. Hind end of maxilla reaching to vertical below middle of eye. Two nostrils on each side, the anterior one tubular. Interorbital space flat with two anterior open pores. Gill rakers present only on vertical arch, 4-6 on first arch. One row of curved teeth on upper jaw, lower jaw with 3 rows of fine teeth. In male, the fourth and fifth spines of the first dorsal fin filamentous and reaching beyond middle of caudal fin. In female, the 2nd-4th spines of first dorsal fin elongated but not even reaching to middle of second dorsal fin. Pectoral fin pointed. Pelvic fin united. Caudal fin lanceolate.

<u>Scales</u>: In lateral series 26-28; in transverse series 6-7. Ctenoid scales on body excluding breast, absent on head and nape.

Colour: Head and upper profile of the body dark brown with a large number of irregular black spots. A bright bluish green blotch on opercle. Two brown bands across nape. A conspicuous black vertical band below the eye. 6-8 black blotches laterally. In male, the elongated dorsal spines has black blotches. Dorsal and anal fins dusky black and intensely spotted. In female, the fins are dull white and not spotted. Caudal fin pale red with 7 rows of brown spots. Middle 3 rays of pelvic fin dull red.

Distribution: Ennore estuary, Godavari and Mahanadi on the East coast of India and Vembanad lake on the West coast of India.

Remarks: O. nilsseni was originally described from Ennore estuary (Menon and Govindan, 1976). But O. nilsseni has been earlier observed from Mahanadi estuary, Orissa on the east coast of India (Talwar, 1969c) and was reported as O. jaarmani. Kurup and Samuel (1981a) recorded it from south west coast of India; observed sexual dimorphism in O. nilsseni and described (Kurup and Samuel, 1981b) the colour and pit organ.

Awaous Cuvier and Valenciennes, 1837

Awaous Cuvier and Valenciennes, 1837: 97.

Chonophorus Poey, 1858: 274.

Trichopharynx Ogilby, 1397: 769.

Key to species

Scales in lat. series 52–57, in tr. series 14–16; two black streak from eye to maxillary .... *Awaous stamineus* (Valenciennes).

Awaous stamineus (Valenciennes, 1842)

Plate 45.1

Gobius stamineus Valenciennes, 1842: 179.

Gobius grammepomus Bleeker, 1855: 20.; Gunther, 1861: 64.

Gobius striatus Day, 1878: 292.

Awaous stamineus Koumans, 1953: 153.

Description: Based on 7 specimens, ranging in size 44.0–103.0 mm SL (53.0–124.0 mm TL).

Fin formula: D. VI; I, 10; A. I, 9–10; P. 16; V. I, 5; C. 27.

Body measurements expressed in percent of standard length: greatest body depth 15.90–21.35 (M = 19.37); head length 27.97–29.54 (M = 28.73); snout to D_1 fin origin 36.40–37.50 (M = 37.06); snout to D_2 fin origin 52.27–57.28 (M = 55.05); snout to A fin origin

56.71–61.16 (M = 58.89); snout to pectoral fin origin 29.54–31.06 (M = 30.10); snout to pelvic fin origin 28.35–32.52 (M = 29.30); D_1 base length 11.36–12.62 (M = 12.10); D_2 base length 23.86–26.11 (M = 25.05); A base length 22.81–26.19 (M = 24.49); least depth of caudal peduncle 8.95–11.36 (M = 10.06).

In percent of head length: snout length 35.89–43.58 (M = 43.00); orbit diameter 16.94–19.14 (M = 19.19); least width of interorbital space 16.00–17.02 (M = 14.44).

Body elongated and posteriorly compressed. Head depressed. Gape of mouth nearly horizontal, upper jaw very prominent. Lips thick. Hind end of maxilla reaching to vertical below anterior margin of eye. Two nostrils on each side, anterior one tubular. Interorbital space nearly flat. Anterior margin of tongue bifid. Gill rakers on first arch (2–3) + (5–6) = 7–9. Jaw teeth multiserial, outer row slightly enlarged in both jaws. Mucous canals not distinct. Two dorsal fins, not widely separated, height less than body depth. Pectoral fin pointed. Pelvic fin united. Caudal fin obtusely truncate.

<u>Scales</u>: In lateral series 52–57, in transverse series 14–16. Scales present on body, absent on head excluding postorbital region. Scales of breast, belly and

postorbital region cycloid, rest ctenoid.

<u>Colour</u>: Greenish-brown above, dull white below. Head mottled with brown spots. Two black streaks from anterior margin of eye to maxillary. A lateral series of indistinct brown spots in midline of the body. Irregular brown spots on dorsal profile. 4-6 rows of brown spots in dorsal and caudal fins.

<u>Distribution</u>: Indo-Australian Archipelago, and West coast of India.

<u>Glossogobius</u> Gill, 1862

<u>Glossogobius</u> Gill, 1862: 46.
<u>Cephalogobius</u> Bleeker, 1874: 320.

<u>Key to species</u>

A black circular process from upper part of iris to pupil of eye; first dorsal fin with 2 black ocelli; fins with indistinct rows of brown spots .... <u>Glossogobius</u> <u>biocellatus</u> (Cuvier and Valenciennes).

No black circular process in the eye; first dorsal fin without 2 black ocelli; fins with very distinct rows of brown spots .... <u>Glossogobius</u> <u>giuris</u> (Hamilton-Buchanan, 1822).

<u>**Glossogobius biocellatus**</u> (Cuvier and Valenciennes, 1837)

<u>Plate 45.2</u>

<u>**Gobius biocellatus**</u> Cuvier and Valenciennes, 1837: 73; Day, 1878: 289.

<u>**Gobius sumatranus**</u> Bleeker, 1854: 83.

<u>**Glossogobius biocellatus**</u> McCulloch and Ogilby, 1919: 237; Fowler, 1928: 402; Koumans, 1953: 163; Munro, 1955: 238.

<u>**Description**</u>: Based on 15 specimens ranging in size 45.0–81.0 mm SL (53.0–99.0 mm TL).

<u>**Fin formula**</u>: D. VI; I, 9; A. I, 8; P. 18; V. I, 5; C. 20.

Body measurements expressed in percent of standard length: greatest body depth 16.03–22.22 (18.47); head length 3[illegible].24–3[illegible].81 (M = 31.51); snout to D_1 fin origin 34.21–38.88 (M 36.74); snout to D_2 fin origin 53.08–58.59 (M = 56.63); snout to A fin origin 55.55–61.32 (M = 58.72); snout to pectoral fin origin 30.62–3[illegible].81 (M = 31.68); snout to pelvic fin origin 27.86–33.08 (M = 30.40); D_1 base length 11.[illegible]2–14.08 (M = 12.62); D_2 base length 18.38–22.33 (M = 20.43); A base length 18.38–23.45 (M = 20.30); pectoral fin length 20.37–25.92 (M = 22.92); pelvic fin length 20.14–25.39 (M = 22.07); least depth of caudal peduncle 8.49–9.87 (M = 8.31).

In percent of head length: snout length 29.41–36.73 (M = 33.30); orbit diameter 15.38–18.36 (M = 17.06); least width of interorbital space 8.16–11.90 (M = 10.64).

Body elongated, posteriorly compressed. Head depressed. Snout pointed. Gape of mouth oblique, lower jaw prominent. Lips thick. Hind tip of maxilla reaching to vertical below anterior margin of eye. Interorbital space concave. Eye with a circular black process from upper part of iris into pupil. Anterior tip of tongue bifid. Gill rakers on first arch (1–2) + (6–7) = 7–9. Jaws with multiserial teeth, outermost row enlarged. Cheek with distinct mucous canals. Dorsal fins not widely separated, height less than body depth. Pectoral fin obtusely rounded. Pelvic fin united. Caudal fin oblong.

Scales: In lateral series 29–32, in transverse series 10–11. Scales present on body including breast, absent on head excluding post orbital region and upper part of opercle. Scales of head and belly weakly ctenoid, other scales ctenoid.

<u>Colour</u>: Brownish-black. 5 indistinct black blotches in lateral series. All fins except pectoral blackish. First dorsal fin with two black ocelli between 1st-2nd spines and 5th-6th spines. All fins except pelvic fin with rows of brown spots.

<u>Distribution</u>: Philippines, Hongkong, Fiji, Samoa, Australia, Sri Lanka and India.

<u>Glossogobius giuris</u> (Hamilton-Buchanan, 1822)
Plate 45.3

<u>Gobius giuris</u> Hamilton-Buchanan, 1822: 50; Cuvier and Valenciennes, 1837: 72; Gunther, 1861: 21.
<u>Glossogobius giuris</u> McCulloch and Ogilby, 1919: 236; Fowler, 1928: 402; Koumans, 1953: 165; Munro, 1955: 239; Chatterjee, 1978: 250.

<u>Description</u>: Based on 25 specimens ranging in size 34.0-198.0 mm SL (42.0-250.0 mm TL).

<u>Fin formula</u>: D.VI; I, 9; A. I, 7-8; P. 18-19; V. I, 5; C. 18.

Body measurements expressed in percent of standard length: greatest body depth 16.50-19.11 (M = 17.99); head length 30.76-33.49 (M = 32.05); snout to

D_1 fin origin 37.25–39.83 (M = 38.15); snout to D_2 fin origin 55.83–58.53 (M = 56.52); snout to A fin origin 55.88–60.16 (M = 59.43); snout to pectoral fin origin 31.69–33.18 (M = 32.37); snout to pelvic fin origin 30.88–35.98 (M = 33.15); D_1 base length 10.65–14.64 (M = 12.50); D_2 base length 16.39–20.58 (M = 19.37); A base length 12.87–17.03 (M = 15.37); pectoral fin length 20.83–25.64 (M = 23.54); pelvic fin length 19.16–21.76 (M = 20.29); least depth of caudal peduncle 8.82–10.13 (M = 9.31).

In percent of head length: snout length 31.03–37.17 (M = 34.41); orbit diameter 14.10–20.00 (M = 15.42); least width of interorbital space 12.06–17.50 (M = 14.00).

Body elongated, posteriorly compressed. Head depressed. Snout pointed. Gape of mouth oblique, lower jaw very prominent. Lips thick. Hind tip of maxilla reaching to vertical below middle of eye. Interorbital space concave. Eye without a circular black process. Anterior margin of tongue bifid. Gill rakers on first arch (1–3) + (4–7) = 5–10. Jaws with multiserial teeth, outer row enlarged. 4–5 caniniform teeth in the anterior tip of lower jaw. Cheek with distinct mucous canals. Two dorsal fins, not widely separated, height less than body depth. Pectoral fin oblong. Pelvic fin united. Caudal fin obtusely rounded.

Scales: In lateral series 29-32, in transeverse series 8. Scales present on body, opercle and preopercle. Scales of head, breast and belly cycloid or weakly ctenoid, other scales ctenoid.

Colour: This species shows colour dimorphism in different habitats. Specimens collected from freshwater zones of the lake are dull white to green with 5 distinct black blotches mid-laterally. Dorsal and anal fins with 5-6 rows of brown spots. Specimens collected from saline areas are brownish-black with 5-6 indistinct black blotches in lateral series, sometimes appearing as an interrupted lateral band. Scales of dorsal profile are mottled with small brown spots. Dorsal and caudal fins with very distinct rows of brown spots. Pectoral base with an irregular black spot. Abdomen dull white. Pelvic fin black. Other fins dusky.

Distribution: East and South Africa, Mauritius, Malaya, Thailand, China, Philippines, Malanesia, Polynesia, Australia, Sri Lanka, Bangladesh, Burma, Pakistan and coasts of India.

Other materials examined: ZSI No. F 1326/2 (36.0 and 123.0 mm SL) Pondicherry, A. G. K. Menon Coll.

Gobiopsis Steindachner, 1860

Gobiopsis Steindachner, 1860: 291.

Pogonogobius Smith, 1931: 37.

Herreogobius Koumans, 1940: 139.

Barbatogobius Koumans, 1941: 241.

Key to species

Scales in lat. series 36–38, in tr. series 14–15; hind end of maxilla reaching to vertical below middle of eye; body with 6–8 brownish irregular oblique bands appearing like chains .... *Gobiopsis macrostomus* Steindachner, 1860.

Gobiopsis macrostomus Steindachner, 1860
Plate 46.1

Gobiopsis macrostomus Steindachner, 1860: 291; Chatterjee, 1978: 265.

Gobius macrostoma Day, 1878: 286.

Barbatogobius asanai Koumans, 1941: 242; Natarajan and Subrahmanyam, 1975: 138.

Description: Based on 2 specimens, 54.0 and 63.0 mm SL (65.0 and 76.0 mm TL).

Fin formula: D. VI; I, 10–11; A. I, 8–9; P. 20–22; V. I, 5; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 18.25–18.51 (M = 18.38); head length 31.48–31.77 (M = 31.61); snout to D_1 fin origin 38.88–39.41 (M = 39.34); snout to D_2 fin origin 57.14–60.18 (M = 58.66); snout to A fin origin 62.03–64.28 (M = 63.15); snout to pectoral fin origin 32.40–32.53 (M = 32.46); snout to pelvic fin origin 29.62–33.33 (M = 31.47); D_1 base length 10.31–12.03 (M = 11.17); D_2 base length 19.84–22.22 (M = 21.03); A base length 14.28–14.81 (M = 14.54); pectoral fin length 21.29–23.80 (M = 22.54); pelvic fin length 19.44–20.63 (M = 20.03); least depth of caudal peduncle 10.31–12.03 (M = 11.17).

In percent of head length: snout length 23.52–27.50 (M = 25.51); orbit diameter 10.00–14.70 (M = 12.35); least width of interorbital space 29.41–32.50 (M = 30.95).

Body elongated and posteriorly compressed. Head well depressed. Gape of mouth nearly oblique. Hind end of maxilla nearly reaching to vertical below middle of eye. Two nostrils on each side, tubular. Interorbital space broad and flat. Anterior margin of tongue rounded. Anterior tip of snout and chin with barbels. Gill rakers on first arch 3+8 = 11. Jaws with multiserial teeth, anterior row caninoid. Two dorsal fin, height less than half of body depth. Pectoral and caudal fins rounded.

Scales: In lateral series 36–38, in transverse series 14–15. Scales present on body, absent on postorbital region. Nape with small crowded scales. Scales of belly and breast cycloid, other scales ctenoid.

Colour: Brownish above, belly dull white. Eyes blue. 7–8 oblique irregular brown bands which joins each other and appearing like chains. Dorsal fins blackish. Other fins brown. Dorsal and caudal fins with rows of spots. Basal part of pectoral fin with a black band, upper part of pectoral axil with a black blotch.

Distribution: Thailand and coasts of India.

Other materials examined: ZSI F 5742/2 (43.5 mm SL) history unknown.

Acentrogobius Bleeker, 1874

Acentrogobius Bleeker, 1874: 321.
Porogobius Bleeker, 1874: 321.
Drombus Jordan and Seale, 1905: 797.
Exyrias Jordan and Seale, 1906: 405.
Creisson Jordan and Seale, 1907: 43.

__Opua__ Jordan, 1925: 36.

__Obtoriophagus__ Whitley, 1933: 9[illegible].

__Auloparoia__ Smith, 1945: 534.

__Key to species__

Scales in lat. series 36, in tr. series 1[illegible]; preopercle scaled on upper part; opercle totally scaled; no open pore behind eye ....
... __Acentrogobius__ __viridipunctatus__ (Cuvier and Valenciennes).

Scales in lat. series 29-32, in tr. series 8-11; preopercle naked; opercle scaled on upper part; open pore behind eye ....
... __Acentrogobius__ __caninus__ (Cuvier and Valenciennes).

__Acentrogobius__ __viridipunctatus__ (Cuvier and Valenciennes, 1837)

Plate 46.2

__Gobius__ __viridipunctatus__ Cuvier and Valenciennes, 1837: 62; Gunther, 1861: 24; Day, 1878: [illegible]36; Fowler, 1928: 4[illegible]5.

__Gobius__ __chlorostigma__ Bleeker, 1849: 27.

__Acentrogobius__ __viridipunctatus__ Koumans, 1953: 56; Munro, 1955: 24[illegible]; Chatterjee, 1978: 232.

Description: Based on a single specimen, 57.0 mm SL (71.0 mm TL).

Fin formula: D. VI; I, 10; A. I, 9; P. 15; V. I, 5; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 21.05; head length 28.94; snout to D_1 fin origin 37.71; snout to D_2 fin origin 54.38; snout to A fin origin 61.40; snout to pectoral fin origin 29.82; snout to pelvic fin origin 31.57; D_1 base length 12.28; D_2 base length 26.31; A base length 16.66; pectoral fin length 22.80; pelvic fin length 21.05; least depth of caudal peduncle 13.15.

In percent of head length: snout length 30.30; orbit diameter 12.12; least width of interorbital space 18.18.

Body elongated and somewhat compressed. Head slightly depressed. Gape of mouth oblique, lower jaw prominent. Hind end of maxilla reaching to vertical below middle of eye. Two nostrils on each side, the anterior one tubular. Interorbital space concave. Anterior margin of tongue rounded. Nape, opercle and interopercle with distinct mucous canals. Gill rakers on first arch 6+12 = 18. Anterior teeth enlarged and caniniform in both jaws. Multiserial teeth behind the canine teeth. Two dorsal fins, not widely separated, height less than body depth, second dorsal fin pointed posteriorly. Pectoral fin long and pointed. Pelvic fins obtuse and united. Caudal fin obtuse.

Scales: In lateral series 36, in transverse series 10. Scales present on body, upper part of preopercle, entire opercle and postorbital region. Scales of head and breast cycloid, other ctenoid.

Colour: Greenish black. Scales mottled with green spots. Fins blackish. Dorsal and caudal fins with distinct rows of spots.

Distribution: Africa, Thailand, China, Hongkong, Philippines, Ryukyu Islands, Sri Lanka and coasts of India.

Acentrogobius caninus (Cuvier and Valenciennes, 1837)
Plate 46.3

Gobius caninus Cuvier and Valenciennes, 1837: 86; Bleeker, 1849: 27; Gunther, 1861: 38; Fowler, 1928: 404.

Acentrogobius caninus Hardenberg, 1936: 253; Koumans, 1953: 61; Munro, 1955: 240.

Description: Based on 3 specimens ranging in size 34.0–44.0 mm SL (42.[illegible]–56.[illegible] mm TL).

Fin formula: D. VI; [illegible], 9–10; A. I, 8–9; P. 18; V. I, 5; C. 24.

Body measurements expressed in percentage of standard length: greatest body depth 20.45–2[illegible].66 (M = 21.72); head length 28.[illegible]0–30.66 (M = 29.49); snout to D_1 fin origin 30.38–36.36 (M = 32.41); snout to D_2 fin origin 54.54–56.00 (M = 55.47); snout to A fin origin 57.33–59.09 (M = 58.41); snout to pectoral fin origin 29.54–32.00 (M = 30.80); snout to pelvic fin origin 29.[illegible]1–33.33 (M = 30.76); D_1 base length 16.[illegible]–16.17 (M = 16.08); D_2 base length 24.[illegible]–26.47 (M = 25.15); A base length 14.72–18.66 (M = 16.51); pectoral fin length 23.36–27.[illegible]4 (M = 25.90); pelvic fin length 20.45–23.52 (M = 23.24); least depth of caudal peduncle 12.50–14.66 (M = 13.46).

In percent of head length: snout length 26.[illegible]8–30.00 (M = 28.[illegible]4); orbit diameter 17.39–2[illegible].00 (M = 17.79); least width of interorbital space 12.50–16.00 (M = 14.25).

Body elongated and compressed. Head slightly depressed. Gape of mouth oblique, lower jaw prominent. Hind end of maxilla reaching to vertical below middle of eye. Two nostrils on each side, anterior one tubular. Anterior margin of tongue rounded. An open pore behind eye. Nape, cheek, opercle and interopercle with distinct mucous canals. Gill rakers on first arch 3+ (8–11) = 11–14. Jaw teeth multiserial, outermost row enlarged and cananiform. Two dorsal fins, height less than body depth, second dorsal fin pointed posteriorly. Pectoral fin long and pointed. Pelvic fin united. Caudal fin obtuse.

Scales: In lateral series 29–32, in transverse series 8–11. Scales present on body, absent on head excluding postorbital and upper part of opercle. Cycloid scales on head, nape and breast, other scales ctenoid.

Colour: Greenish-brown with shining blue spots on body. Fins dusky black.

Distribution: Madagascar, Siam, China, Japan, Riukiu Islands, Fiji Islands, Sri Lanka and India.

2.4.44. FAMILY : AMBLYOPIDAE

Characters of taxonomic value: Body elongated and eel-like. Mouth nearly vertical, lower jaw very prominent. Jaw with multiserial teeth, outermost series often enlarged and cananiform. No teeth on prevomer and palatine bones. Eyes small to indistinct. Gill membrane united with isthmus.

No groove on the upper gill cover. Chin with rows of papillae. Scales rudimentary or absent. Lateral line absent. Single dorsal fin, spinous part short, dorsal and anal fins confluent with caudal fin. Pectoral fin without free silky rays. Pelvic fin united. Caudal fin lanceolate or oblong.

A single genus _Taenioides_ is represented in Vembanad lake. Day (1878) described these species of fishes under the genus _Gobioides_ and reported 7 species from India, of which 3 species are now placed under the genus _Taenioides_. Koumans (1953) described 4 species from Indo-Australian Archipelago. Recently, Chatterjee (1978) reported 3 species from Gangetic delta (West Bengal).

Key to genus

Chin with barbels; jaws with canine teeth; pectoral fin shorter than pelvic fin; mouth nearly vertical .... _Taenioides_ Lacepede.

Taenioides Lacepede, 1798

Taenioides Lacepede, 1798: 58?.
Amblyopus Valenciennes, 1837: 157.
Psilosomus Swainson, 1839: 183.
Lame De Vis, 1883: 236.

Key to species

Dorsal and anal fins confluent with caudal fin; dorsal, anal and caudal fins blackish; gill rakers on first arch (4–6) + (13–18) .... *Taenioides buchanani* (Day).

Dorsal and anal fins separated from the caudal fin by a deep notch; dorsal, anal and caudal fins grey; gill rakers on first arch (1–2) + (9–11) .... *Taenioides cirratus* (Blyth).

Taenioides buchanani (Day, 1873)
Plate 47.1

Amblyopus buchanani Day, 1873: 110.
Gobioides buchanani Day, 1878: 318.
Taenioides buchanani Koumans, 1953: 27?; Chatterjee, 1978: 1?5.

Description: Based on 2 specimens, 151.? and 161.0 mm SL (187.0 and 193.0 mm TL).

Fin formula: D. VI, 4?–42; A. I, 35–37; P. 2?–22; V. I, 5; C. 16.

Body measurements expressed in percent of standard length: greatest body depth 8.60–8.69 (M = 8.66); head

length 13.90–14.59 (M = 14.24); snout to D fin origin 2_.49–20.52 (M = 2_.50); snout to A fin origin 35.09–39.75 (M = 37.42); snout to pectoral fin origin 14.56–15.52 (M = 15.04); snout to pelvic fin origin 14.56–15.83 (M = 15.19); pectoral fin length 9.__–9.27 (M = 9.13); pelvic fin length 10.59–11.80 (M = 11.19); least depth of caudal peduncle 3.41.3.97 (M = 3.69).

In percent of head length: snout length 33.33–38.29 (M = 35.31); orbit diameter 2.12–2.38 (M = 2.25); least width of interorbital space 21.42–25.53 (M = 23.47).

Body elongated and eel-like, head subcylindrical. Gape of mouth nearly vertical, lower jaw very prominent. Eye not distinct. 3 rows of very short barbels on each side of chin. Mucous canal not distinct on head. Gill rakers on first arch (4–6) + (13–18) = 17–24. A single row of canine teeth on each jaw, behind the canine teeth multiserial fine teeth. A pair of canines at symphysis of lower jaw. Dorsal and anal fins confluent with caudal fin, the latter elongated and pointed. Pectoral fin short. Pelvic fin united.

Scales: Rudimentary in the posterior part of body, absent anteriorly.

Colour: Reddish brown. Dorsal, anal and caudal fins blackish. Other fins colourless.

Distribution: Burma and coasts of India.

Other materials examined: ZSI No. F 7259/2 (154.0 and 200.0 mm SL) history unknown.

Taenioides cirratus (Blyth, 1860)
Plate 47.2

Amblyopus cirratus Blyth, 1860: 147.
Amblyopus brachygaster Gunther, 1861: 134.
Gobioides cirratus Day, 1878: 318.
Taenioides cirratus Herre, 1927: 33; Koumans, 1953: 270; Chatterjee, 1973: 110.

Description: Based on 10 specimens ranging in size 141.0-161.0 mm SL (154.0-176.0 mm TL).

Fin formula: D. VI, 46-54; A. I, 44-46; P. 16; V. I, 5; C. 14.

Body measurements expressed in percent of standard length: greatest body depth 6.83-8.30 (M = 7.59); head length 14.33-15.83 (M = 15.16); snout to D fin origin 23.39-25.17 (M = 24.29); snout to A fin origin 37.06-39.43 (M = 38.02); snout to pectoral fin origin 14.64-

16.56 (M = 15.65); snout to pelvic fin origin 15.46–17.19 (M = 16.27); pectoral fin length 4.89–6.11 (M = 5.55); pelvic fin length 10.86–12.81 (M = 12.03); least depth of caudal peduncle 2.76–3.59 (M = 3.22).

In percent of head length: snout length 30.35–32.48 (M = 31.85); least width of interorbital space 15.94–18.20 (M = 17.12).

Body elongated and eel-like, head subcylindrical. Gape of mouth nearly vertical, lower jaw very prominent. Eyes not very distinct, nearly hidden. 3 rows of distinct barbels on chin. Mucous canals not distinct on head. Gill rakers on first arch (1–2) + (9–11) = 10–13. An outer row of canine teeth in both jaws, bands of fine teeth in inner series. Dorsal and anal fins separated from caudal fin with a distinct notch. Caudal fin lanceolate. Pectoral fin short and rounded. Pelvic fins united.

Scales: Absent.

Colour: Pinkish-brown. Caudal fin dusky black. Vertical fins grey.

Distribution: Indo-Australian Archipelago, Japan, Australia, Zanzibar, coasts of India including Andaman Nicobar Islands.

__Other materials examined:__ ZSI No. 2072 (224.5 mm SL) Calcutta, F. Day Coll.

2.4.45. __FAMILY__ : __TRYPAUCHENIDAE__

__Characters of taxonomic value:__ Body elongated, eel-like. Mouth oblique. Multiserial teeth in jaws, canines absent. No teeth on prevomer and palatine bones. Eyes small and rudimentary. Gill membrane united with isthmus. Scales cycloid, present on body, absent or present on head. Mucous canals feebly developed. Lateral line absent. Dorsal fin continuous. Pectoral fin without free silky rays. Pelvic fin usually united. Caudal fin oblong or pointed.

A single genus __Trypauchen__ is represented in the Vembanad lake. A brief review on fishes of the genus __Trypauchen__ shows that there is the report of a single species from India (Day, 1878; Chatterjee, 197-) and Sri Lanka waters (Munro, 1955). Koumans (1953) described 3 species under this genus from the Indo-Australian Archipelago.

__Key to genus__

A small groove on upper gill cover, which has blind end; pelvic fins completely united to form a funnel-shaped

adhesive disc ....
...... *Trypauchen* Valenciennes.

Trypauchen Valenciennes, 1837

Trypauchen Valenciennes, 1837: 152.

Key to species

Lat. scales 80-86, in tr. series 20-21 ......
.... *Trypauchen vagina* (Bloch and Schneider).

Trypauchen vagina (Bloch and Schneider, 1801)
Plate 47.3

Gobius vagina Bloch and Schneider, 1801: 73.
Gobioides ruber Hamilton-Buchanan, 1822: 33.
Trypauchen vagina Valenciennes, 1837: 153; Bleeker, 1849: 37; Day, 1878: 300; Fowler, 1934: 161; Koumans, 1953: 277; Munro, 1955: 243; Chatterjee, 1978: 120.

Description: Based on 15 specimens ranging in size 102.0-179.0 mm SL (123.0-206.0 mm TL).

Fin formula: D. VI, 45-48; A. I, 42-45; P. 16; V. I, 5; C. 14-16.

Body measurements expressed in percen of standard length: greatest body depth 10.76-12.58 (M = 11.33); head length 17.04-19.11 (M = 17.93); snout to D fin origin

21.25–23.52 (*M* = 22.08); snout to A fin origin 33.80–36.27 (*M* = 35.57); snout to pectoral fin origin 17.61–19.60 (*M* = 18.20); snout to pelvic fin origin 17.93–19.60 (*M* = 18.62); pectoral fin length 5.83–6.89 (*M* = 6.34); pelvic fin length 5.00–7.40 (*M* = 6.59); least depth of caudal peduncle 4.90–6.55 (*M* = 5.06).

In percent of head length: snout length 25.00–32.55 (*M* = 29.31); least width of interorbital space 16.07–19.14 (*M* = 17.86).

Body elongated and compressed. Mouth superior, gape of mouth oblique. Hind tip of maxilla reaching to vertical below eye. Interorbital space elevated. Eyes rudimentary. Gill rakers rudimentary. Jaws with an outer series of caninoid teeth, inner series with fine teeth. Dorsal and anal fins confluent with caudal fin. Pectoral fin very small and rounded. Pelvic fin small, united and not emarginate posteriorly. Caudal fin rounded.

Scales: In lateral series 80–86; in transverse series 20–21. Cycloid scales present on body excluding breast. Head and nape naked.

Colour: Rosy-red above, white below. Fins white. Eyes blackish.

Distribution: Persian Gulf, Thailand, Vietnam, Malaya, China, Taiwan, Sri Lanka, Pakistan and coasts of India.

Other materials examined: ZSI No. 2107 (125.0 mm SL) Calcutta, F. Day Coll.

SUB ORDER : ACANTHUROIDEI

2.4.46. FAMILY : ACANTHURIDAE

Characters of taxonomic value: Body oblong or oval and well compressed. Mouth terminal and small. Teeth compressed, sometimes denticulated. Palate toothless. Two nostrils on each side. Gill membrane united with isthmus. Lateral line complete. Single dorsal fin. Anal fin with 2-3 spines. Pelvic fin with one spine and 3-5 rays. Caudal peduncle with spine or bony plate. Caudal fin truncate or emarginate.

Among the fishes of the family Acanthuridae, fishes of the genus *Acanthurus* was only represented in the study area. A brief review shows that 13 species under the genus *Acanthurus* was reported from India (Day, 1878), 21 species were described from Indo-Australian Archipelago (Beaufort and Chapman, 1951) and 8 species from Sri Lanka waters (Munro, 1955). Jones and Kumaran (1967) reported two new distributional records from the coast of peninsular India and also reported 10 species from the Laccadive Archipelago (Jones and Kumaran, 1980).

Key to genus

Three anal spines; caudal peduncle with one antrorse spine on each side; teeth well developed, immovable and broad; pelvic with 5 soft rays; dorsal with 8-9 spines .... Acanthurus Forsskal.

Acanthurus Forsskal, 1775

Acanthurus Forskal, 1775: 59.
Rhombotides Klein, 1775: 922.
Hepatus Linneaus, 1766: 507.
Acronurus Gunther, 1861: 345.

Key to species

Body depth 50.98-52.52% in SL; no light ring around the mouth; no black mark on shoulder; corner of mouth nearer to hind border of preopercle than to eye; 8-9 slender teeth on each side of both jaws; dorsal and anal fins with light longitudinal bands .... Acanthurus matoides Valenciennes.

Acanthurus matoides Valenciennes, 1835
Plate 48.1

Acanthurus matoides Cuvier and Valenciennes, 1835: 204; Day, 1878: 205; Beaufort and Chapman, 1951: 156; Munro, 1955: 214.

Hind end of maxilla not reaching to anterior margin of eye. Interorbital space convex. Anterior nostril with a flap. Gill rakers on first arch (6-7) + (11-13) = 17-20. 8-9 teeth on each side of both jaws. Lateral line slightly arched. Caudal fin truncate, lobes pointed.

Scales: Lateral line scales 182-198; in transverse series 79-90. Body, head and paired and unpaired fins base with small rough scales.

Colour: Body brownish-black. Dorsal anal, and caudal fins brownish. Soft dorsal and anal with 3-4 longitudinal white narrow bands. Pectoral fin base brownish, yellowish distally. Pelvic fin black.

Distribution: Hawaiian Islands, Marquesas, Indonesia, Philippines, Australia, East coast of Africa, Sri Lanka and coasts of India including Laccadives.

2.4.47. FAMILY : SIGANIDAE

Characters of taxonomic value: Body compressed, skin slippery, scales cycloid and elongated. Two nostrils. Mouth terminal, not protractile. Single row of incisor like teeth on jaws, vomerine and palatine teeth absent. Dorsal fin with 13 spines and 10 rays, with a procumbent spine in front of it. Anal with 7 spines and 9 rays, pelvic fins with two spines (proximal and distal) and 3 rays. Most of them are deeply coloured and can inflict stabs.

Gunther (1861) listed 29 species of Rabbit fishes from the collections of British Museum. Day (1878,1889) reported 9 species from India. 17 species were recorded from Indo-Australian Archipelago (Beaufort and Chapman, 1951). Munro (1955) listed 6 species from Sri Lanka waters. Four species occur in Red sea, two of which have migrated through the Suez Canal and now established in Eastern Mediterranean (Tuvia, 1964,1966). Murty (1969) reported two species from the reference collection of CMFRI. Sawel and Woodland (1974) described a new species from Fiji. Fischer and Whitehead (1974) listed 21 species from Eastern Indian and Western Central Pacific. Recently, Woodland and Randall (1979) described another new species from Central and western Indian Ocean, thus raising the number of Siganids to eight in this area.

Members of the family Siganidae are difficult to be identified because of their morphological uniformity and so the difference in colour pattern have been traditionally used to differentiate the species (Woodland and Randall, 1979).

Siganids were formerly known as Teuthids, however, Nielsen and Klausewitz (1968), Taylor (1970) and Woodland (1972,1973) had proposed to the International Commission on Zoological Nomenclature that the genus *Teuthis* Linnaeus 1766 be supressed in favour of the genus name *Siganus* Forsskal 1775. Family Siganidae is composed of a single genus *Siganus* and the other intended genus *Lo* Seale 1906 has given only the subgeneric status (Sawel and Woodland, 1974).

Siganus Forsskal 1775

Teuthis Linnaeus, 1766: 507; Cantor: 207.
Siganus Forsskal, 1775: 25.
Centrogaster Houttuyn, 1782: 333.
Amphacanthus Bloch and Schneider: 115.

Key to species

1. Last dorsal spine longer than 1 dorsal spine; body height more than 44.0% in SL; soft dorsal and anal high and angular .... 2.

Last dorsal spine shorter than 1 dorsal spine; body height 36.0-41.5% in SL; soft dorsal and anal arched .... 3.

2. Head blunt, no distinct notch on the occiput; maxilla situated opposite well below lower border of eye;

last dorsal spine 1.75 times length of I dorsal spine; 21-23 rows of scales between lat. line and median dorsal spine; spots completely absent in the body; 15 longitudinal golden yellow bands .... Siganus lineatus (Cuvier and Valenciennes).

Head slightly pointed, a distinct notch on the occiput; maxilla situated opposite lower border of eye; lat dorsal spine 1.25 times length of I dorsal spine; 30-34 rows of scales between lat. line and median dorsal spines; white oval spots on dorsal profile and head; longitudinal brown bands on belly .... Siganus javus (Linnaeus).

3. No distinct notch on the occiput; maxilla situated opposite lower border of eye; 21-25 rows of scales between lat. line and median dorsal spine; black shoulder spot; five black cross bands on the caudal fin .... Siganus canaliculatus (Park).

Siganus lineatus (Cuvier and Valenciennes, 1835)

Plate 43.2

Amphacanthus lineatus Cuvier and Valenciennes, 1835: 130.

Teuthis lineata Gunther, 1861: 322.

Siganus lineatus Jordan and Seale, 1907: 35; Fowler and Bean, 1929: 319; Fowler, 1934: 429; Woodland, 1979: 390.

__Description__: Based on 2 specimens ranging in size 120.0-134.0 mm SL (142.0-165.5 mm TL).

__Fin formula__: D. I, XIII, 10; A. VII, 9; P. 14; V. I, 3, I; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 45.89-48.75 (M = 47.32); head length 27.61-28.12 (M = 27.86); snout to D fin origin 35.07-35.41 (M = 35.24); snout to A fin origin 53.73-55.00 (M = 54.36); snout to pectoral fin origin 24.16-25.00 (M = 24.58); snout to pelvic fin origin 34.32-34.58 (M = 34.45); base D fin 64.58-68.65 (M = 66.61); base A fin 42.50-44.40 (M = 43.45); pectoral fin length 21.26-22.50 (M = 21.88); pelvic fin length 17.08-18.28 (M = 17.68); longest D spine (7th) 12.91-14.71 (M = 13.49); longest A spine 11.66-13.43 (M = 12.54); least depth of caudal peduncle 7.70-8.95 (M = 8.32).

In percent of head length: snout length 43.70-48.64 (M = 46.17); orbit diameter 28.37-30.37 (M = 29.37); least width of interorbital space 32.88-34.45 (M = 33.66).

Body very oval and well compressed, slight concavity on the occiput and so a gradual ascent to dorsal fin origin. Interorbital space convex. Head blunt, snout tip humped. Maxilla situated opposite well below lower border of eye.

Preopercular lower angle denticulated. Anterior nostril is having very small flap. Gill rakers on first arch (anterior) 6+(18-19) = 24-25. In both upper and lower jaws, a single row of incisor like teeth (26). The teeth in upper jaw is having a median cusp, bicusped teeth in lower jaw. Palatine and vomerine teeth absent. Last dorsal spine 1.75 times of first dorsal spine. Soft dorsal and anal high and angular. Caudal fin truncate.

Scales: Lateral line scales 148-154; in transeverse series 102-106. Scale rows between lateral line and 4th dorsal spine 21-23. Cheek covered with visible scales, 11-12 rows below mid orbit. Scales present all over the body.

Colour: Spots and blotches are totally absent. Upper profile slightly greenish, lower profile dull white. Fifteen parallel longitudinal golden yellow bands on the body, not extending into the head. Interspace between the bands are greater than the width of the band. Head dark brown, snout tip black. Preopercle yellow. Dorsal, caudal and ventral fins blackish, anal fin very black. A black stripe just behind dorsal base. Golden yellow behind the end of soft dorsal.

Distribution: New Guinea, Vanicolo, Central and Western Indian Ocean, African coast, India: west coast.

Remarks: The colour in life of this species is not yet fully described. Gunther (1861) described that in I. lineata, the ten longitudinal streaks are anastomosing with one another but in the present specimens, all the fifteen bands are parallel and not forming into any net work. Beaufort and Chapman (1951) considered S. lineatus as the synonym of S. guttatus (Bloch), but the present specimens do not agrees with their description. Kurup and Samuel (1981e) has reported S. lineatus from the West coast of India and also given a re-description.

Siganus javus (Linnaeus, 1766)
Plate 49.1

Teuthis javus Linnaeus, 1766: 507; Gunther, 1861: 315.
Amphacanthus javus Cuvier and Valenciennes, 1835: 118; Bleeker, 1850: 9.
Teuthis java Day, 1878: 165.
Siganus javus Jordan and Seale, 1907: 35; Fowler, 1928: 279; Beaufort and Chapman, 1951: 111; Munro, 1955: 209; Fischer and Whitehead, 1974;, Woodland, 1979: 390.

Description: Based on 12 specimens ranging in size 67.0-136.0 mm SL (82.0-158.0 mm TL).

__Fin formula__: D. I, XIII, 10–11; A. VII, 9; P. 16; V. I, 3, I; C. 22.

Body measurements expressed in percent of standard length: greatest body depth 44.77–48.43 (M = 46.22); head length 25.36–29.16 (M = 26.80); snout to D fin origin 30.59–35.11 (M = 33.30); snout to A fin origin 52.98–56.54 (M = 55.42); snout to pectoral fin origin 23.16–26.19 (M = 24.82); snout to pelvic fin origin 35.67–36.90 (M = 36.12); base D fin 66.66–71.87 (M = 68.33); base A fin 41.66–45.20 (M = 43.22); pectoral fin length 18.75–21.42 (M = 20.10); pelvic fin length 14.45–17.17(M = 15.48); longest D spine (7th) 11.90–15.67 (M = 13.64); longest A spine 11.71–14.28 (M = 13.03); least depth of caudal peduncle 5.97–7.42 (M = 6.78).

In percent of head length: snout length 36.73–42.58 (M = 39.44); orbit diameter 28.57–32.65 (M = 30.08); least width of interorbital space 30.00–34.28 (M = 33.02).

Body compressed, oval, deep concavity on the occiput and so a steep ascent to dorsal fin origin. Interorbital space convex. Head pointed, snout tip humped. Maxilla situated opposite lower border of eye. Preopercular lower angle denticulated. Anterior nostril is having a small flap. Some of the gill rakers are branched. Gill raker on first arch (anterior) (5–7) + (16–20) = 21–27.

A single row of teeth in upper and lower jaws (32). Teeth in upper jaw is having a median cusp, bicusped in the lower jaw. Palatine and vomerine teeth absent. Last dorsal spine 1.25 times of 1st dorsal spine. Soft dorsal and anal rays high and angular. Caudal fin truncate.

Scales: Lateral line scales 194-202; in transverse series 118-124. Scales rows between lateral line and 4th dorsal spine 30-35. Scales on cheek embeded in the body and similar scales in the body also.

Colour: Head and upper profile brown with numerous white oval spots arranged in regular pattern. Belly dull white, the spots are coalescing into 4-6 undulating brown lines. Dorsal, anal, caudal and ventral fins brown, pectoral colourless.

Distribution: Japan, Singapore, Malay, Archipelago, New Guinea, Sri Lanka, Philippines, coast of Australia to New South Wales and India: east and west coast including Andamans.

Other materials examined: ZSI Nos. 1770 (140 mm SL) Andamans, Dup. Cat. 41 (117.0 mm SL) 273 (117.0 mm SL) 382 (137.0 mm SL) 383 (99.0 mm SL) 125.0 mm SL) Akyab, Burma, F. Day Coll.

<u>Siganus canaliculatus</u> (Park, 1797)

<u>Plate 49.2</u>

<u>Chaetodon canaliculatus</u> Mungo Park, 1797: 33.

<u>Amphacanthus guttatus</u> var. <u>oramin</u> Bloch and Schneider, 1801: 207.

<u>Amphacanthus margaritiferus</u> Cuvier and Valenciennes, 1835: 145; Bleeker, 1857: 334.

<u>Teuthis margaritifera</u> Gunther, 1861: 317; Day, 1878: 167.

<u>Teuthis oramin</u> Gunther, 1861: 318.

<u>Siganus oramin</u> Jordan and Richardson, 1908: 271; Fowler and Bean, 1929: 307; Beaufort and Chapman, 1951: 107; Munro, 1955: 209.

<u>Siganus canaliculatus</u> Fowler, 1928: 279; Beaufort and Chapman, 1951: 115; Fischer and Whitehead, 1974; Woodland, 1974.

<u>Description</u>: Based on 25 specimens ranging in size 42.5–111.0 mm SL (51.0–137.0 mm TL).

<u>Fin formula</u>: D. I, VIII, 10; A. VII, 9; P. 16; V. I, 3, I; C. 20–22.

Body measurements expressed in percent of standard length: greatest body depth 36.48–41.02 (M = 38.75); head length 26.11–30.23 (M = 28.03); snout to D fin origin 27.32–31.29 (M = 26.36); snout to A fin origin 51.35–55.81 (M = 54.25); snout to pectoral fin origin 23.49–27.77 (M =

25.68); snout to pelvic fin origin 32.22–36.47 (M = 34.87); base D fin 66.02–71.11 (M = 68.58); base A fin 38.88–43.29 (M = 41.16); pectoral fin length 18.18–22.35 (M = 20.22); pelvic fin length 13.25–16.93 (M = 15.01); longest D spine (7th) 11.11–15.68 (M = 13.31); longest A spine (3rd) 11.34–15.68 (M = 12.65); least depth of caudal peduncle 5.45–7.25 (M = 6.04).

In percent of head length:snout length 35.47–40.42 (M = 38.16); orbit diameter 27.58–34.34 (M = 31.20); least width of interorbital space 29.31–36.36 (M = 31.78).

Body compressed, oblong, slight concavity on the occiput and a gradual ascent to dorsal fin origin. Interorbital space slightly convex. Head blunt, snout tip humped. Maxilla located opposite lower border of eye. Preopercular lower angle denticulated. Anterior nostril with a short flap. Some of the gill rakers are branched. Gill raker on first arch (anterior) (4–6) + (17–19) = 21–25. A single row of teeth in upper and lower jaws. Incisor like (26) teeth in upper jaw is having a median cusp, bicusped in lower jaw. Palatine and vomerine teeth absent. Last dorsal spine smaller than first dorsal spine. Soft dorsal and anal low and arched. Caudal fin slightly emarginate.

Scales: Lateral line scales 178-190, in transverse series 92-98. Scale row between lateral line and 4th dorsal spine 20-23. Scales of the body and cheek concealed.

Colour: Fishes of this species shows marked colour variations. Generally most of them are uniformly brown with numerous white oval spots. In some specimens the body is dull white with a large number of brown spots. The size of the spots differ from specimen to specimen. The spots on head and upper profile is normally small, elongated ones on side. Dorsal and anal fins spotted brown. A very conspicuous black round blotch behind the upper part of gill opening. Five vertical cross bands on caudal fin. Ventral and caudal fins pale brown, pectoral slightly yellowish.

Distribution: Central, Western and Eastern Indian Ocean, Western Central Pacific, Singapore, Japan, New Guinea, Natal, Madagascar, Zanzibar, Seychells, Mauritius, Arabian coasts, Riukiue Islands, Formosa, Philippines, coast of North Australia, Fiji, Samoa, Malacca, Malayan Archipelago, Sri Lanka, China and India: east and west coast including Andamans.

Other materials examined: ZSI Nos 53 (174.0 mm SL) Andamans, 1769 (124.0 mm SL) Madras, F. Day Coll.

Remarks: Beaufort and Chapman (1951) described *S. oramin* (Bloch and Schneider) and *S. canaliculatus* as two separate species. In recent works, *S. oramin* is considered as the synonym of *S. canaliculatus* (Fischer and Whitehead, 1974). According to Woodland the name *Canaliculatus* Park 1797 has priority over *Oramin* (Lam, 1974). Lam (1974) described the two forms of *S. canaliculatus* one with 5-6 rows of pin head sized spots above lateral line and other with 3 rows of slightly larger spots above lateral line.

SUB ORDER : CHANNOIDEI

2.4.48. FAMILY : CHANNIDAE

Characters of taxonomic value: Body elongated, anteriorly depressed and posteriorly compressed. Head depressed with shield-like scales. Mouth large, terminal; lower jaw slightly prominent. Well developed teeth in jaws and intermaxillaries. Gill membrane free from isthmus. Scales ctenoid and straiated. Lateral line present. Fins spineless, dorsal and anal fin long. Accessary respiratory organs present. Caudal fin rounded.

This family was formerly known as Ophiocephalidae and 10 species under two genera were reported from India (Day, 1878), 11 species were reported from Indo-Australian Archipelago (Weber and de Beaufort, 1922) and 5 species were accounted from Sri Lanka waters (Munro, 1955). Recently, Reddy (1978) conducted the detailed taxonomic studies on fishes of the family Channidae and reported that the family Channidae includes a single genus Channa and is represented by 8 species in Indian waters.

Channa Scopoli, 1777

Channa Scopoli, 1777: 42.
Ophicephalus Bloch, 1794: 53.

Key to species

D. 39-40; A. 24-25; cephalic sense pits multiple, sieve like; lat. scales 56-62, 10 tr. rows of dorsicephalic scales before the level of opercle .... Channa striata (Bloch).

Channa striata (Bloch, 1793)
Plate 49.3

Ophiocephalus striatus Bloch, 1793: 141; Cuvier and Valenciennes, 1831: 417; Bleeker, 1850: 13; Gunther, 1859: 474; Day, 1878: 366; Weber and de Beaufort, 1922: 317; Munro, 1955: 16[illegible].
Channa striata Jayaram, 1976: 320; Reddy, 1978: 96.

<u>Description</u>: Based on 9 specimens ranging in size 82.0–302.0 mm SL (100.0–355.0 mm TL).

<u>Fin formula</u>: D. 39–40; A. 24–25; P. 16; V. 6; C. 16.

Body measurements expressed in percent of standard length: greatest body depth 17.51–19.20 (M = 18.57); head length 32.45–34.75 (M = 33.37); snout to D fin origin 35.43–38.41 (M = 36.66); snout to A fin origin 53.28–55.48 (M = 54.20); snout to pectoral fin origin 32.11–34.14 (M = 33.41); snout to pelvic fin origin 35.36–28.41 (M = 36.48); D base length 56.93–59.72 (M = 58.56); base A fin 34.43–36.42 (M = 35.60); pectoral fin length 15.23–18.90 (M = 16.63); pelvic fin length 10.50–12.25 (M = 11.55); least depth of caudal peduncle 8.[illegible]–9.75 (M = 9.14).

In percent of head length: snout length 19.14–22.68 (M = 20.99); orbit diameter 13.26–17.50 (M = 14.49); interorbital space 21.27–24.56 (M = 22.85).

Body elongated, anterior sub-cylindrical, posteriorly compressed. Mouth terminal, lower jaw slightly prominent. Hind tip of maxilla reaching to well beyond vertical below posterior margin of eye. Cleft of mouth oblique. Interorbital space flat. Two nostrils on each side, the anterior one tubular, the posterior one nearer to eye. Gill rakers rudimentary with some spines. Teeth in bands on jaws and intermaxillaries. Mandible with canine teeth also. Slender teeth on vomer and palatine. Lateral line slightly high anteriorly, reaching to caudal fin base. Pelvic fin thoracic. Caudal fin rounded.

__Scales:__ In lateral series 56-58; in transverse series 13-14. Scales present on head, body and fins base.

__Colour:__ Upper profile brownish-black, dull white or yellowish below. 14-16 black oblique bands on dorsal profile reaching to midline of the body. Similar oblique bands on ventral profile, with right angles with upper bars. Head and body mottled with brown stripes. Fins blackish.

__Distribution:__ Philippines, Pinang, Malay Peninsula, Siam, China, Pakistan, Burma, Bengladesh, Sri Lanka and India.

__Other materials examined:__ SI No. 1370 (145.0 mm SL) Pakistan, 1372 and 1376 (96.0 and 56.0 mm SL) Malabar, F. Day Coll.

SUB ORDER : ANABANTOIDEI

2.4.49. __FAMILY__ : __ANABANTIDAE__

__Characters of taxonomic value:__ Body elongated, anteriorly depressed and posteriorly compressed. Snout pointed.

Mouth terminal, cleft of the mouth oblique, lower jaw prominent. Jaw with bands of conical teeth. Gill membrane united with isthmus. Scales ctenoid. Lateral line present. Dorsal and anal fins long, with strong spines and rays. Pectoral rounded. Pelvic fin thoracic. Accessary respiratory organ present.

A single genus is represented in the Vembanad lake. A single species is known from Indo-Pacific area (Day, 1878; Weber and de Beaufort, 1922; Munro, 1955).

Key to genus

Dorsal longer than anal, dorsal origin above pectoral, anal origin below 8th dorsal spine; lat. line complete but interrupted; polvic fin with one spine and 5 rays, the outer rays normal .... *Anabas* Cuvier.

Anabas Cuvior, 1817

Anabas Cuvier, 1817: 339.

The genus *Anabas* is monotypic in the Indo-Pacific area.

Anabas testudineus (Bloch, 1795)
Plate 49.4

Anthias testudineus Bloch, 1795: 121.

<u>Anabas scadens</u> Cuvier and Valenciennes, 1831: 249; Bleeker, 1857: 329; Gunther, 1861: 375; Day, 1878: 370.

<u>Anabas testudineus</u> Cuvier, 1817: 310; Bleeker, 1879: 7; Weber and de Beaufort, 1922: 334; Munro, 1955: 226.

<u>Description</u>: Based on 5 specimens ranging in size 107.0-148.0 mm SL (132.0-184.0 mm TL).

<u>Fin formula</u>: D. XVIII, 9; A. IX, 10; P. 14-15; V. I, 5; C. 16.

Body measurements expressed in percent of standard length: greatest body depth 30.61-37.38 (M = 33.02); head length 31.29-35.51 (M = 32.85); snout to D fin origin 32.99-38.31 (M = 35.14); snout to A fin origin 57.00-61.14 (M = 58.65); snout to pectoral fin origin 33.33-35.51 (M = 34.09); snout to pelvic fin origin 36.73-41.12 (M = 39.23); D base length 59.45-61.69 (M = 60.39); A base length 35.13-38.31 (M = 37.17); pectoral fin length 20.74-23.64 (M = 22.11); pelvic fin length 17.22-18.69 (M = 17.75); least depth of caudal peduncle 14.95-15.30 (M = 15.15).

In percent of head length: snout length 22.36-23.91 (M = 23.22); orbit diameter 15.78-18.47 (M = 17.44); least width of interorbital space 31.57-34.36 (M = 32.92).

Body moderately elongated, anteriorly cylindrical and posteriorly compressed. Mouth terminal, lower jaw prominent. Cleft of mouth oblique, hind tip of maxilla reaching to well beyond vertical below anterior margin of eye. Interorbital space convex. Preorbital, interopercle, subopercle and opercle strongly serrated. Two nostrils on each side, the anterior one with a fleshy flap, posterior one near to eye. Gill rakers rudimentary, 7-8 short rakers on lower gill arch. Teeth on jaws in narrow bands, on vomer somewhat conical. Palate eduntulous. Lateral line interrupted. Caudal fin rounded.

<u>Scales</u>: In lateral series 32-34; in transverse series 12-14. Scales present on head and body. Scale sheath at dorsal and anal fins base high. Caudal and paired fins with basal scales.

<u>Colour</u>: Body dull green with 10 indistinct dark oblique stripes. Ventral side dull white. Opercle tip black. A black blotch on caudal peduncle. Dorsal and anal fins greenish. Paired fins slightly reddish. Caudal fin brown.

<u>Distribution</u>: Philippines, China, Tankin, Malakka, Siam, Burma, Sri Lanka and India.

<u>Other materials examined</u>: ZSI No. F 4225/2 (76.0-101.0 mm SL, 3 eg) Manipur, A.G.K. Menon Coll.

SUB ORDER : MASTACEMBELOIDEI

2.4.30. FAMILY : MASTACEMBELIDAE

Characters of taxonomic value: Body elongated and compressed. Mouth small, the upper jaw overhangs lower jaw. Snout produced into a fleshy tentacle, the tubular anterior nostril at its anterior most sides. Villiform teeth in jaws. Elongated cycloid scales present on head and body. Lateral line distinct. Dorsal fin with a series of isolated spines followed by the soft dorsal. Anal fin with 3 spines. Pectoral fin rounded, pelvic fin absent. Gill membrane free from isthmus.

Among the two genera known under the family Mastacembelidae (Beaufort and Briggs, 1962), the genus *Mastacembelus* is alone represented in Vembanad lake. Day (1865) described a new species from the coast of Malabar thus raised the total species of 5 in Indian waters (Day, 1878). Subsequently, John (1936) reported 2 species from Travancore, Kerala. The occurrence of a single species in Sri Lanka waters (Munro, 1955) and 6 species in Indo-Australian Archipelago (Beaufort and Briggs, 1962) are also reported. Sufi (1956) conducted a revision of the oriental fishes of the family Mastacembelidae.

Key to genus

Striations absent beneath the snout; fleshy tentacle on snout moderate .... Mastacembelus Scopoli.

Mastacembelus Scopoli, 1777

Mastacembelus Scopoli, 1777: 42.

Key to species

D. XXVIII–XXIX, 54–61; anal rays 66–71; scales between lat. line and XV dorsal spine 14–16; dorsal and anal confluent with caudal with a notch; lips not well developed; cleft of mouth nearly reaching to vertical below posterior nostril .... Mastacembelus guentheri Day.

D. XXXVI–XXXVII, 70–76; anal rays 56–60; scales between lat. line and XV dorsal spine 24–26; dorsal and anal confluent with caudal without a notch; lips well developed; cleft of mouth nearly reaching to vertical below anterior margin of eye .... Mastacembelus armatus Lacepede.

Mastacembelus guentheri Day, 1865:
Plate 50.1

Mastacembelus guentheri Day, 1865: 154; 1878: 341.

Description: Based on 18 specimens ranging in size 110.0–258.0 mm SL (119.0–268.0 mm TL).

Fin formula: D. XXVIII–XXIX, 54–61; A. III, 66–71; P. 22; C. 12.

Body measurements expressed in percent of standard length: greatest body depth 10.90–13.28 (M = 12.41); head length 14.28–17.64 (M = 16.30); snout to D fin spine origin 18.02–19.62 (M = 19.14); snout to soft dorsal fin origin 62.50–66.85 (M = 64.49); snout to A fin origin 57.63–61.11 (M = 59.69); snout to pectoral fin origin 15.04–17.27 (M = 16.23); pectoral fin length 4.29–5.55 (M = 4.87); least depth of caudal peduncle 1.35–2.20 (M = 1.72).

In percent of head length: snout length 39.13–43.18 (M = 40.91); orbit diameter 7.40–9.23 (M = 8.63); least width of interorbital space 9.87–12.96 (M = 10.66).

Body elongated, tapering anteriorly and posteriorly. Cleft of mouth horizontal, not reaching to vertical below anterior margin of eye. Interorbital space convex. Eye covered with the membrane. Anterior nostril as a tubular tentacle at the anterior most region of the snout and trilobed. Posterior nostril as an oval slit-like opening, in front of eye. Gill rakers absent. Villiform teeth present in jaws. Lateral line arched anteriorly, interrupted at the posterior most region. Origin of dorsal spines from vertical above posterior end of pectoral fin, the latter rounded. Vent situated in the posterior half of the body, the origin of anal close to vent. Origin of soft dorsal slightly behind the level of anal fin origin. Dorsal and anal fins confluent with caudal fin, but demarcated by a distinct notch, the latter obtusely pointed.

Scales: 14-16 rows of scales between lateral line and XV dorsal spine. Elongated cycloid scales present on head and body including fins base.

Colour: Brownish-black above, abdomen golden yellow. Two black stripes from the margin of eye, one to opercle and other vertically downwards. A black vertical band in front of eye. Body with 27-32 black cross bars, most of them branching and united in the ventral profile and appearing like chains. Soft dorsal and anal fins intensely spotted. Pectoral yellowish.

Distribution: Positively known only from the fresh waters of central Kerala.

Remarks: This species is found to be endemic to the fresh waters of central Kerala since there is no positive record from other areas of India. The available description of this species was only those of Day (1865) and so a re-description is very essential.

Mastacembelus armatus (Lacepede, 1800)
Plate 50.2

Macrognathus armatus Lacepede, 1800: 286; Hamilton-Buchanan, 1822: 28.

Mastacembelus armatus Cuvier and Valenciennes, 1831: 456; Bleeker, 1853: 97; Gunther, 1861: 542; Day, 1878: 340; Munro, 1955: 267; Beaufort and Briggs, 1962: 433.

Description: Based on 5 specimens ranging in size 382.0-588.0 mm SL (398.0-605.0 mm TL).

Fin formula: X. XXXVI-XXXVII, 70-76; A. III, 56-60; P. 20; C. 16.

Body measurements in percent of standard length: greatest body depth 7.82-8.63 (M = 8.29); head length 15.44-16.62 (M = 15.90); snout to D fin spine origin 18.02-19.52 (M = 19.12); snout to soft dorsal fin origin 59.86-67.01 (M = 64.09); snout to A fin origin 54.56-63.35 (M = 59.06); snout to pectoral fin origin 15.57-16.87 (M = 16.08); pectoral fin length 4.13-4.85 (M = 4.48);

least depth of caudal peduncle 2.35–2.72 (M = 2.53).

In percent of head length: snout length 30.43–37.28 (M = 34.45); orbit diameter 7.00–7.62 (M = 7.22); least width of interorbital space 8.91–11.01 (M = 9.90).

Body elongated, anteriorly tapering and posteriorly rounded. Cleft of mouth horizontal, nearly reaching to vertical below anterior margin of eye. Interorbital space convex. Eye covered with membrane. Anterior nostril as a tubular tentacle at the anterior most region of the snout and trilobed. Posterior nostril as a slit-like opening in front of eye. Gill rakers absent. Teeth villiform in jaws. Lateral line slightly arched anteriorly, reaching to caudal peduncle. Origin of dorsal spines above posterior third of pectoral fin, the latter rounded. Vent situated nearly in the middle of the body, the origin of anal fin close to vent. Origin of anal before that of soft dorsal. Dorsal and anal fins confluent with caudal fin without a notch, caudal fin rounded.

Scales: 24–26 rows of scales between XV dorsal spine and lateral line. Elongated cycloid scales present on body, head ecluding snout and fins base.

Colour: Brownish-black above, abdomen dull white. Two lateral black bands from eye to middle region of body, often forming hexagonal rings from middle region to caudal peduncle. One row of irregular black blotches on dorsal profile, often join with the lateral band, also extending to doft dorsal and anal fins, and imparting black streaks. Pectoral fin with 6–7 rows of minute black dots.

Distribution: Malay Peninsula, Siam, Tenasserim, Burma, Balutschistan, Sri Lanka, Pakistan and India.

Other materials examined: ZSI Cat. No. 397 (163.0 mm SL) Orissa, 2151 (165.0 mm SL) Madras, F. Day Coll.

ORDER : SYNBRANCHIFORMES

SUB ORDER : SYNBRANCHOIDEI

2.4.51. FAMILY : SYNBRANCHIDAE

Characters of taxonomic value: Body cylindrical and elongated. Mouth large, cleft of mouth reaching far behind the level of eye. Teeth present on maxilla, mandible and palate. Scales absent. Lateral line distinct. Dorsal and anal fins and vent in the posterior half of body. Dorsal and anal fins confluent with caudal fin, the latter tapering posteriorly. Pectoral and pelvic fins absent. Gill opening on ventral side of the body.

Three genera, each having only one species were reported from India (Day, 1878) and Indo-Australian

Archipelago (Weber and de Beaufort, 1916). A single genus and species was represented in Sri Lanka waters (Munro, 1955).

Key to genus

Gill membrane confluent, free from isthmus; gills on four arches well developed, gill opening undivided, narrow and restricted to ventral surface .... Synbranchus Bloch.

Synbranchus Bloch, 1795

Synbranchus Bloch, 1795: 53.

A single species is known from India.

Synbranchus bengalensis (Mc Clelland, 1845)
Plate 50.3

Ophisternon bengalensis Mc Clelland, 1845: 197; Kaup, 1856: 121; Bleeker, 1859: 179.

Symbranchus bengalensis Gunther, 1870: 16; Day, 1878: 657; Weber and de Beaufort, 1916: 416; Munro, 1955: 102.

Description: Based on a single specimen, 522.0 mm SL (527.0 mm TL).

Body measurements expressed in percent of standard length: greatest body depth 4.59; head length 10.91; snout to D fin origin 68.19; snout to A fin origin 76.24.

In percent of head length: snout length 9.52; orbit diameter 5.55; least width of interorbital space 8.73.

Body elongated and cylindrical, tail tapering. Head depressed. Snout pointed. Upper jaw slightly overhangs lower jaw. Interorbital space nearly flat. Anterior nostril tube-like and opens on tip of snout, posterior nostril slit-like and situated in front of eye. Gill rakers absent. Teeth in upper jaw small, pointed and continuous at symphysis. A single row of teeth on mandible and palate. Lateral line reaching to caudal peduncle. Origin of dorsal at a level slightly anterior to anal fin origin, the latter commences from behind vent. Caudal fin slightly distinct.

<u>Scales</u>: Absent.

<u>Colour</u>: Dark brown above, yellowish-white below. Very minute dark brown spots on dorsal profile. Dorsal and anal fins black, its margin fringed with dull white.

Distribution: Malay Archipelago, Philippines, East Indies, Sri Lanka and India.

Remarks: The occurrence of *S. bengalensis* was reported from Kayamkulam and Veli lakes of Kerala (Samuel, 1962).

ORDER : PLEURONECTIFORMES

SUB ORDER : PLEURONECTOIDEI

2.4.52. FAMILY : BOTHIDAE

Characters of taxonomic value: Body oval, snout pointed. Preopercular margin free and exposed. Eyes and pigmentation on left side of the head. Mouth terminal, lower jaw prominent. Dorsal fin commences from above or in front of upper eye. Pectoral and pelvic fins present on both sides. Dorsal and anal fins not confluent with caudal fin. Scales cycloid and ctenoid. Lateral line on ocular side single, sometimes branched and arched anteriorly.

Among the fishes of the family Bothidae, fishes of the genus *Pseudorhombus* was only represented in the study area. Day (1878) placed the genus *Pseudorhombus* under the family Pleuronectidae and described 3 species from Indian seas. 11 species were reported under the genus *Pseudorhombus* from the Indo-Pacific region

(Weber and de Beaufort, 1929). Norman (1934) in his comprehensive systematic revision of the family Bothidae recognized 38 genera under 3 subfamilies and also described 24 species under the genus Pseudorhombus, of which at least 10 species were reported from the Seas around India. Saramma (1963) noted two species of this genus from the bottom fishes off Cochin collected by R.V. Conch. Fischer and Whitehead (1974) listed 19 species from the Eastern Indian Ocean and Western Central Pacific. Ramanathan and Natarajan (1980) described 5 species from the Porto Novo waters, South East coast of India. Other taxonomic studies and survey reports of Flounders of the Indo-Pacific area were those of Jordan and Starks (1906), Oshima (1927), Pradhan (1964), Punpoka (1964) and Shen (1967,1969).

Key to sub-family

Pelvic fins short based, nearly symmetrical; pelvic and pectoral fins branched wholly or at its inner and posterior parts .... Paralichthinae.

Sub-family: Paralichthinae

Key to genus

Lat. line equally developed on both sides with supratemporal branch reaching below 9th to 11th dorsal rays; dentition equally developed on both sides; uniserial teeth in both jaws; dorsal and anal fins more or less scaled, scales small on ocular side; lat. line scales more than 58 .... *Pseudorhombus* Bleeker.

Pseudorhombus Bleeker, 1862

Pseudorhombus Bleeker, 1862: 426; Day, 1878: 422; Norman, 1934: 39.

Tetrarhombus Macleay, 1882: 126.

Rhombicus Jordan and Snyder, 1901: 379.

Spinirhombus Oshima, 1927: 137.

Istiorhombus Whitley, 1931: 322.

Key to species

Body depth 47.61–51.54% in SL; anterior dorsal rays not prolonged; ctenoid scales on ocular side and cycloid scales on blind side; gill rakers pointed; teeth 6–14 in lower jaw of blind side; ocular side with purple and dark spots; straight portion of the lat. line with two distinct oval black blotches .... *Pseudorhombus arsius* (Hamilton-Buchanan).

Pseudorhombus arsius (Hamilton-Buchanan)

Plate 51.1

Pleuronectus arsius Hamilton-Buchanan, 1822: 128.

Rhombus lentiginosus Richardson, 1843: 495.

Pseudorhombus russelli Gunther, 1862: 424; Day, 1865: 172.

Pseudorhombus polyspilus Bleeker, 1862: 426; Weber and Beaufort, 1929: 106.

Pseudorhombus arsius Gunther, 1862: 426; Day, 1878: 423; Fowler, 1928: 13; Weber and de Beaufort, 1929: 105; Norman, 1934: 101; Munro, 1955: 259; Fischer and Whitehead, 1924; Ramanathan and Natarajan, 1980: 94.

Description: Based on 15 specimens ranging in size 76.0–210.0 mm SL (92.5–252.0 mm TL).

Fin formula: D. 70–76; A. 52–56; P. 12–13; V. 6; C. 17.

Body measurements expressed in percent of standard length: greatest body depth 47.61–51.54 (M = 49.50); head length 27.20–31.54 (M = 29.40); snout to pectoral fin origin 25.90–30.87 (M = 28.10); snout to pelvic fin origin 21.50–25.83 (M = 24.31); pectoral fin length 15.00–18.45 (M = 17.28); pelvic fin length 10.10–11.84 (M = 10.68); least depth of caudal peduncle 11.84–13.75 (M = 12.31).

In percent of head length: snout length 20.51–24.44 (M = 22.50); orbit diameter 15.23–19.43 (M = 17.33); least width of interorbital space 5.00–6.77 (M = 5.43).

Body oval, snout pointed with a distinct notch in front of upper eye. Mouth asymmetrical. Cleft of mouth very oblique, maxilla strongly developed, extending to vertical below lower eye. Upper eye slightly in advance to lower eye, interorbital space very narrow. Two nostrils in front of lower eye, the anterior one with a filament like flap. Gill rakers on first arch (2-5) + (11-13) = 13-18. Canine teeth in lower jaw of the blind side. Teeth in upper jaw are rather slender and asymmetrical. Lateral line starts from the posterior margin of upper eye and extends upto caudal fin, gets curved above pectoral fin and also have one supratemporal branch at posterior superior margin of opercle, which ends at 9-11 dorsal rays. Dorsal fin origin in front of upper margin of upper eye.

Scales: Lateral line scales 71-78, in transverse series 52-56. Ctenoid scales on ocular side and cycloid scales on blind side. Scales present on the body, fins and head except on interorbital space, snout tips and pectoral fins.

Colour: Uniformly dark brown with numerous dark and purple spots and blotches on ocular side. Scales of ocular side are mottled with dark, thus imparting the black colour. Two very distinct black oval blotches surrounded by white dots in a ring in the straight portion of the lateral line, one at its beginning and other beyond its middle. Dorsal, anal, caudal and pelvic fins brown spotted and dusky. Blind side dull white with yellowish tinge.

Distribution: East African coasts, Gulf of Thailand, South Vietnam, Malay Archipelago to Pacific, Australia, Sri Lanka and India: both east and west coasts including Andamans.

Other material examined: ZSI No. 1187 (159.0 mm SL) Andamans, F. Day Coll.

Remarks: Saramma (1963) reported P. arsius from the bottom fishes off Cochin coast. Ramanathan and Natarajan (1980) placed P. arsius under the family Paralichthyidae.

SUB ORDER : SOLEOIDEI

2.4.53. FAMILY : SOLEIDAE

Characters of taxonomic value: Body elongate or oval. Preopercular margin embedded in the skin, covered with scales. Eyes and pigmentation on right side of head. Mouth terminal or inferior. Dorsal fin commences from above eyes or slightly beyond. Pectoral fin present or absent. Dorsal and anal fins confluent or separated from caudal fin. Scales cycloid or ctenoid. Lateral line single and straight on body, sometimes branched on head.

Following Day's (1878) work on the Flat-fishes of India, Norman (1928) described 17 species under 4 genera in the family Soleidae from Indian waters. Saramma (1963) reported 4 species under 4 genera from the bottom fishes off Cochin collected by R.V.Conch. Fischer and Whitehead (1974) listed 43 species under 12 genera from the Eastern Indian Ocean and Western Central Pacific. 11 species under 8 genera were recently reported from Porto Novo waters, South East Coast of India (Ramanathan and Natarajan, 1980). Other notable works on systematics of fishes of the family Soleidae of the Indo-Pacific area are those of Oshima (1927), Weber and de Beaufort (1929), Pradhan (1964), Punpoka (1964) and Shen (1967, 1969).

<u>Key to genera</u>

1. Snout not forming a distinct hook; dorsal and anal fins not confluent with caudal fin; pectoral fin present and well developed; body with distinct black blotches .... <u>Solea</u> Klein.

Snout not forming a distinct hook; dorsal and anal fins confluent with caudal fin; pectoral fins present, free from opercular membrane .... 2.

2. Body elongate and pointed towards caudal fin; a bony process on snout .... *Synaptura* Cantor.

Body oval and caudal fin rounded, no bony process on snout .... *Brachirus* Swainson.

Solea Klein, 1775

Solea Klein, 1775: 440.

Key to species

Body depth 43.24–47.24% in SL; head length 25.00–29.13% in SL; interorbital space 16.66–18.43% in HL; dorsal with 52–64 rays; anal with 42–47 rays .... *Solea ovata* Richardson.

Solea ovata Richardson, 1846
Plate 51.2

Solea ovata Richardson, 1846: 279; Gunther, 1862: 472; Day, 1878: 426; Norman, 1928: 176; Fischer and Whitehead, 1974; Ramanathan and Natarajan, 1980: 100.

Solea humilis Cantor, 1849: 1201; Gunther, 1862: 471; Bleeker, 1866: 16.

Description: Based on 6 specimens ranging in size 37.0–69.0 mm SL (43.0–83.0 mm TL).

Fin formula: D. 52–64; A. 42–47; P. 6–8 (eyed side); 5–6 (blind side); V. 5; C. 18.

Body measurements expressed in percent of standard length: greatest body depth 43.24–47.24 (M = 45.96); head length 25.00–29.13 (M = 26.92); snout to pectoral fin origin 24.32–28.34 (M = 26.35); snout to pelvic fin origin 20.45–24.32 (M = 22.14); pectoral fin length 9.45–12.87 (M = 11.49); pelvic fin length 5.79–8.66 (M = 7.35); least depth of caudal peduncle 9.67–11.81 (M = 10.77).

In percent of head length: snout length 25.00–29.03 (M = 26.84); orbit diameter 16.66–21.05 (M = 19.40); least width of interorbital space 16.66–18.42 (M = 18.69).

Body oval, snout slightly rounded. Mouth inferior, small and curved. Angle of mouth ending vertical below middle of lower eye. Upper eye slightly advance to lower eye, interorbital space broad and concave. Two tubular nostrils in front of lower eye on ocular side, the anterior one bigger. Dorsal and ventral margins of head and posterior margin of preopercle are having numerous papillae-like structures on blind side. Gill rakers absent. Villiform teeth in bands in jaws. Lateral line simple and straight, extends upto caudal fin base. Pelvic fins present on both side.

Scales: Lateral line scales 96-108, in transverse series 79-85. Ctenoid scales on both sides. Scales present all over the body including in the interorbital space, dorsal, anal, caudal and pectoral fins on ocular side.

Colour: Uniformly dark brownish with numerous dark spots and blotches on ocular side. Blind side dull white. Dorsal, anal and caudal fins brown spotted, dorsal and anal fins distal margin colourless. Distal part of pectoral fin is having a black blotch.

Distribution: Malay Peninsula and Archipelago, Gulf of Thailand, China and India: both east and west coasts.

Other materials examined: ZSI Nos 1091 (86.0 mm SL) Madras, 1094 (49.0 mm SL) Madras, F. Day Coll.

Synaptura Cantor, 1849

Synaptura Cantor, 1849: 241.
Eurypleura Kaup, 1858: 282.

Key to species

Body depth 29.35-30.00% in SL; head length 18.84-20.64% in SL; interorbital space without papilla-like structures, 11.11-12.24% in HL; right pectoral small; .

ocular side is not deeply spotted ....
.... *Synaptura commersoniana* (Lacepede).

Synaptura commersoniana (Lacepede, 1802)

Plate 51.3

Pleuronecte commersonien Lacepede, 1802: 656.

Brachirus commersoni Swainson, 1839: 303; Norman, 1929: 178.

Synaptura commersoniana Cantor, 1850: 1204; Bleeker, 1853: 76; Gunther, 1862: 483; Day, 1878: 428; Weber and de Beaufort, 1929: 108; Fischer and Whitehead, 1974; Ramanathan and Natarajan, 1980: 100.

Synaptura commersoni Jerdon, 1851: 148; Munro, 1955: 262.

Description: Based on 3 specimens ranging in size 109.0–130.0 mm SL (123.0–141.0 mm TL).

Fin formula: D. 72–79; A. 60–64; P. 6–7; V. 3; C. 12.

Body measurements expressed in percent of standard length: greatest body depth 29.35–30.00 (M = 29.67); head length 18.84–20.64 (M = 19.74); snout to pectoral fin origin 18.84–20.64 (M = 19.74).

In percent of head length: snout length 23.33–26.53 (M = 24.93); orbit diameter 18.36–18.88 (M = 18.62);

least width of the interorbital space 11.11-12.24 (M = 11.67).

Body elongate, snout rounded and caudal fin tapering. Anterior part of the snout with bony prominence. Angle of mouth reaching behind vertical below middle of lower eye, lower jaw distinctly fringed. Upper eye advance to lower eye, interorbital space narrow and concave. Two tubular nostrils situated in front of lower eye on ocular side. Numerous papillae-like structures on the posterior margin of opercle, dorsal and ventral margins of head on blind side. 4-5 papillae-like structures on the posterior margin of opercle on ocular side. Gill rakers absent. Very small teeth in rows in left jaw. Pectoral and pelvic fins present on both side.

Scales: Lateral line scales 158-162; in transverse series 86-90. Ctenoid scales on ocular side, cycloid scales on blind side. Scales present all over the body and head including interorbital space and caudal fin base.

Colour: Uniformly brown with faint blotches on ocular side. Blind side dull white. Dorsal, anal, caudal and pectoral fins very blackish, fringed with white at the distal margins.

Distribution: Gulf of Thailand, Malay Archipelago, Sri Lanka and India: both east and west coasts.

Other materials examined: ZSI No. 1150 (277.0 mm SL) South Canara, F. Day Coll.

Brachirus Swainson, 1839

Brachirus Swainson, 1839: 303.
Euryglossa Kaup, 1858: 99.

Key to species

Body depth 48.41–52.50% in SL; head length 21.66–24.69% in SL; interorbital space with papillae-like structures, 11.26–14.28% in HL; dorsal with 64–67 rays; anal with 48–52 rays .... Brachirus orientalis (Bloch and Schneider).

Brachirus orientalis (Bloch and Schneider, 1801) Plate 52.1

Pleuronectus orientalis Bloch and Schneider, 1801: 157.
Brachirus orientalis Swainson, 1839: 303; Norman, 1928: 179; Munro, 1955: 263; Ramanathan and Natarajan, 1980: 99.
Solea foliacea Richardson, 1845: 279.
Euryglossa orientalis Kaup, 1858: 99; Fischer and Whitehead, 1974.

<u>*Synaptura orientalis*</u> Gunther, 1862: 484; Day, 1878: 429; Weber and de Beaufort, 1929: 175.

<u>Description</u>: Based on 20 specimens ranging in size 60.0-164.0 mm SL (69.0-188.0 mm TL).

<u>Fin formula</u>: D. 64-67; A. 48-52; P. 8; V. 5; C. 17.

Body measurements expressed in percent of standard length: greatest body depth 48.41-52.50 (M = 49.52); head length 21.66-24.69 (M = 22.33); snout to pectoral fin origin 20.12-24.69 (M = 22.01); snout to pelvic fin origin 17.09-22.53 (M = 18.68); pectoral fin length 7.31-9.16 (M = 8.45); pelvic fin length 5.79-8.33 (M = 6.87).

In percent of head length: snout length 25.37-32.14 (M = 28.79); orbit diameter 13.63-21.05 (M = 16.42); least width of interorbital space 11.26-14.28 (M = 12.43).

Body oval, mouth small. Snout rounded. Angle of mouth reaching to vertical below middle of lower eye. Upper eye slightly in advance to lower eye, interorbital space narrow, concave with papillae-like structures which are in continuation from snout. Lower jaw fringed. Two tubular nostrils in front of lower eye on ocular side.

8-10 irregular groups of papillae-like structures on the body. Gill rakers absent. Villiform teeth in bands in jaws. Lateral line branched, present on both sides. Pelvic fins present on both sides, united basally.

<u>Scales</u>: Lateral line scales 79-84; in transverse series 59-62, ctenoid scales with barbels or papillae on both sides. Scales present all over the body and head, including in the interorbital space, dorsal, anal, caudal and pectoral fins base.

<u>Colour</u>: Body uniformly dark brown with 8-10 vertical black blotches on ocular side. Blind side dull white with yellow tinge. Dorsal, anal and caudal fins dusky black. Pectoral fin black.

<u>Distribution</u>: Persian Gulf, Malay Archipelago to China, Australia, Sri Lanka and India: both east and west coasts.

<u>Other materials examined</u>: ZSI Nos. Cat. 457 (74.0 mm SL) South Canara, F. Day Coll; F 1841/1 (69.0 mm SL) Karachi, L.D. Cumming Coll.

2.4.54. <u>FAMILY : CYNOGLOSSIDAE</u>

<u>Characters of taxonomic value</u>: Body elongate and posteriorly pointed. Preopercular margin embedded in

the skin. Eyes and pigmentation on left side of the head. Mouth anterior or inferior, jaws strongly asymmetrical. Two nostrils, the anterior one tubular. Dorsal fin commences from vertical above eyes. Pectoral fin absent. Pelvic fin absent on eyed side. Dorsal and anal fins confluent with caudal fin. Scales cycloid or ctenoid.

Family Cynoglossidae is composed of three genera, of which fishes of the genus Cynoglossus alone was represented in Vembanad lake. Day (1878) reported 10 species under the genus Cynoglossus from Indian Seas and Weber and de Beaufort (1928) recorded 23 species from Indo-Australian Archipelago. Norman (1928) in his comprehensive work on Flat-fishes of India, described 21 species of fishes under the genus Cynoglossus. Fischer and Whitehead (1974) listed 18 species of this genus from Eastern Indian Ocean and Western Central Pacific. The monumental monograph of the tongue soles of the genus Cynoglossus was prepared by Menon (1977), which solved the disparities existed on taxonomic position of many species of this genus. Recently, Ramanathan and Natarajan (1980) reported 5 species under the genus Cynoglossus from Porto Novo waters, South East coast of India. Other significant revision studies and reports of fishes of the above genus from the Indo-Pacific region were those of Munro (1955), Pradhan (1964), Punpoka (1964), Nijssen (1966), Shen (1967,1969) and Menon (1971).

Key to genus

Two or three lat. lines on ocular side; pelvic fin confluent with anal fin; lips not fringed; mouth inferior; rostrum hooked .... Cynoglossus Hamilton-Buchanan.

Cynoglossus Hamilton-Buchanan, 1822

Cynoglossus Hamilton-Buchanan, 1822: 32.
Cantoria Kaup, 1858: 106.
Arelia Kaup, 1858: 109.
Areliscus Jordan and Snyder, 1900: 380.
Cynoglossoides Bonde, 1922: 23.
Dollfusichthys Chabanaud, 1931: 304.
Dexiourius Chabanaud, 1947: 443.

Key to species

Blind side with cycloid scales and two lat. lines; rictus of mouth nearer to gill opening than to snout; 15-16 scales between the lat. line on ocular side; 12 caudal fin rays; body depth 24.85-26.81% in SL; body without black spots or irregular and incomplete cross bands .... *Cynoglossus bilineatus* (Lacepede).

Blind side with ctenoid scales and no lat. line; rictus of mouth nearer to snout than gill opening; 17-20 scales between lat. line on ocular side; 10 caudal fin rays; body depth 27.27-31.57% in SL; body with black spots or irregular and incomplete cross bands .... *Cynoglossus puncticeps* (Richardson).

Cynoglossus bilineatus Lacepede, 1802

Plate 52.2

Archirus bilineatus Lacepede, 1802: 6.

Cynoglossus bilineatus Ogilby, 1910: 39; Norman, 1928: 198; Weber and de Beaufort, 1929: 194; Munro, 1955: 264; Fischer and Whitehead, 1974; Menon, 1977: 36.

Plagusia quadrilineata Bleeker, 1851: 412.

Cynoglossus quadrilineatus Gunther, 1862: 497; Bleeker, 1875: 32; Day, 1878: 435.

Cynoglossus quinequelineatus Day, 1878: 432.

Cynoglossus sindensis Day, 1878: 434.

Description: Based on 11 specimens ranging in size 173.0-295.0 mm SL (185.0-305.0 mm TL).

Fin formula: D. 106-109; A. 84-88; V. 4; C. 12.

Body measurements expressed in percent of standard length: greatest body depth 24.85–26.81 (M = 25.66); head length 21.01–23.69 (M = 22.68).

In percent of head length: snout length 33.33–36.52 (M = 34.71); orbit diameter 8.53–10.71 (M = 9.96); least width of interorbital space 6.09–7.55 (M = 6.97).

Body elongate, snout rounded. Rostral hook ends before vertical down to anterior nostril. Angle of mouth ending little beyond below vertical to posterior margin of lower eye, nearer to gill opening than to tip of snout. Upper eye slightly advance than lower eye, interorbital space concave. Anterior nostril tubular, placed in front of the lower eye. Posterior nostril slit like, between the orbits. Gill rakers absent. Minute teeth on jaws. Two lateral lines on ocular side, connected them at nape. Lateral line branches are seen in the head. Two lateral lines on blind side.

Scales: Lateral line scales 89–96; in transeverse series 4 –45, between the lateral lines 15–16 on ocular side. Scales of ocular side ctenoid except on lateral line. Cycloid scales on blind side and on lateral line.

Colour: Uniformly brownish on ocular side, dull white on blind side. Opercle is having irregular dark patches at its distal part.

Distribution: Malay Archipelago, Thailand, Japan, Australia, Sri Lanka, Pakistan and India: east and west coasts.

Other materials examined: ZSI No. 1145 (160.0 mm SL) Madras, F. Day Coll.

Remarks: Saramma (1963) reported *C. bilineatus* from the bottom fishes off Cochin, collected by R.V.Conch. Seshappa (1972) observed that in *C. bilineatus* the number of dorsal rays varied from 108-112 and anal rays 86-89. Menon's (1977) description showed much variation in anal rays count (80-88).

Cynoglossus puncticeps (Richardson, 1846)
Plate 52.3

Plagusia puncticeps Richardson, 1846: 280; Whitehead, 1969: 218.

Cynoglossus puncticeps Gunther, 1862: 500; Bleeker, 1875: 37; Norman, 1928: 205; Weber and de Beaufort, 1929: 198; Fowler, 1934: 2[illegible]; Munro, 1955: 265; Fischer and Whitehead, 1974; Menon, 1977: 75; Ramanathan and Natarajan, 1980: 102.

__Plagusia nigrolabeculata__ Richardson, 1846: 280

__Cynoglossus brachyrhynchus__ Gunther, 1862: 499; Bleeker, 1875: 37; Day, 1878: 435.

__Cynoglossus brevis__ Gunther, 1862: 500; Day, 1878: 437.

__Description:__ Based on 20 specimens ranging in size 66.0-180.0 mm SL (70.0-195.0 mm TL).

__Fin formula:__ D. 97-101; A. 74-80; V. 4; C. 10.

Body measurements expressed in percent of standard length: greatest body depth 27.27-31.57 (M = 29.62); head length 18.79-23.94 (M = 21.67).

In percent of head length: snout length 26.66-33.33 (M = 29.84); orbit diameter 9.43-12.12 (M = 10.73); least width of interorbital space 5.80-8.51 (M = 7.14).

Body elongate, snout slightly rounded. Rostral hook short, ends before vertical down to anterior nostril. Angle of mouth ending below posterior border of lower eye, little nearer to tip of snout than to gill opening. Upper eyes slightly advanc than lower eye, interorbital space concave. Anterior nostril tubular placed in front of lower eye. Posterior nostril slit-like, in the interorbital space. Gill rakers absent. Teeth very small in jaws. Two lateral lines on ocular side, connected them at the nape region. Lateral line branches seen on opercle. No lateral line of blind side.

Scales: Lateral line scales 91-1.3, in transverse series 44-47, between the lateral lines 17-20. Ctenoid scales present on both sides. Scales present all over the body including caudal fin base and interorbital space of the ocular side.

Colour: *C. puncticeps* showed variation in pigmentation pattern so that it shows colour dimorphism. Usually the head and body of the ocular side is dark brownish with numerous black spots. The dorsal and anal fins are dusky black with brown spots. In some specimens the black spots are appearing like irregular vertical bands on head and body of the ocular side. Some of the rays of dorsal and anal fins are black coloured. The blind side is dull white.

Distribution: Malay Archipelago to Philippines, Gulf of Thailand, South China, Australia, Sri Lanka and India: both east and west coasts.

Other materials examined: ZSI Nos. 1147 (140.0 mm SL) Calicut, 1148 (128.0 mm SL) Bombay, 2693 (140.0 mm SL) Madras, F. Day Coll.

Remarks: The available description of *C. puncticeps* showed that the number of rays in both dorsal and anal fins are highly variable. Seshappa (1972) conducted the morphometric studies on _C. puncticeps_ from the west coast of India and observed that the number of dorsal rays varied from 96–103 with 36.7% of specimens had 101 rays, which was the highest frequency. Similarly, the anal rays varied from 75–81 and 79.3% of the total specimens examined had 77–79 rays. Comparatively lesser number of dorsal (90–100) and anal (72–78) rays were reported by Menon (1977) in his monograph. Ramanathan and Natarajan (1980) accounted the highest fin rays count (96–109) in dorsal fin.

ORDER : TETRAODONTIFORMES

SUB ORDER : BALISTOIDEI

2.4.55. FAMILY : TRIACANTHIDAE

Characters of taxonomic value: Body well compressed. Caudal peduncle long, tapering towards the base of caudal fin. Snout pointed. Mouth terminal. Teeth in two series in jaws, inner series rounded and those of outer series incisor like. Gill opening restricted. Scales small and ridged. Nasal pit present. No lateral line. Two dorsal fins, first with 5 spines. Pelvic fin with one strong spine. Caudal fin forked.

the study area. A brief review on Triacanthid fishes show that Day (1878) reported two species from India, Munro (1955) noted 2 species from Sri Lanka waters, Beaufort and Briggs (1962) described 5 species from Indo-Australian Archipelago and Jones and Kumaran (1980) reported 3 species from Laccadive Archipelago.

Key to genus

Second dorsal spine not more than half of first; tip of dorsal and ventral spines covered with integument; scales with a prominent spinule on top of a cruciform ridge .... Triacanthus (Cuvier).

Triacanthus (Cuvier, 1817)

Triacanthus Cuvier, 1817: 153.

Key to species

Body depth 32.35-50.00% in SL; snout not much produced; upper profile nearly straight; pelvis between ventral spines scarcely narrow behind; interorbital space with a median ridge; membrane between spinous dorsalfin blackish .... Triacanthus brevirostris Schlegel.

Triacanthus brevirostris Schlegel, 1850
Plate 53.1

Triacanthus brevirostris Schlegel, 1850: 294; Gunther, 1870: 209; Day, 1878: 685; Beaufort and Briggs, 1962: 273; Munro, 1955: 273.

__Description__: Based on 15 specimens ranging in size 36.0-169.0 mm SL (47.0-215.0 mm TL).

__Fin formula__: D.V, 24-25; A. 19-20; P. 14; V. I; C. 16.

Body measurements expressed in percent of standard length: greatest body depth 32.35-50.00 (M = 35.23); head length 27.51-31.25 (M = 29.70); snout to D_1 fin origin 35.50-42.50 (M = 38.70); snout to D_2 fin origin 52.80-58.75 (M = 56.63); snout to A fin origin 59.39-62.88 (M = 61.30); snout to pectoral fin origin 29.77-33.75 (M = 32.24); snout to pelvic fin origin 33.14-40.00 (M = 35.84); base D_2 fin 26.63-29.31 (M = 27.86); base A fin 18.93-22.50 (M = 20.49); pectoral fin length 9.55-12.50 M = 11.29); longest D spine (1st) 25.49-35.39 (M = 29.43); ventral spine length 20.41-27.77 (M = 23.70); least depth of caudal peduncle 4.14-5.50 (M = 4.63).

In percent of head length: snout length 58.06-60.00 (M = 58.19); orbit diameter 27.95-32.72 (M = 29.89); least width of interorbital space 27.77-35.48 (M = 30.99).

Body rhombic and well compressed. Hind end of maxilla not visible. Interorbital space broad, concave with a median ridge. Gill rakers on first arch (3-4) + (12-13) = 15-17. Jaws having two series of teeth, outer series with 10 incisor like teeth in both jaws. Inner series with obtusely rounded teeth, 6 in upper jaw and 2 in lower jaw. First dorsal spine very strong. Pectoral fin rounded. Pelvis between ventral spines rather broad. Caudal fin deeply forked.

Scales: Very small rough, ridged scales present on head, body and spines.

Colour: Dorsal profile silvery-dusky with golden tinge, ventral profile silvery. Nape, interorbital space and upper margin of caudal peduncle blackish. Orbital margin red. Basal part of spinous membrane blackish. Soft dorsal, caudal, anal and pectoral fins yellowish. Pelvic fin colourless.

Distribution: China, Korea, Admirality Islands, Thailand, Philippines, Sri Lanka, coasts of India including Laccadives.

Other material examined: ZSI No. 2243 (144.0 mm SL) Madras, F. Day Coll.

SUB ORDER : TETRAODONTOIDEI

2.4.56. FAMILY : TETRAODONTIDAE

Characters of taxonomic value: Body short and oval. Mouth terminal. Teeth fused into two plates on each jaw, with a median suture and forming a powerful beak. A single nostril on each side, often with two fleshy flaps. Body without scales, or with spines. Dorsal and anal fins short and without spines. Pelvic fin absent. Caudal fin emarginate or truncate.

A brief review on the literature on the fishes of the family Tetraodontidae shows that Day (1878) described 16 species of puffer fishes under the genus *Tetradon* from Indian waters. Munro (1955) recognized 3 genera from Sri Lanka waters and reported 10 species. 33 species under 6 genera were described from Indo-Australian Archipelago (Beaufort and Briggs, 1962). Jones and Kumaran (1980) reported 5 species under the genus *Tetraodon* from the Laccadive Archipelago.

Key to genera

Nasal organ in a depression surrounded by a lower rim, produced into a posterior and anterior flap; sides without spines .... *Chelonodon* Muller.

Nasal organ a single or bifid elevated tube; sides with spines .... Tetraodon Linnaeus.

Chelonodon Muller, 1839

Chelonodon Muller, 1839: 252.

A single species is known from Indo-Pacific area (Beaufort and Briggs, 1962).

Chelonodon patoca (Hamilton-Buchanan, 1822)
Plate 53.2

Tetrodon patoca Hamilton-Buchanan, 1822: 7; Guncher, 1870: 283; Day, 1878: 703.

Chelonodon patoca Herre, 1924: 487; Fowler, 1928: 472; Munro, 1955: 282; Beaufort and Briggs, 1962: 390.

Description: Based on 20 specimens ranging in size 22.0-60.0 mm SL (29.0-73.0 mm TL).

Fin formula: D. 9; A. 7; P. 16; C. 11.

Body measurements expressed in percent of standard length: greatest body depth 40.00-58.53 (M = 47.05); head length 35.65-42.66 (M = 37.96); snout to D fin origin 70.49-77.77 (M = 73.44); snout to A fin origin 70.96-75.67 (M = 73.39); snout to pectoral fin origin 39.09-47.05 (M = 42.39); base D fin 6.55-10.66 (M = 8.25);

base A fin 5.21–7.40 (M = 6.23); D fin height 15.45–20.83 (M = 18.14); A fin height 15.17–20.37 (M = 17.30); pectoral fin length 13.54–18.51 (M = 15.76); least depth of caudal peduncle 11.40–13.91 (M = 12.19).

In percent of head length: snout length 40.74–50.00 (M = 45.74); orbit diameter 23.80–30.23 (M = 27.59); least width of interorbital space 50.09–60.00 (M = 53.09).

Body anteriorly cylindrical and posteriorly compressed. The lower margin of eye in level with mouth. Interorbital space flat. A single nostril on each side, in a depression with two flaps anteriorly and posteriorly. Gill rakers nearly rudimentary, 5–7 on first gill arch. The upper lateral line bends down below dorsal fin, reaching to caudal fin base. Lower lateral line distinct from vertical above vent tocaudal fin base. Dorsal and anal fins rounded. Caudal fin truncate.

Spines: Present from head to origin of first dorsal on back and from pectoral fin to vent on the ventral region.

Colour: Greenish-black on back, dull white below. 4 dark cross bands on dorsal profile. Back and sides with white spots. All fins except caudal yellowish. Caudal fin dusky black.

Distribution: East coast of Africa, Madagascar, Gulf of Iran, China, Philippines, Australia, Trobiand Islands, Admirality Islands, Sri Lanka and coasts of India including Andamans.

Other materials examined: ZSI No. 1190/2 (112.0 mm SL) Madras, A.G.K.Menon Coll.

Tetraodon Linnaeus, 1758

Tetraodon Linnaeus, 1758: 15.

Key to species

D. 13-14; A. 10-12; P. 22; dorsal and anal rounded; back, sides and caudal with large black blotches ... . Tetraodon fluviatilis (Hamilton-Buchanan).

D. 10; A. 8; P. 17-18; dorsal and anal high and angular; sides black enclosing irregular white spots; caudal with white spots forming transverse bands and basal black lateral streak .... Tetraodon leopardus Day.

Tetraodon fluviatilis Hamilton-Buchanan, 1822
Plate 54.1

Tetradon fluviatilis Hamilton-Buchanan, 1822: 6; Guncher, 1870: 299; Day, 1878: 707.

Chelonodon fluviatilis Munro, 1955: 282.

Tetraodon fluviatilis Beaufort and Briggs, 1962: 395.

Description: Based on 7 specimens ranging in the size 95.0–117.0 mm SL (119.0–146.0 mm TL).

Fin formula: D. 13–14; A. 10–12; P. 22; C. 10.

Body measurements in percent of standard length: greatest body depth 39.47–46.15 (M = 44.24); head length 36.18–36.75 (M = 36.50); snout to D fin origin 69.34–73.66 (M = 72.02); snout to A fin origin 71.79–72.63 (M = 72.28); snout to pectoral fin origin 37.18–39.73 (M = 38.75); base D fin 11.57–14.95 (M = 13.25); base A fin 10.00–11.16 (M = 10.47); D fin height 14.73–17.09 (M = 16.50); A fin height 16.58–19.65 (M = 17.80); pectoral fin length 13.56–16.23 (M = 15.06); least depth of caudal peduncle 15.57–17.09 (M = 15.95).

In percent of head length: snout length 39.13–44.80 (M = 41.80); orbit diameter 20.73–24.63 (M = 21.57); least width of interorbital space 60.86–67.53 (M = 63.86).

Body globular, caudal region compressed. Eye in level with mouth. Interorbital space flat. A single nostril on each side, two oval flaps in a stem. Gill rakers nearly rudimentary, 9–10 on first arch. The upper lateral line arched, reaching to caudal fin base. Lower lateral line visible from vertical above vent to caudal peduncle. Dorsal and anal fins rounded. Caudal fin truncate.

Spines: Indistinct spines on posterior part of the head on back and sides. Very distinct spines on belly.

Colour: Brownish-black above, yellowish-white below. Back, sides of the body, abdomen and caudal fin with very conspicuous large black blotches. Other fins yellowish.

Distribution: Philippines, Malay Peninsula, Siam, Burma, Sri Lanka and coasts of India including Andamans.

Other materials examined: ZSI No. 2704 (94.0 mm SL) Madras, F. Day Coll.

Tetraodon leopardus Day, 1878
Plate 54.2

Tetrodon leopardus Day, 1878: 706.
Arothron leopardus Munro, 1955: 282.

Description: Based on 4 specimens ranging in size 73.0-82.0 mm SL (92.0-103.0 mm TL).

Fin formula: D. 10; A. 8; P. 17-18; C. 8.

Body measurements expressed in percent of standard length: greatest body depth 34.01–35.61 (M = 34,58); head length 34.01–34.93 (M = 34.36); snout to D fin origin 66.66–69.86 (M = 68.67); snout to A fin origin 71.23–74.82 (M = 73.48); snout to pectoral fin origin 35.97–38.35 (M = 37.01); base D fin 9.52–10.27 (M = 9.84); base A fin 6.70–8.16 (M = 7.23); D fin height 19.72–20.73 (M = 20.10); A fin height 17.80–18.36 (M = 18.35); pectoral fin length 13.60–15.06 (M = 14.43); least depth of caudal peduncle 13.69–14.28 (M = 14.01).

In percent of head length: snout length 42.85–45.09 (M = 43.21); orbit diameter 25.49–30.35 (M = 27.74); least width of interorbital space 60.00–60.78 (M = 60.49).

Body slightly elongated, anteriorly cylindrical and posteriorly compressed. Eye in level with mouth. Interorbital space flat. A single nostril on each side, two flaps joined at the base. Gill rakers very small structures, 8–9 on first gill arch. The upper lateral line arched, reaching to caudal peduncle. Lower lateral line distinct from vertical above vent to caudal peduncle. Dorsal and anal fins high and angular. Caudal fin truncate.

Spines: Indistinct spines on back, sides and belly.

Colour: Greenish-black on back, dull white below. Sides black enclosing irregular white spots. Caudal fin with round white spots, forming transverse bands. A basal black lateral streak on caudal fin. Other fins yellowish.

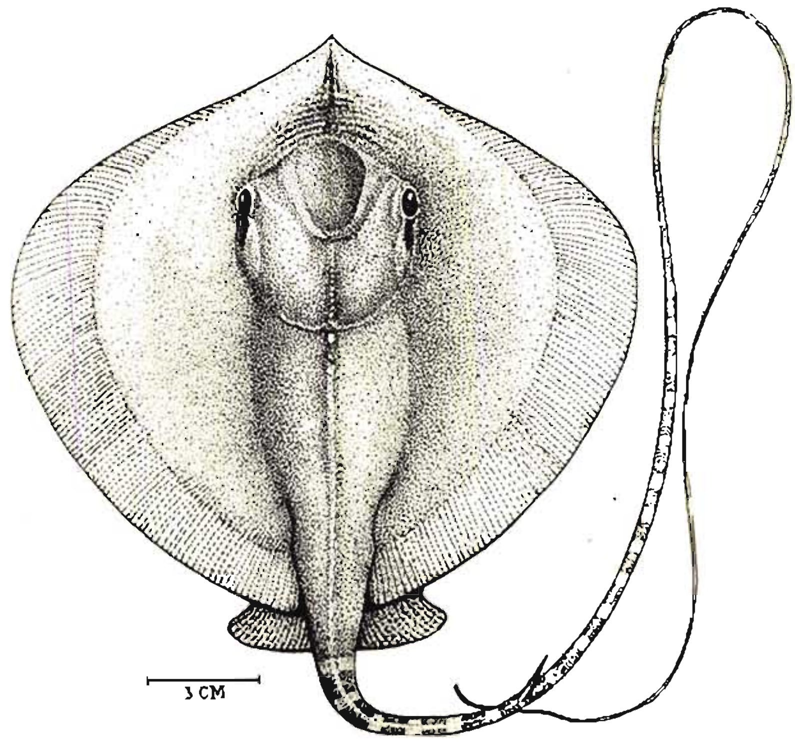
Distribution: Sri Lanka and coasts of India.

Other materials examined: ZSI No. F 2370/2 (72.0-75.0 mm SL, 4 eg) Madras, ZSI, Madras Coll.

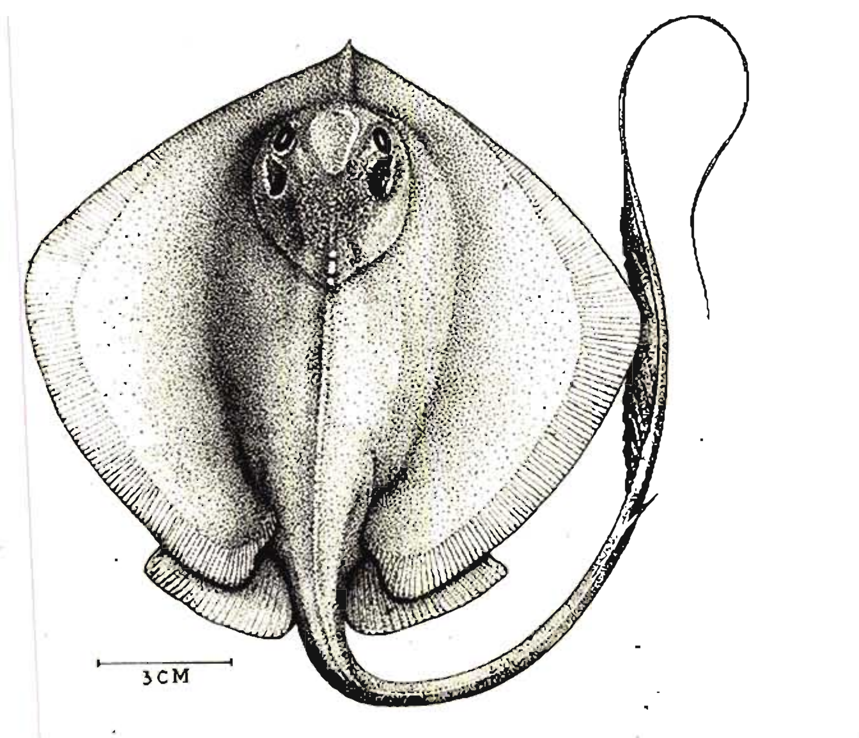
Plate 2.1. *Dasyatis* (*Himantura*) *uarnak*

2. *Dasyatis* (*Pastinachus*) *sephen*

PLATE 2



1

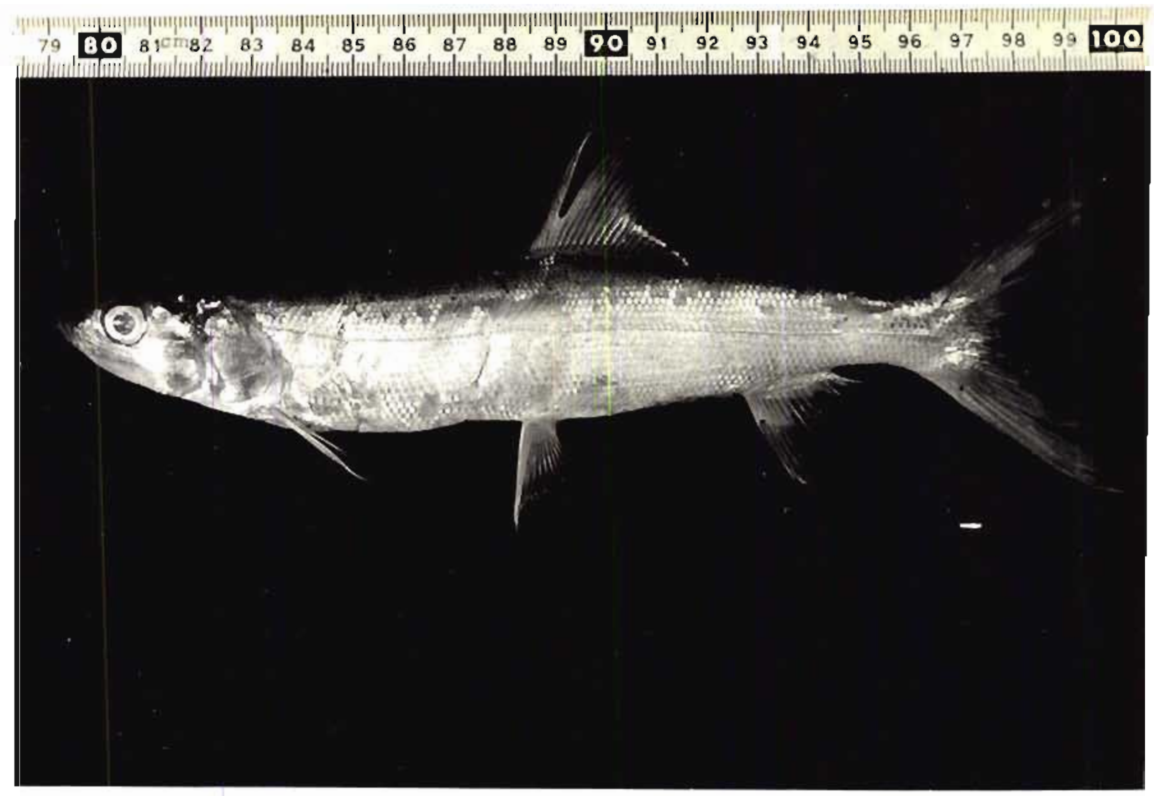


2

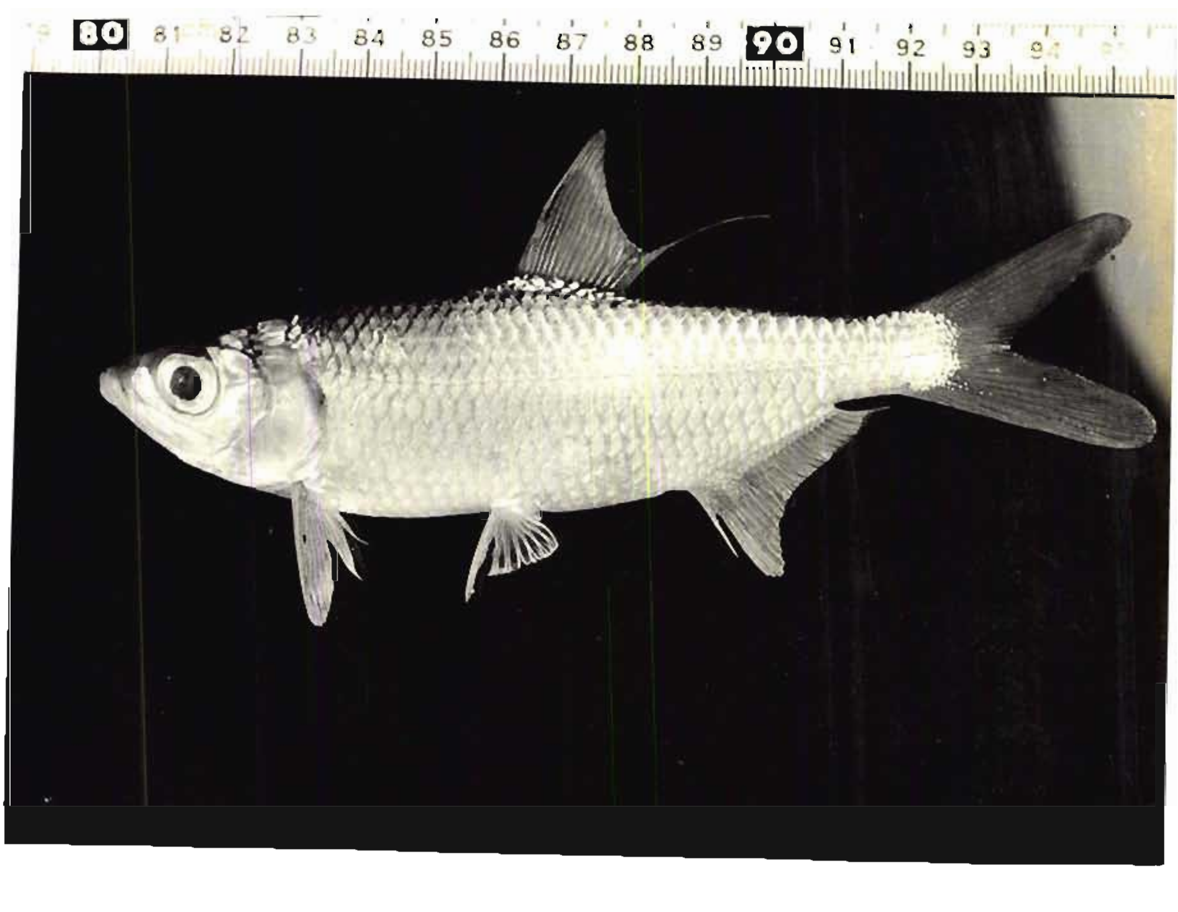
Plate 3.1. *Elops machnata*

2. *Megalops cyprinoides*

PLATE 3



1



2

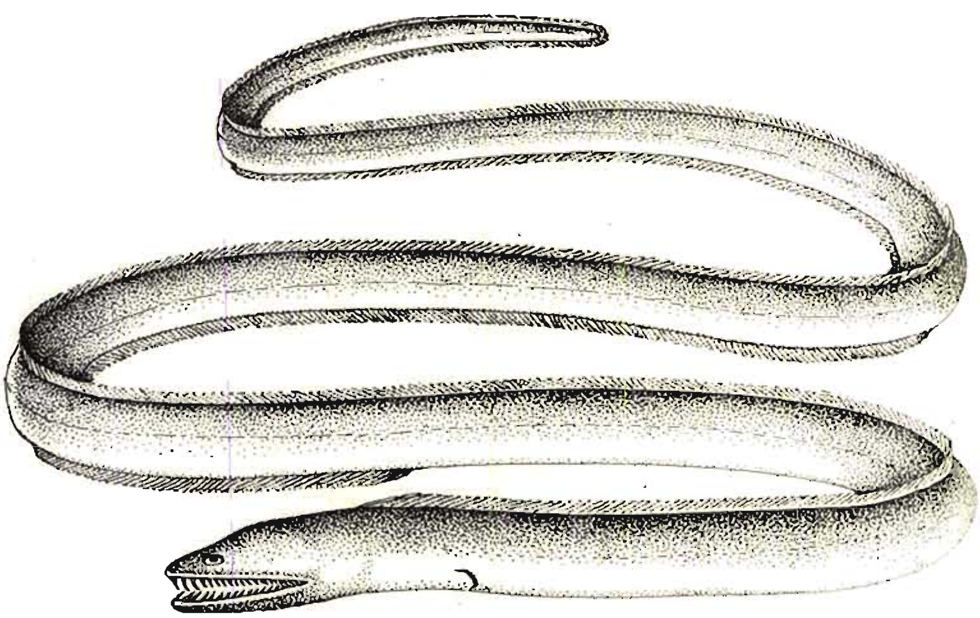
Plate 4.1. *Anguilla bicolor bicolor*

2. *Thyrsoidea macrurus*

PLATE 4

1

4CM



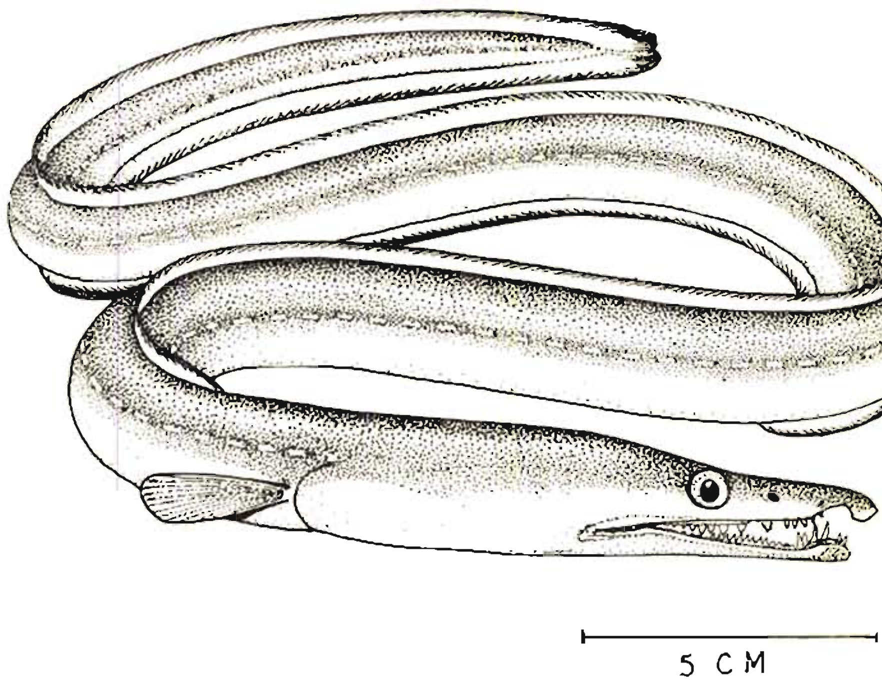
2

9.5CM

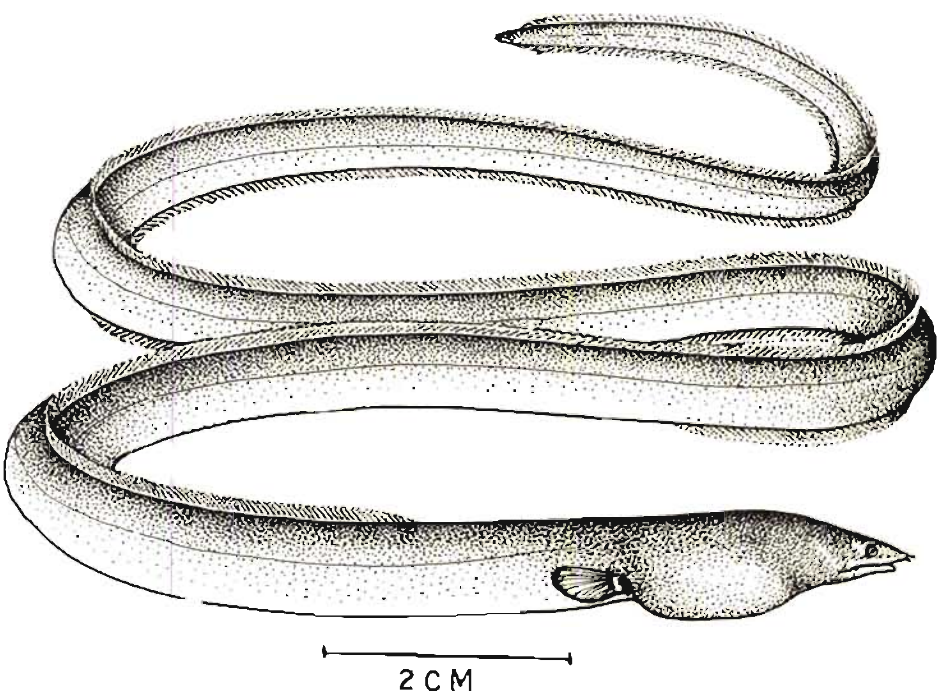
Plate 5.1. _Muraenesox bagio_

2. _Pisoodonophis boro_

PLATE 5



1

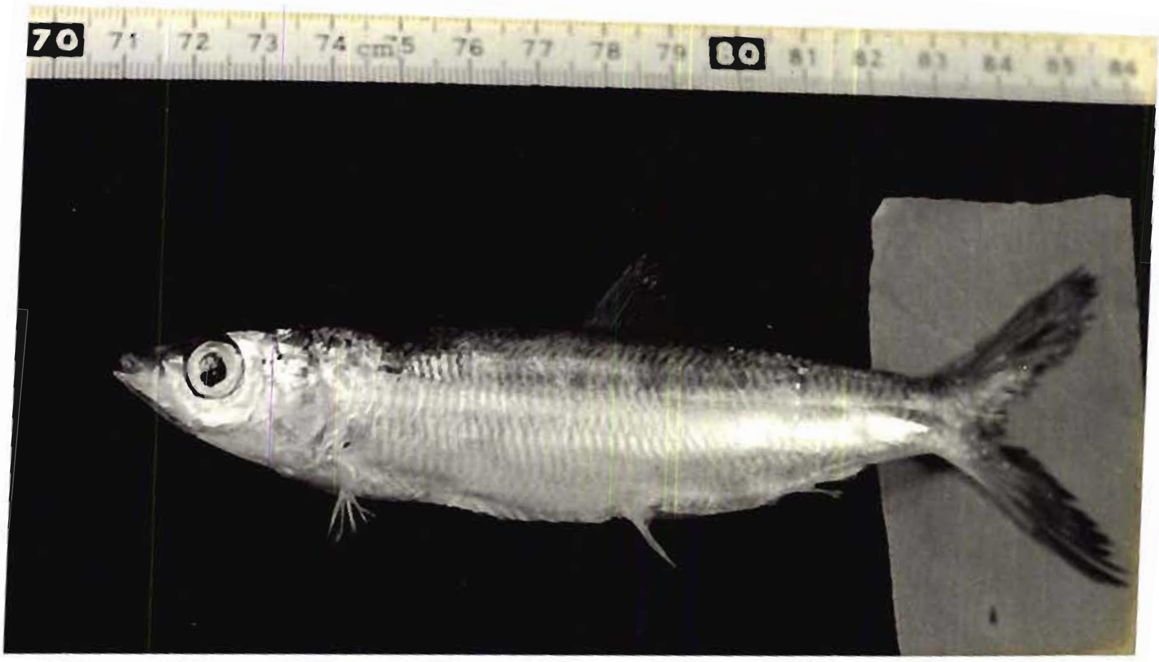


2

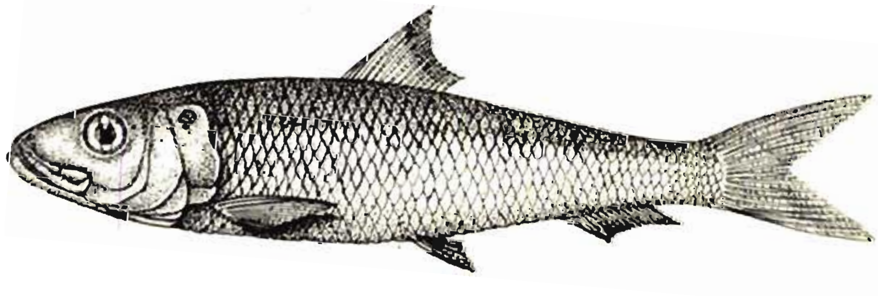
Plate 6.1. _Dussumieria acuta_

2. _Sardinella_ (_Sardinella_) _longiceps_

PLATE 6



1



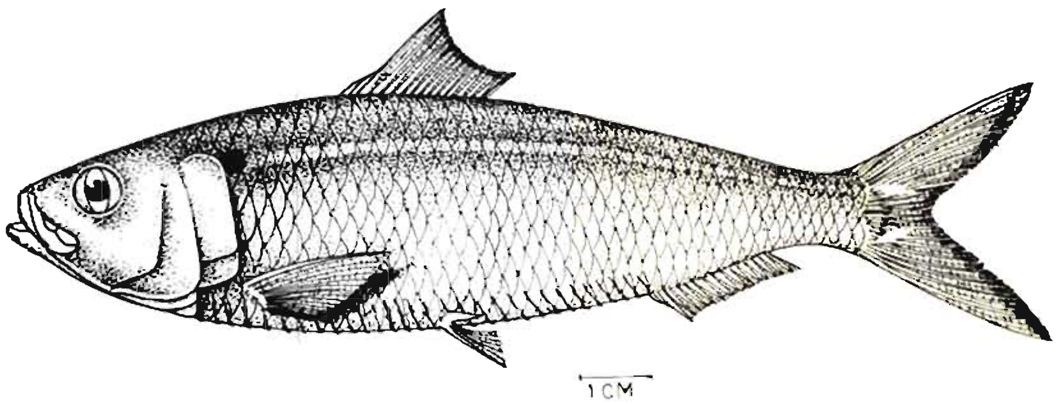
2

1CM

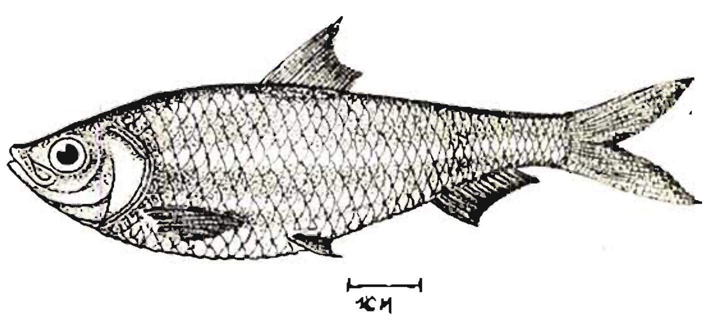
Plate 7.1. *Sardinella (Clupeonia) gibbosa*

2. *Escualosa thoracata*

PLATE 7



1

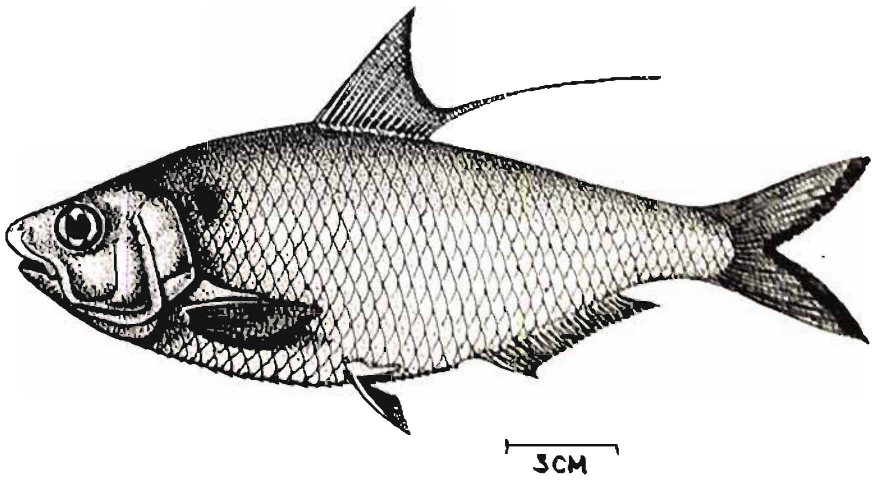


2

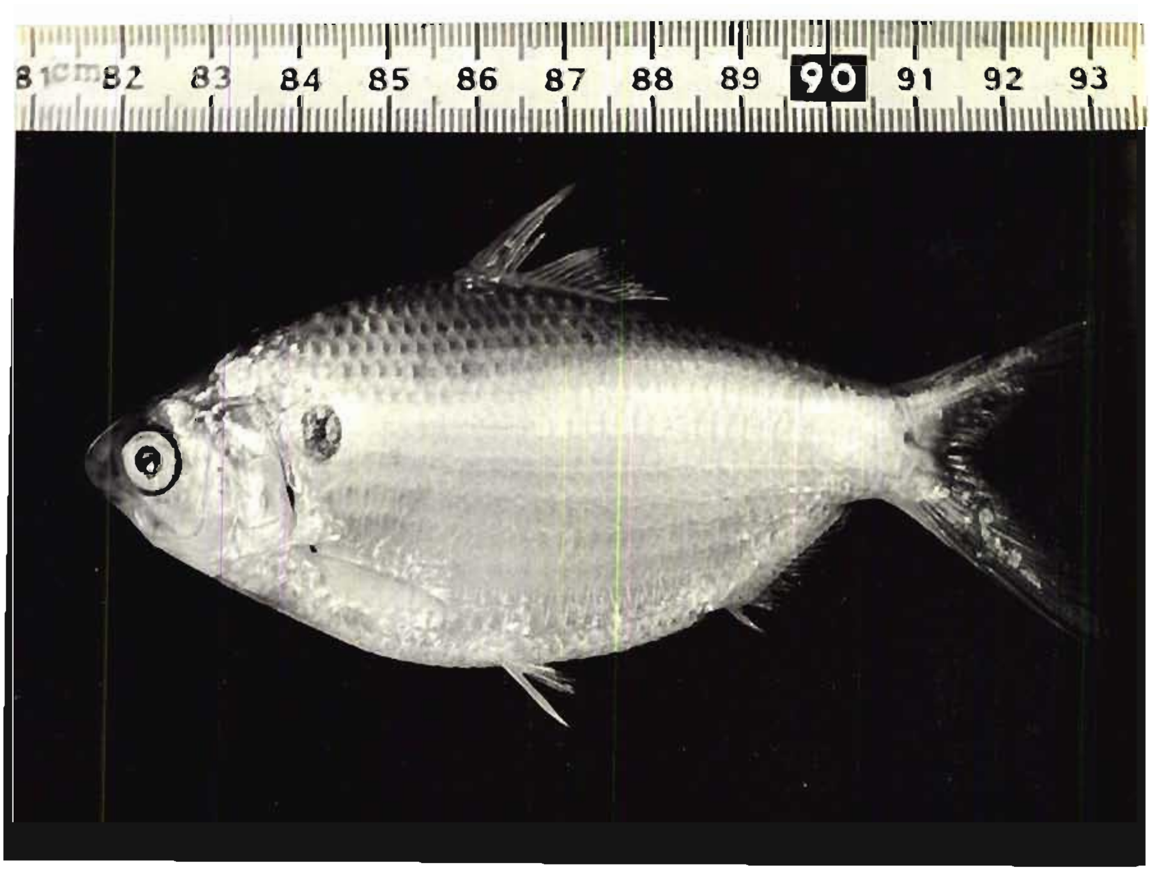
Plate 8.1. _Nematalosa nasus_

2. _Anodontostoma chacunda_

PLATE 8



1

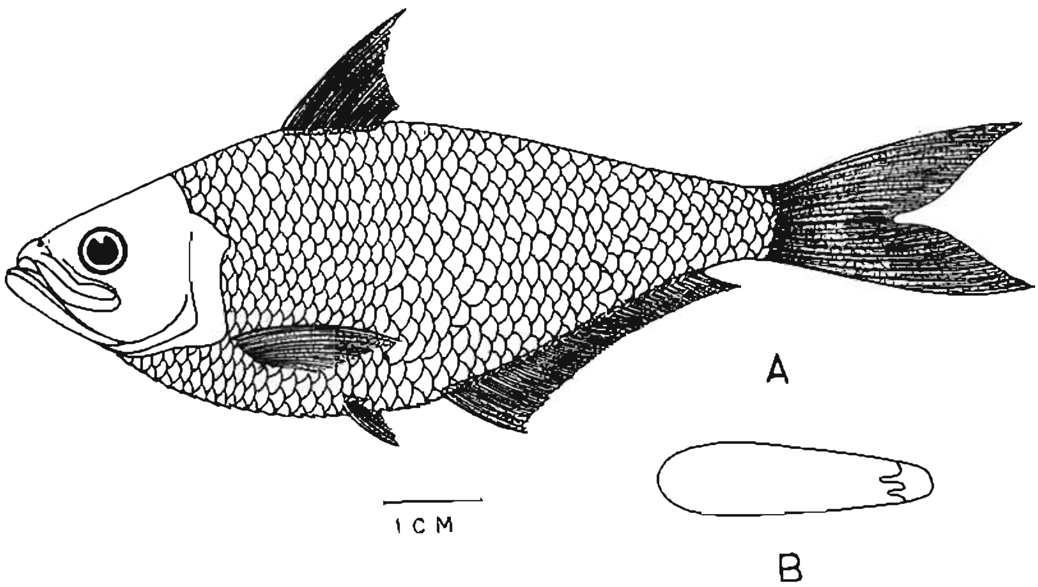


2

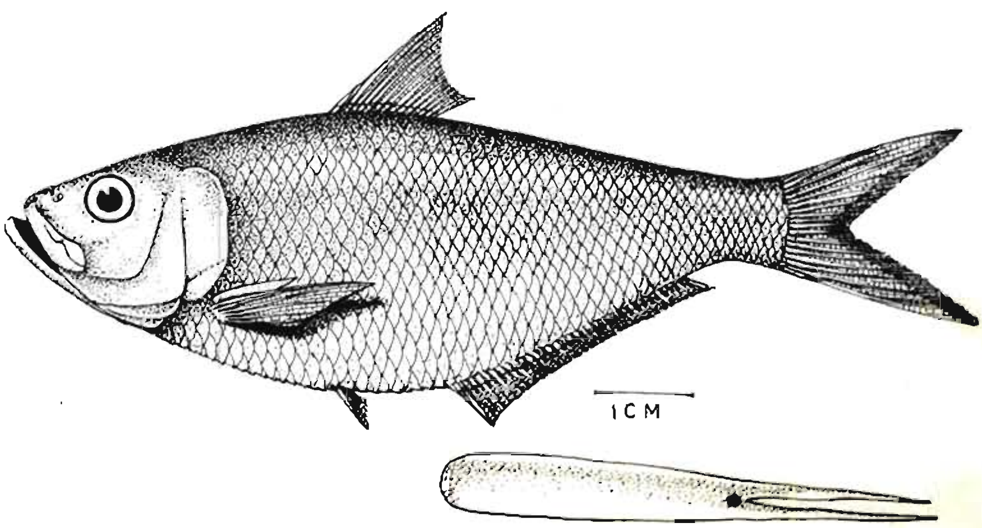
Plate 9.1. *Ilisha sirishai*

2. *Ilisha melastoma*

PLATE 9



1



2

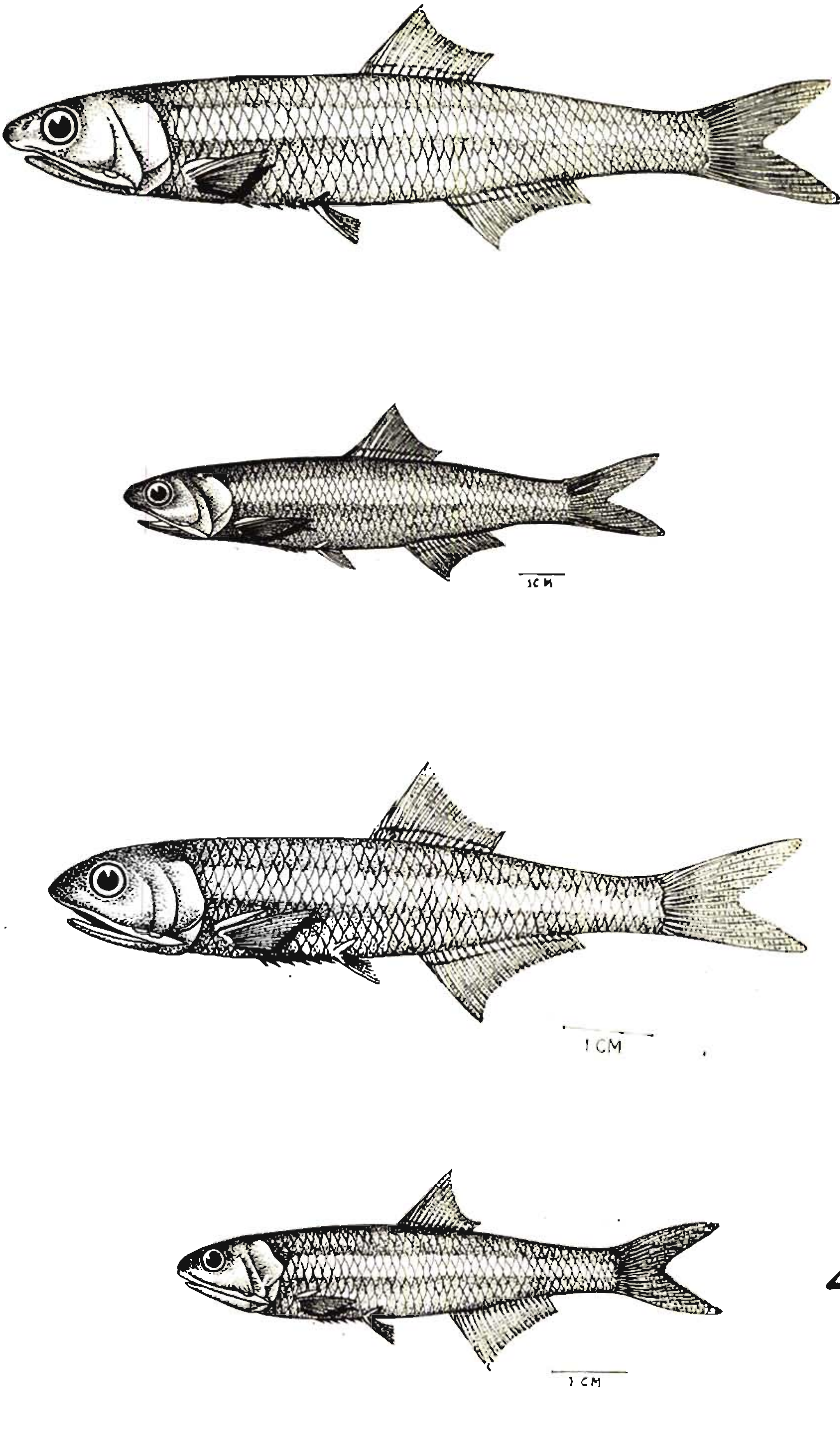
Plate 10.1. *Stolephorus indicus*

2. *Stolephorus commersonii*

3. *Stolephorus waitei*

4. *Stolephorus insularis*

PLATE 10



1

2

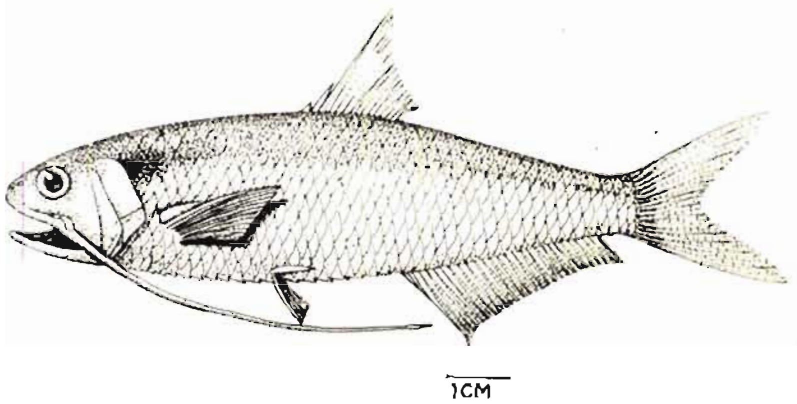
3

4

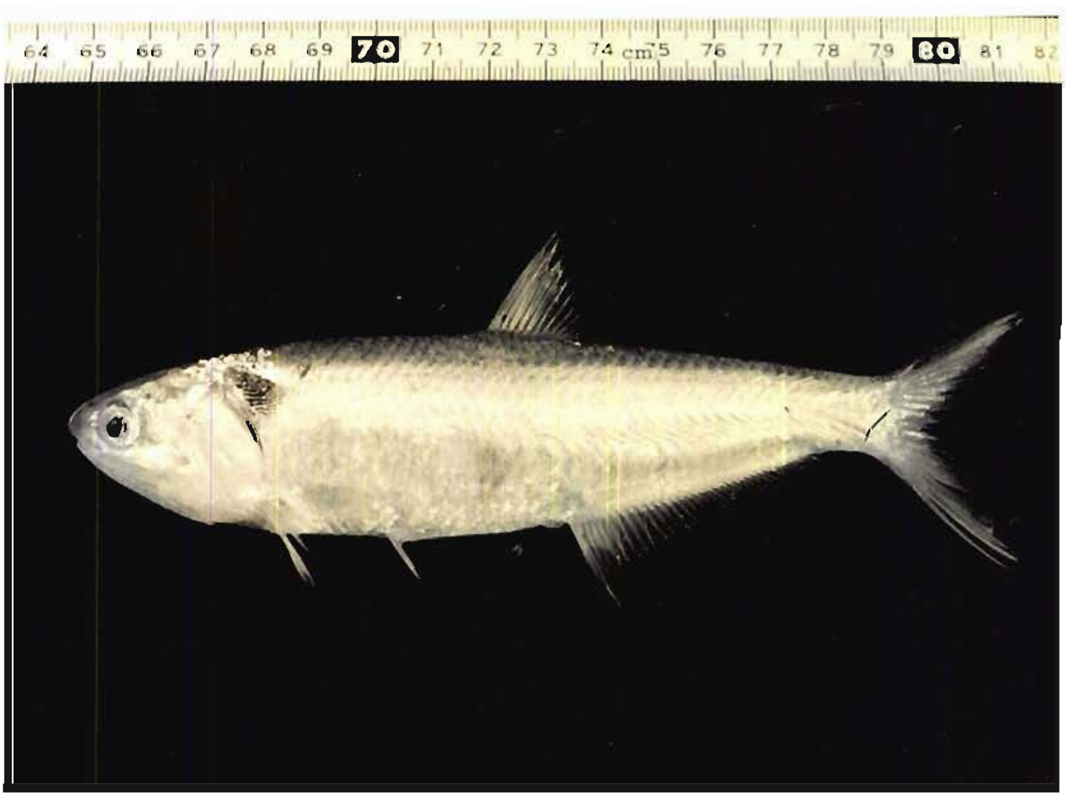
Plate 11.1. _Thryssa setirostris_

2. _Thryssa mystax_

PLATE 11



1

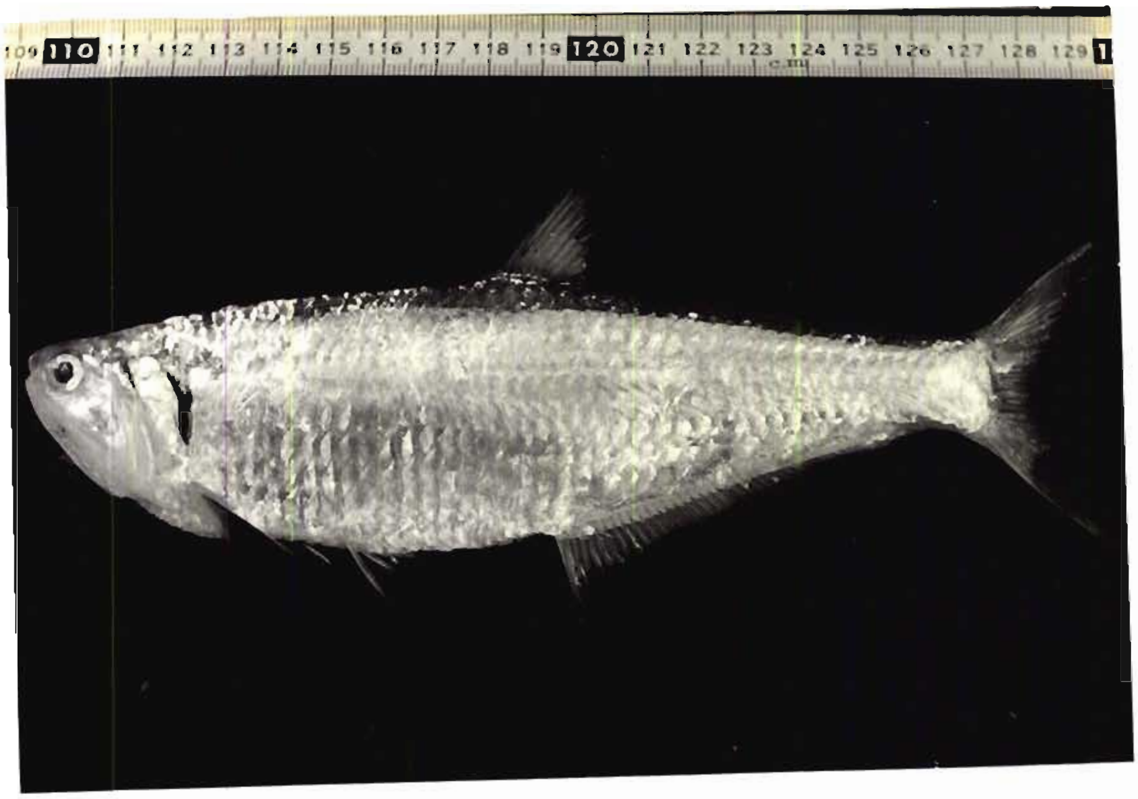


2

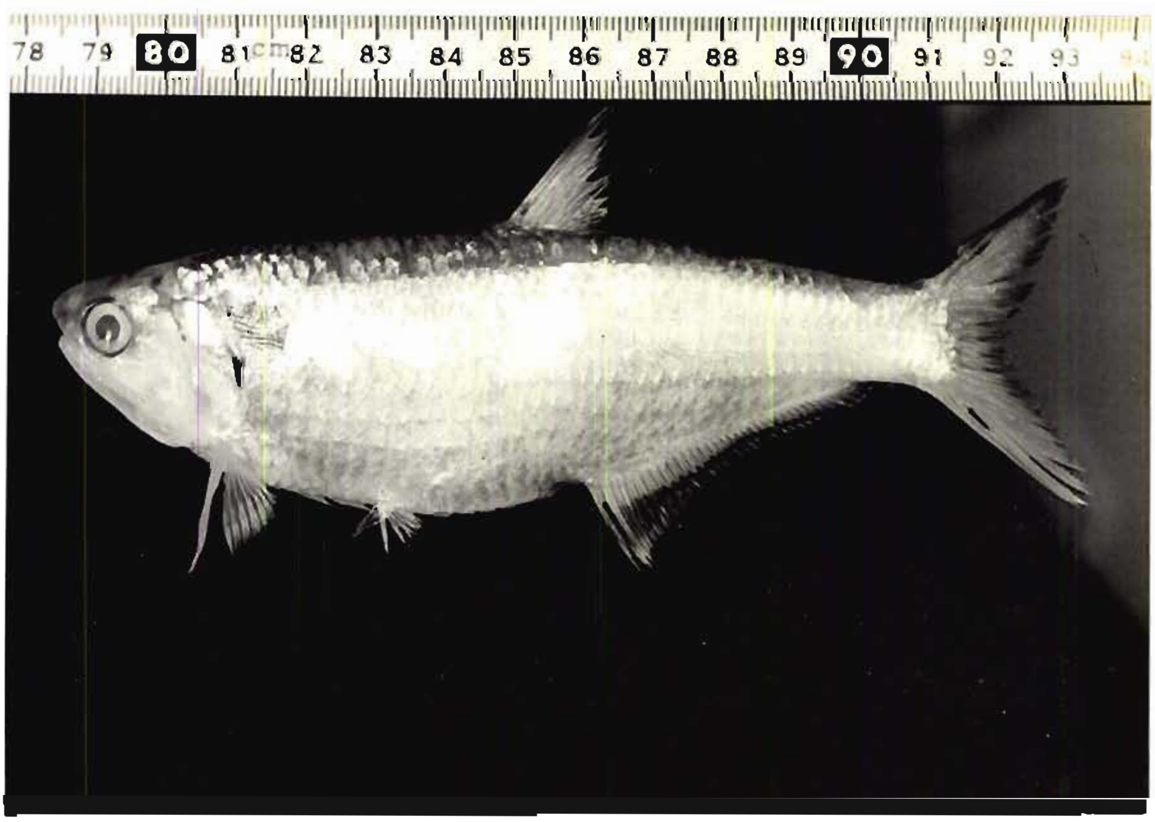
Plate 12.1. *Thryssa purava*

2. *Thryssa kammalensis*

PLATE 12



1

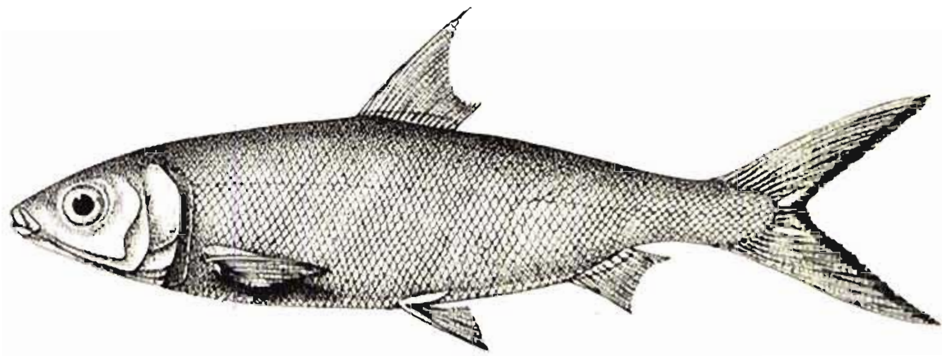


2

Plate 13.1. <u>Chanos chanos</u>

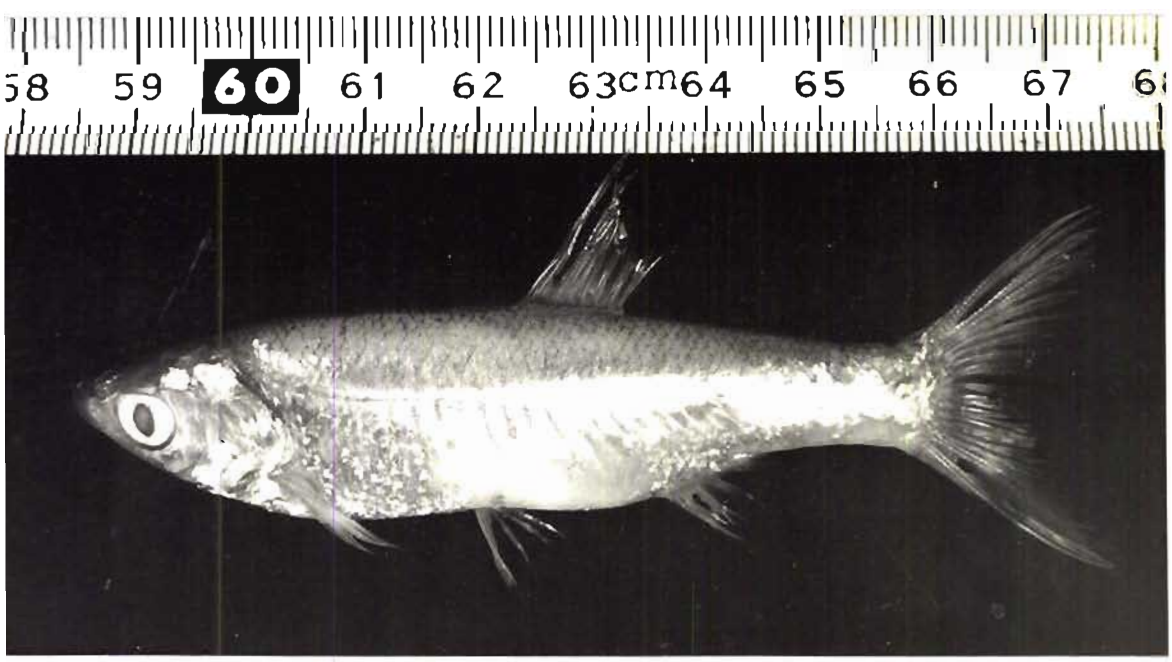
2. <u>Amblypharyngodon mola</u>

PLATE 13



3 CM

1



2

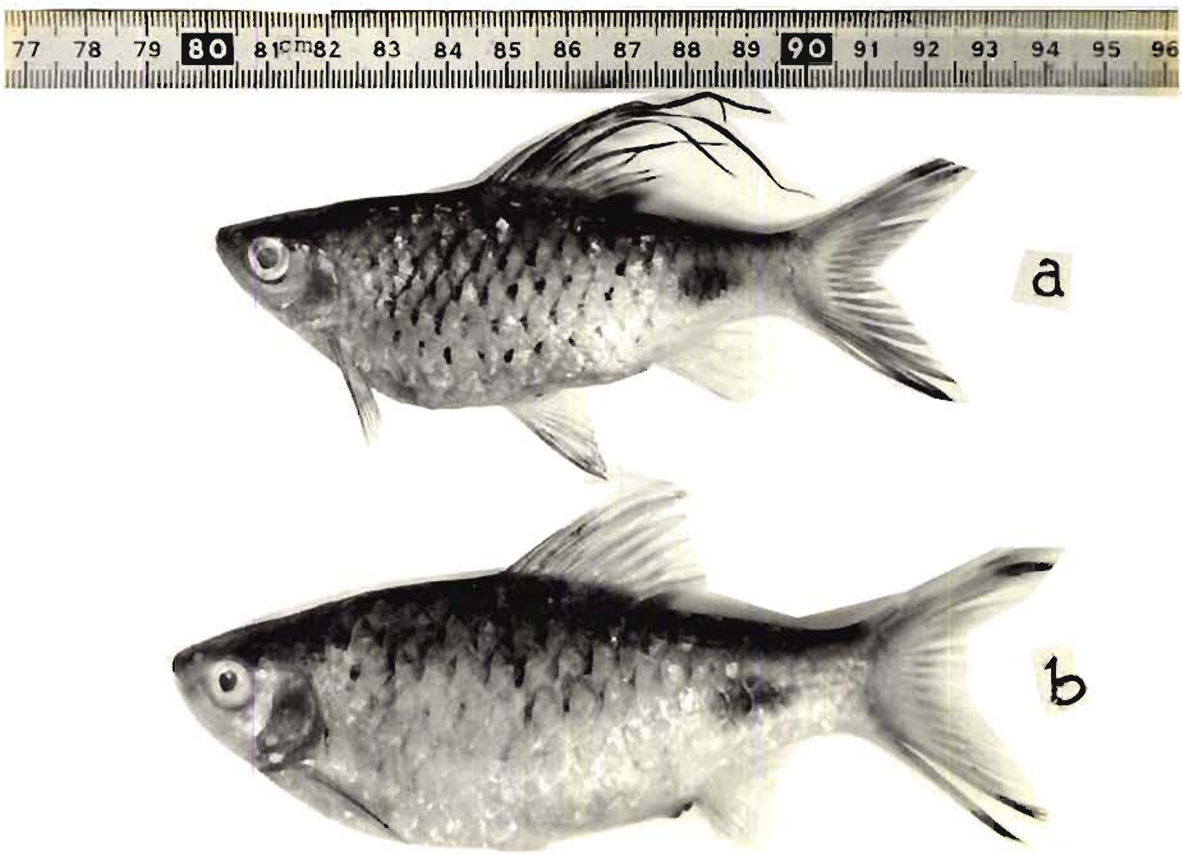
Plate 14.1. _Puntius filamentosus_

a) Male

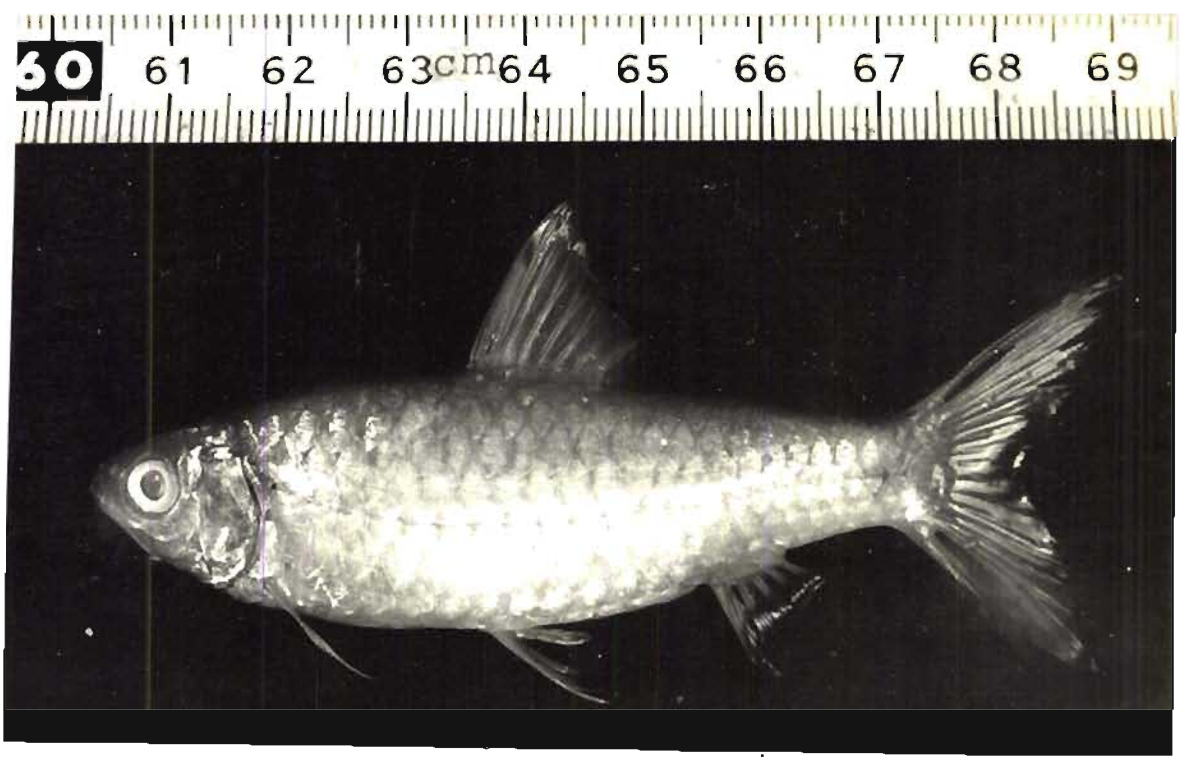
b) Female

2. _Puntius amphibius_

PLATE 14



1

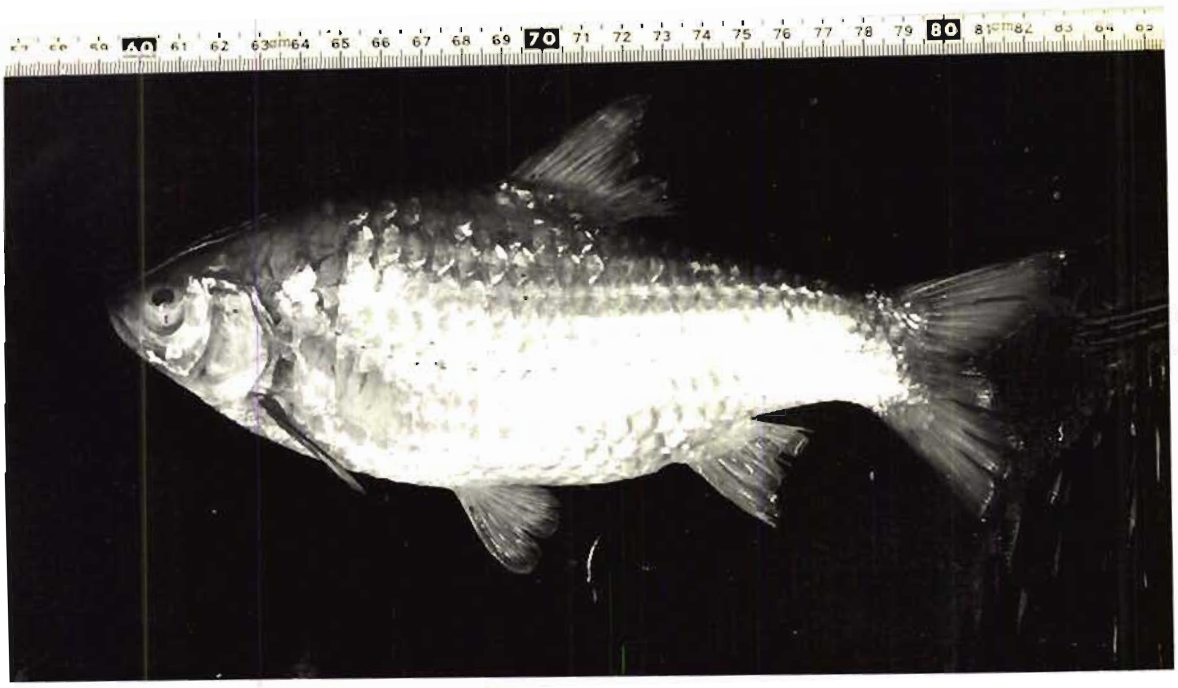


2

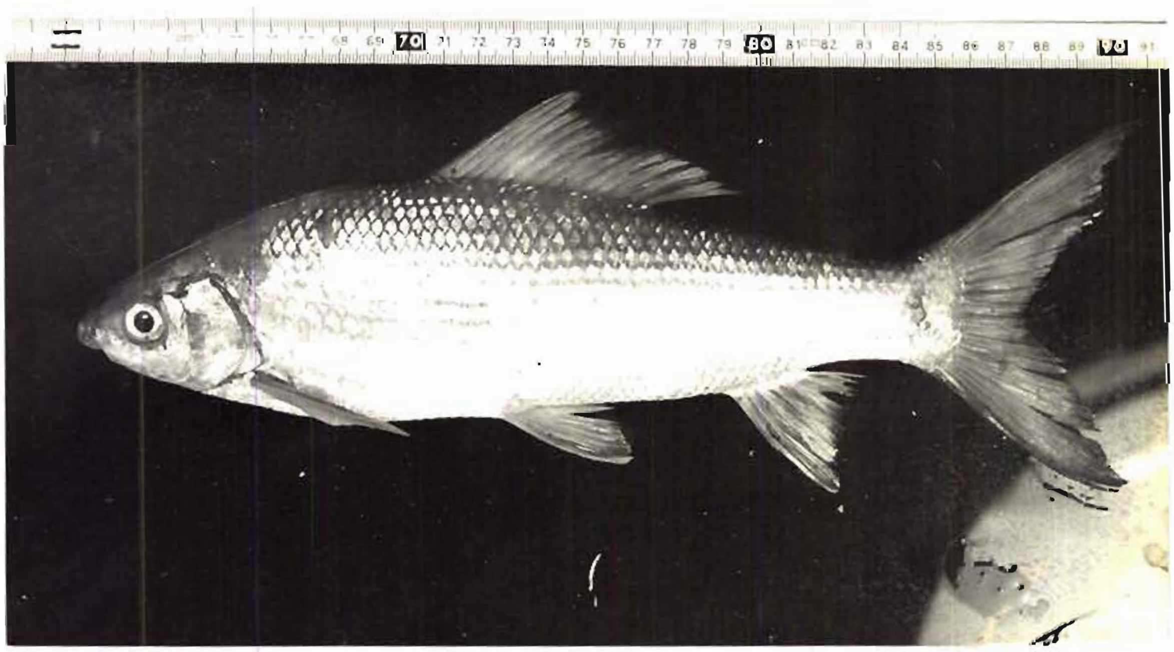
Plate 15.1. _Puntius sarana_

2. _Labeo dussumieri_

PLATE 15



1



2

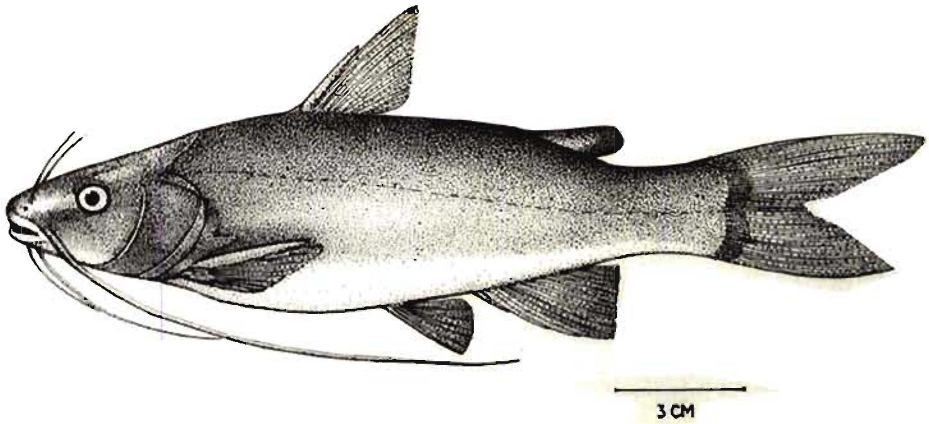
Plate 16.1. *Mystus* (*Mystus*) *gulio*

2. *Mystus* (*Mystus*) *malabaricus*

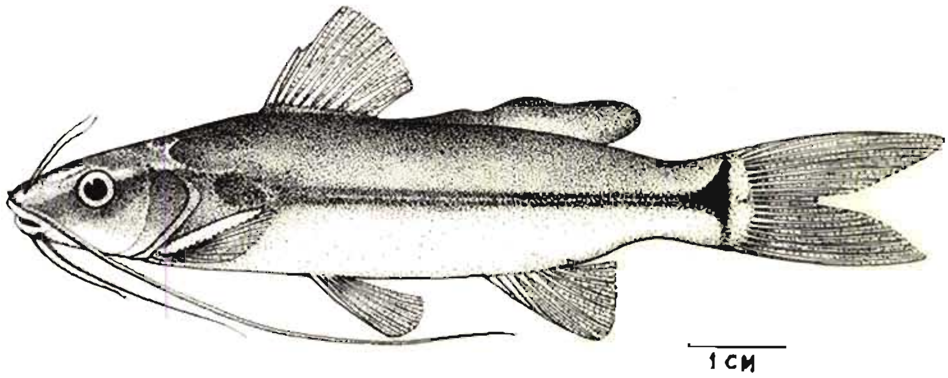
3. *Mystus* (*Mystus*) *oculatus*

4. *Horabagrus brachysoma*

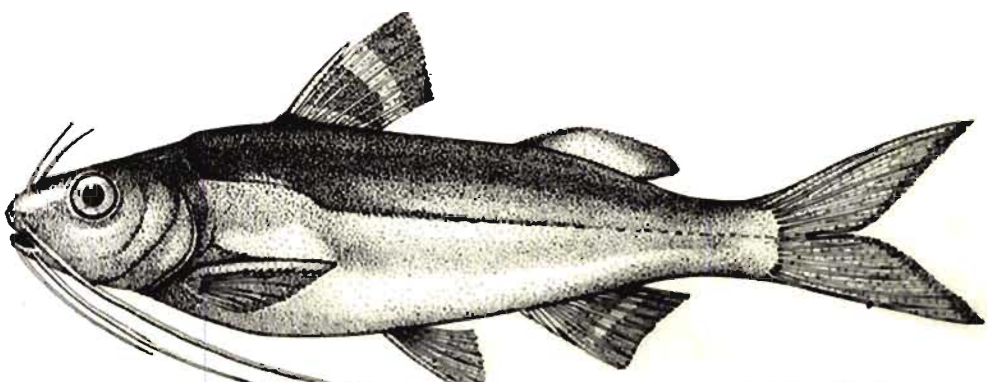
PLATE 16



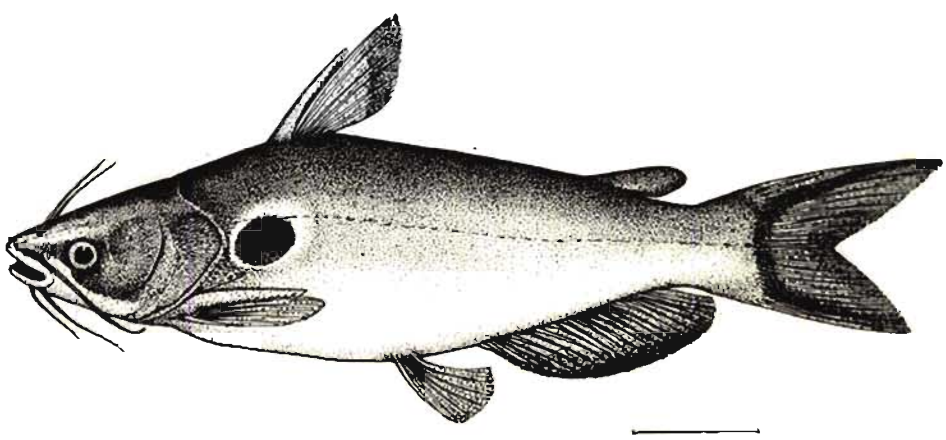
1



2



3



4

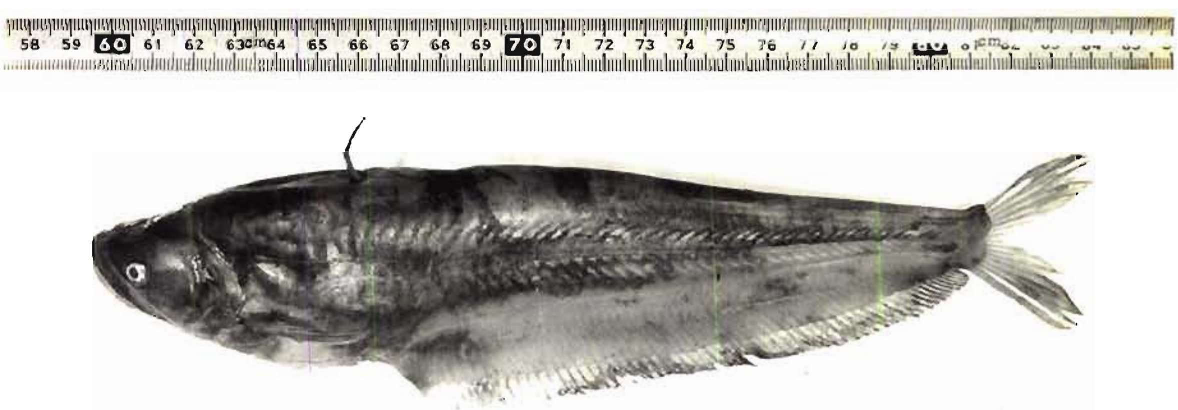
Plate 17.1. *Wallago attu*

2. *Ompok bimaculatus*

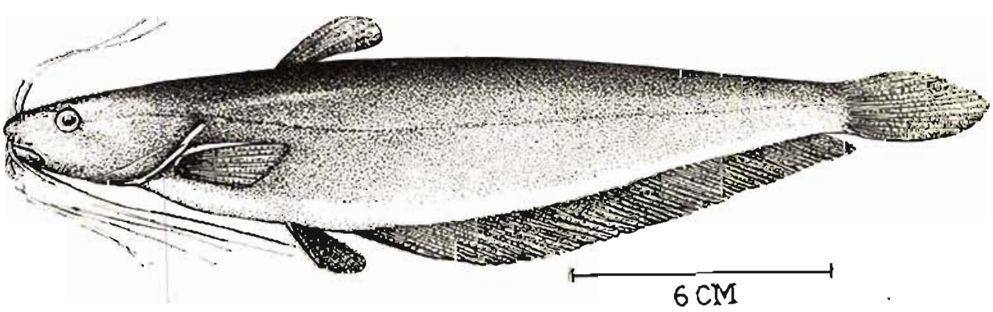
3. *Heteropneustes fossilis*

PLATE 17

1



2

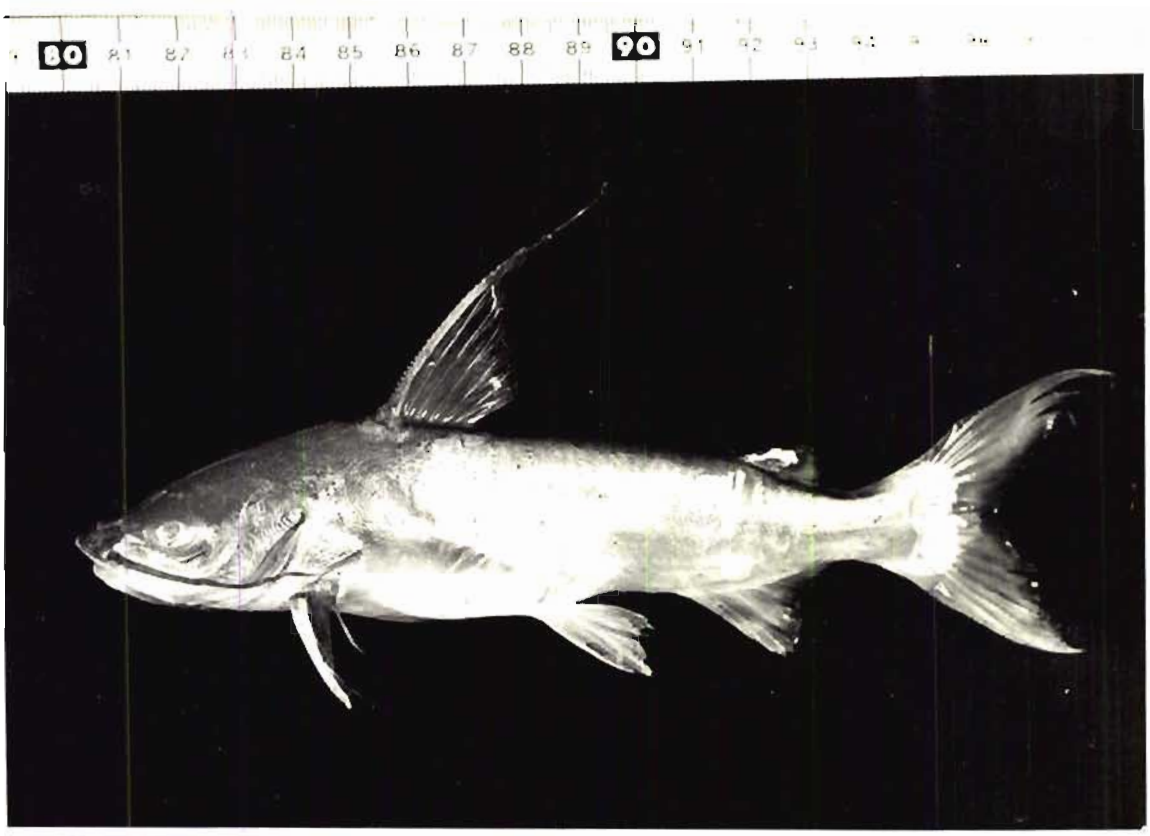


3

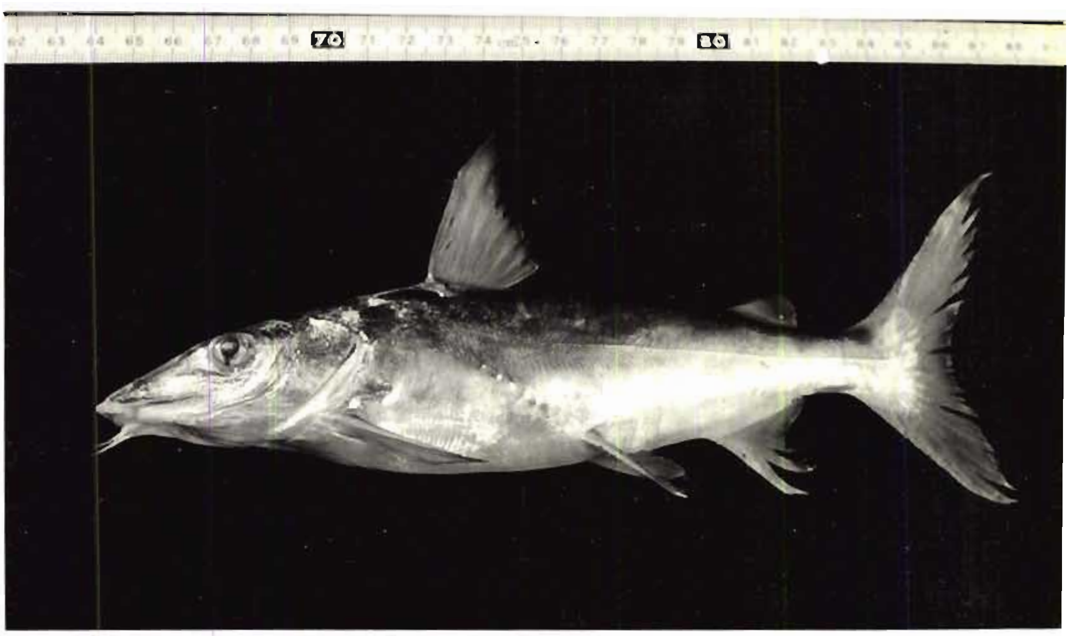
Plate 18.1. *Tachysurus maculatus*

2. *Tachysurus subrostratus*

PLATE 18



1

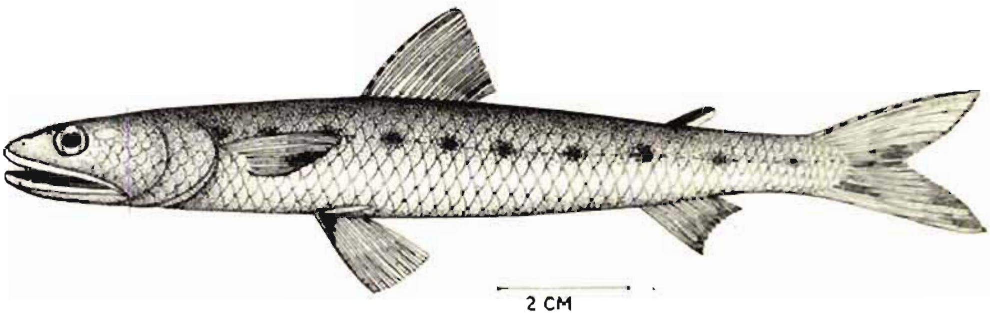


2

Plate 19.1. *Saurida undosquamis*

2. *Austrobatrachus dussumieri*

PLATE 19



1

2

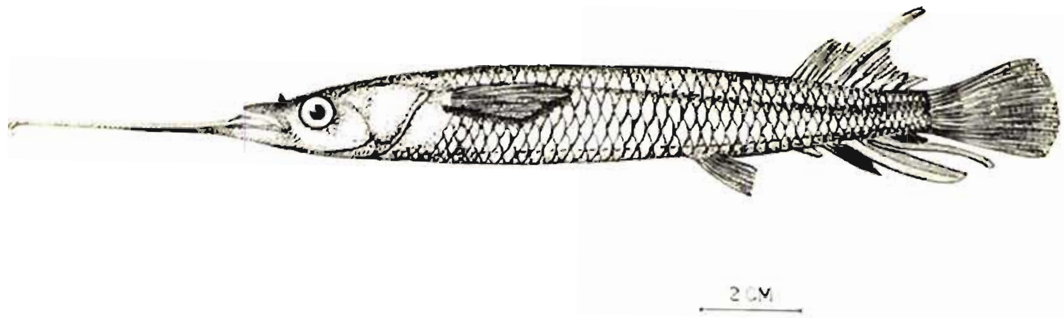
Plate 20.1. *Zenarchopterus dispar*

2. *Rhynchorhamphus georgii*

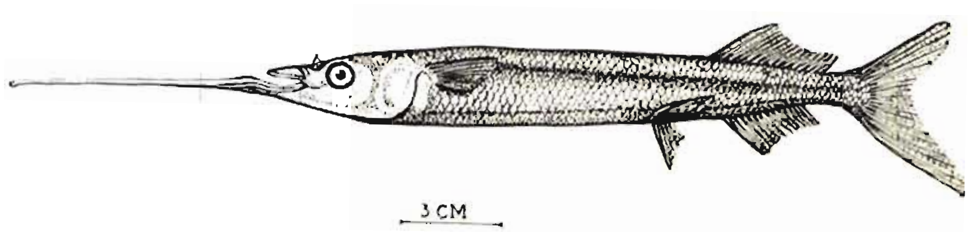
3. *Hyporhamphus* (*Hyporhamphus*) *xanthopterus*

4. *Hyporhamphus* (*Hyporhamphus*) *limbatus*

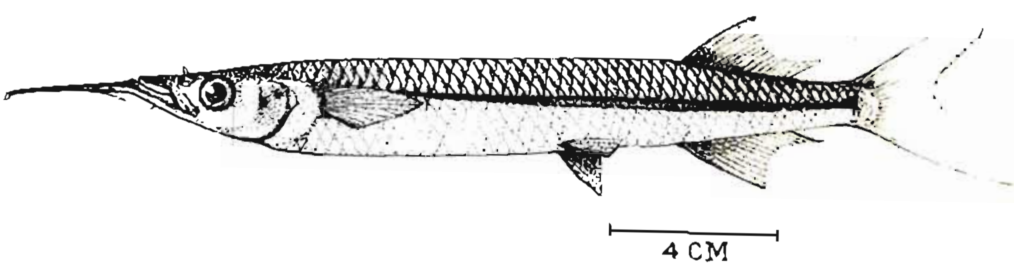
PLATE 20



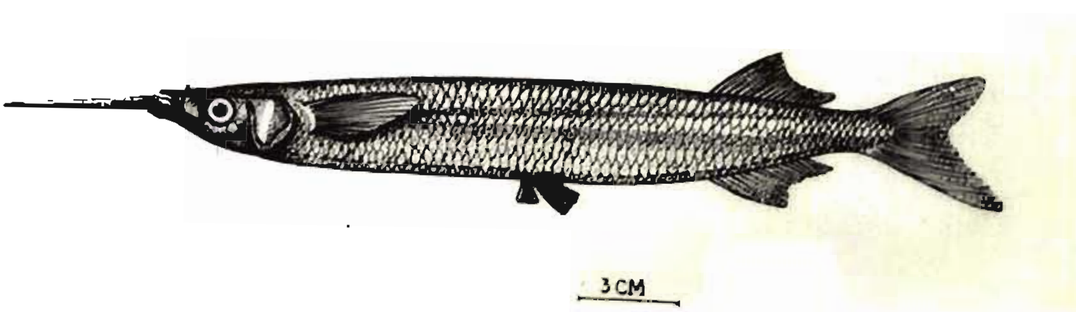
1



2



3



4

Plate 21.1. Strongylura strongylura

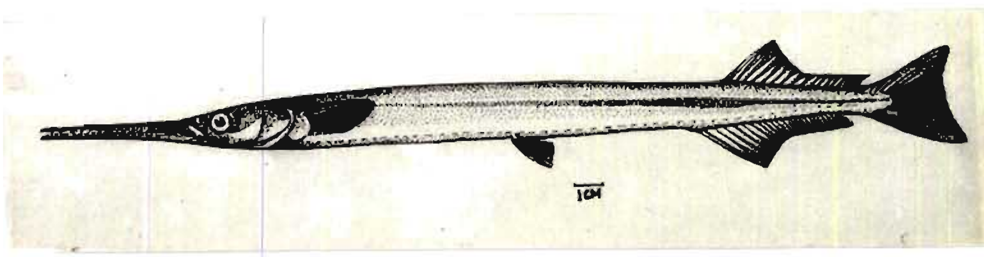
2. Strongylura leiura leiura

3. Tylosurus crocodilus crocodilus

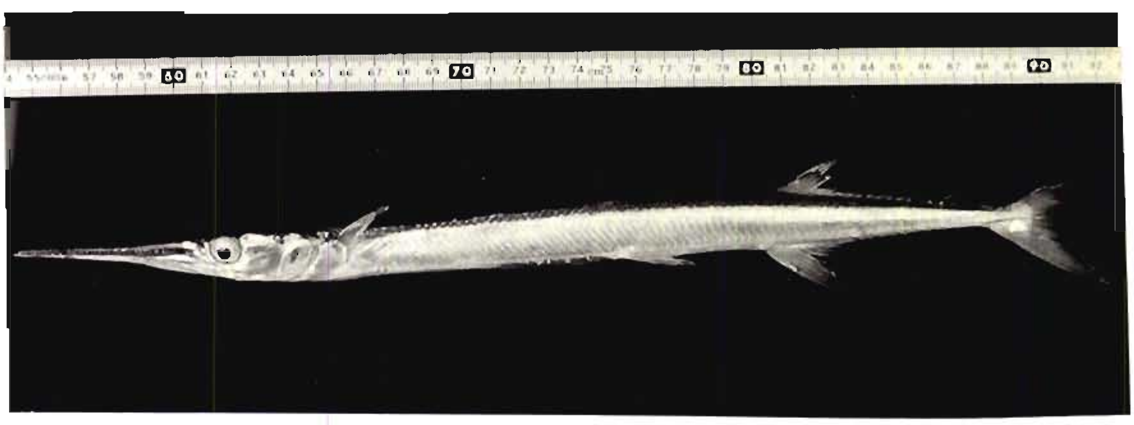
4. Xenentodon cancilla

PLATE 21

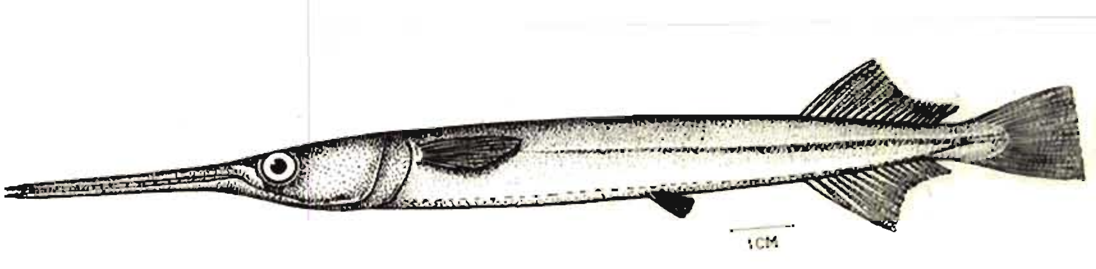
1



2



3

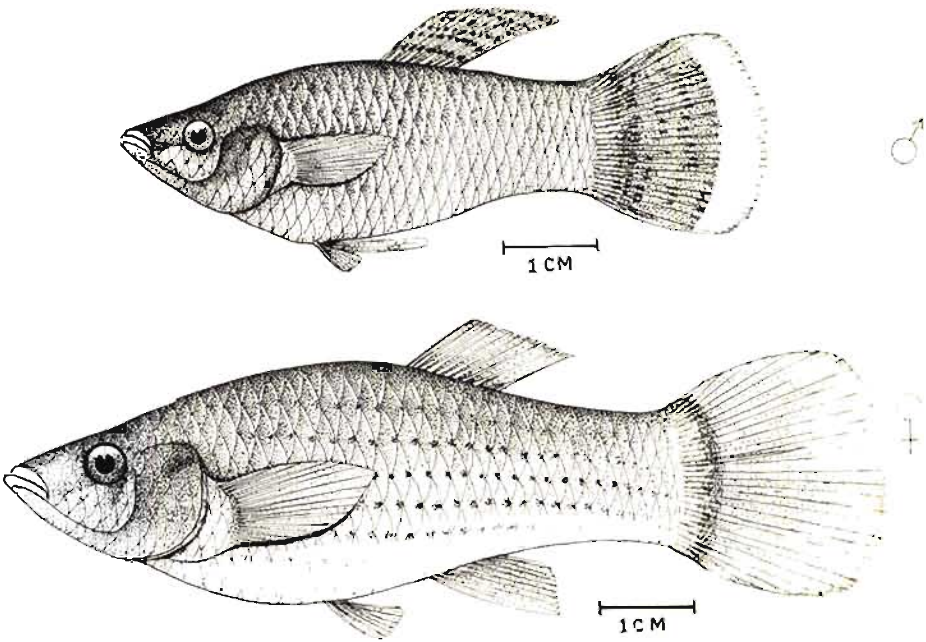


4

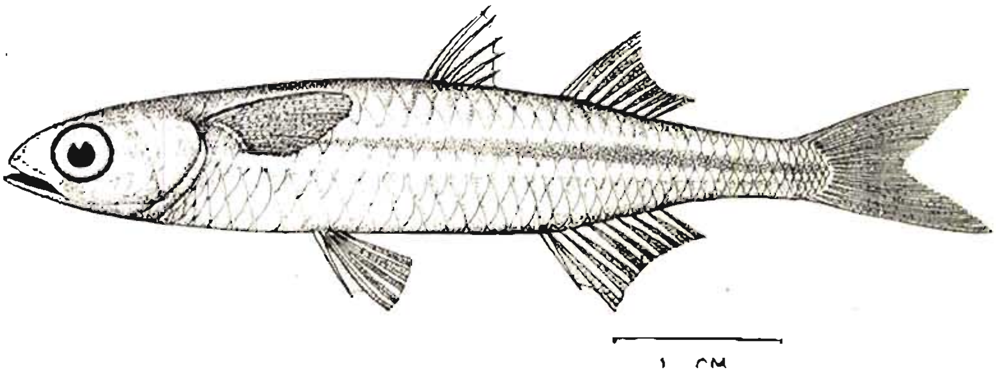
Plate 22. 1. <u>Gambusia affinis patruelis</u>

2. <u>Atherina duodecimalis</u>

PLATE 22



1

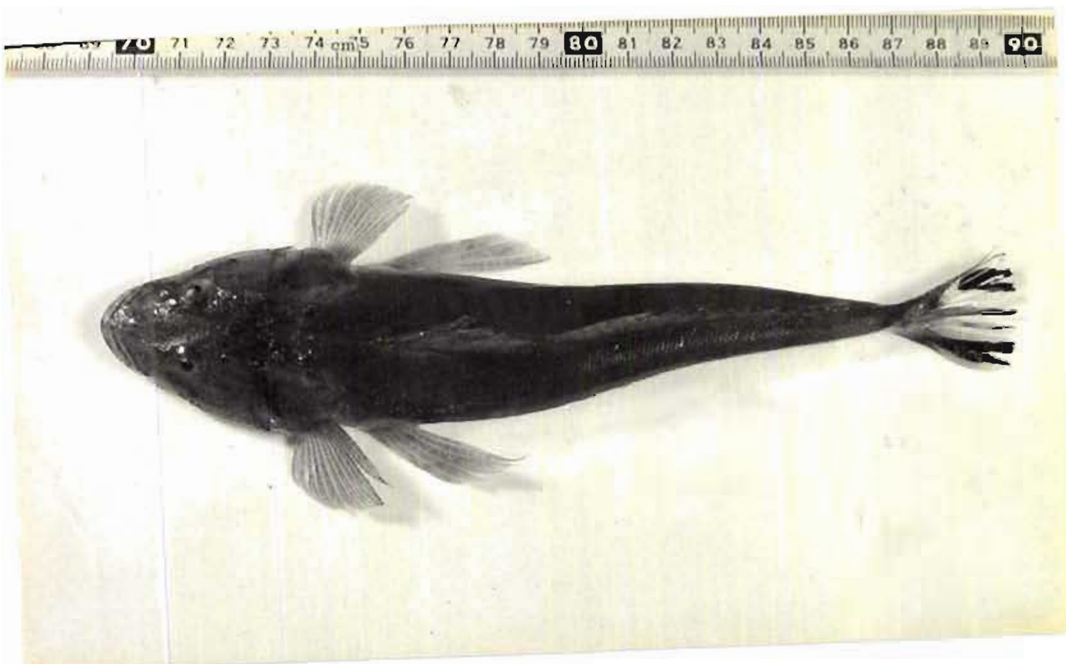


2

Plate 23.1. *Platycephalus indicus*

2. *Platycephalus crocodilus*

PLATE 23


70 71 72 73 74 cm 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90

1


70 80 90

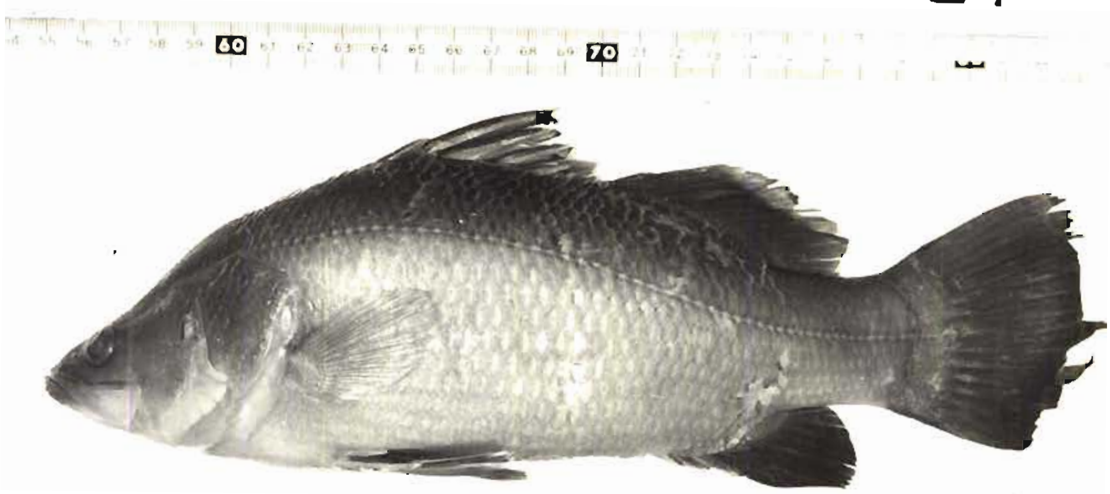
2

Plate 24.1. *Lates calcarifer*

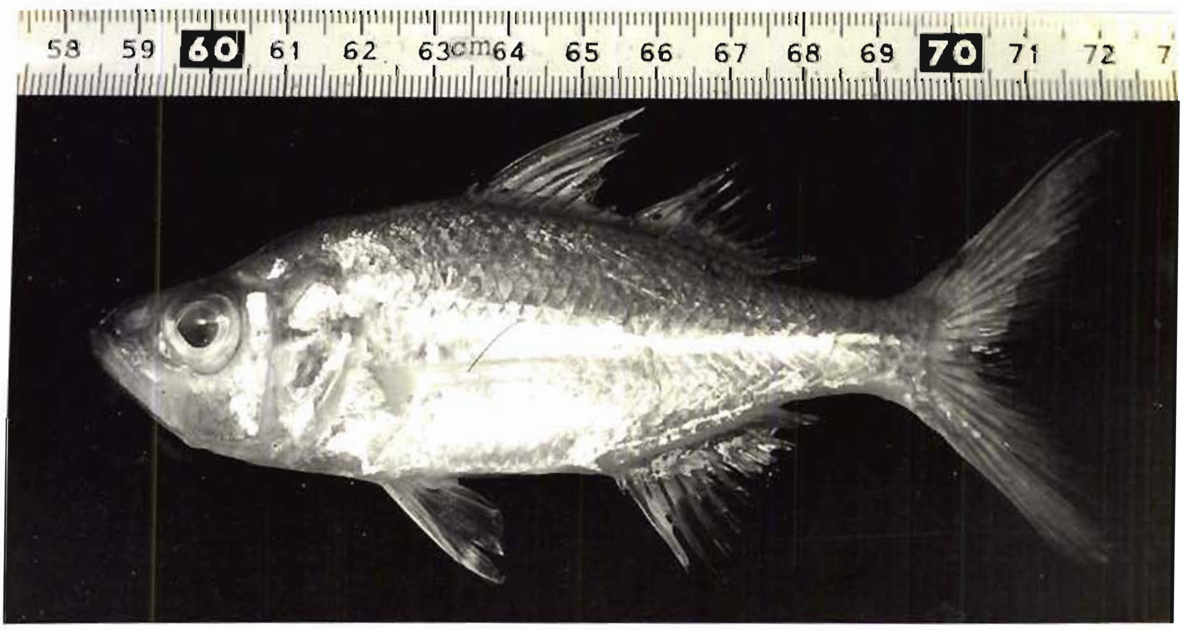
2. *Ambassis dayi*

3. *Ambassis thomassi*

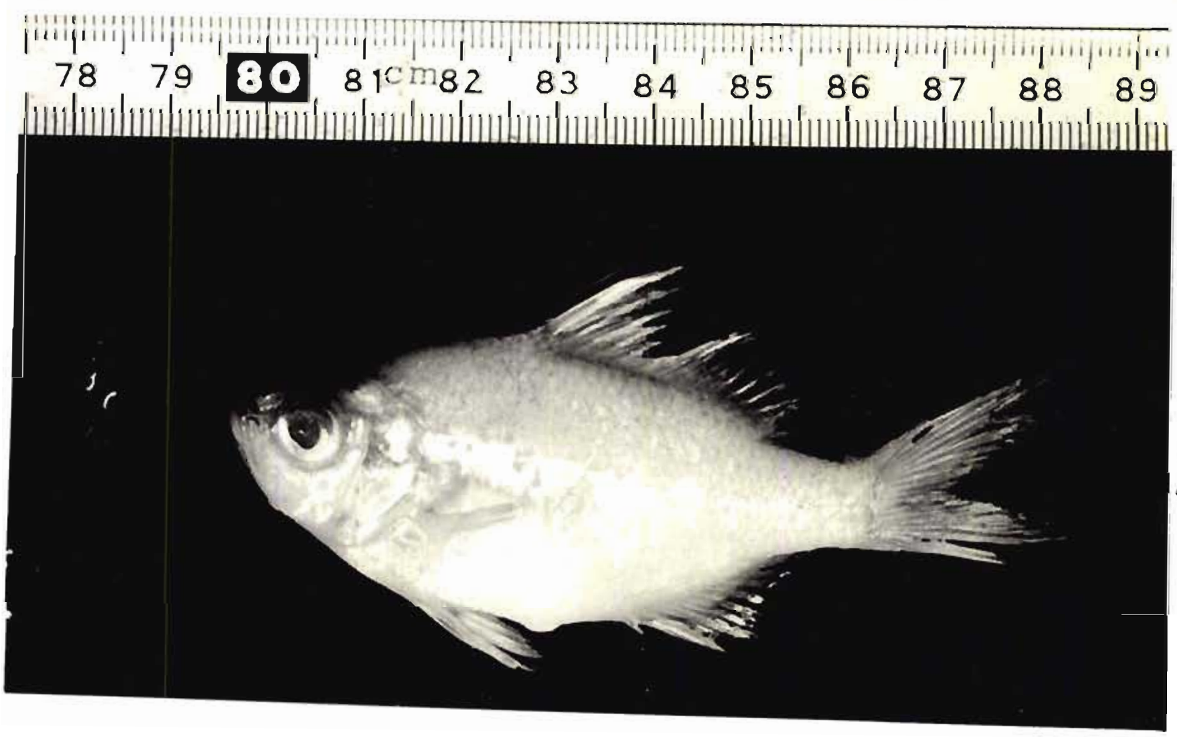
PLATE 24



1


58 59 60 61 62 63cm64 65 66 67 68 69 70 71 72 7

2

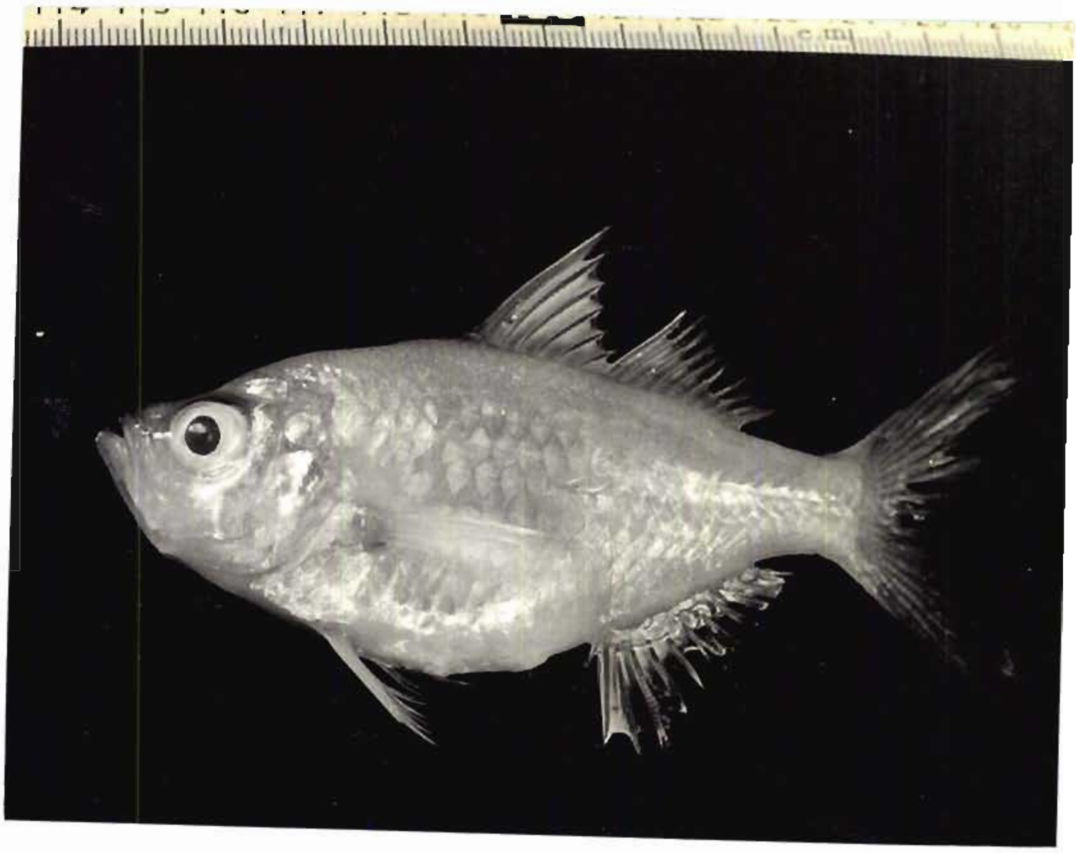

78 79 80 81cm82 83 84 85 86 87 88 89

3

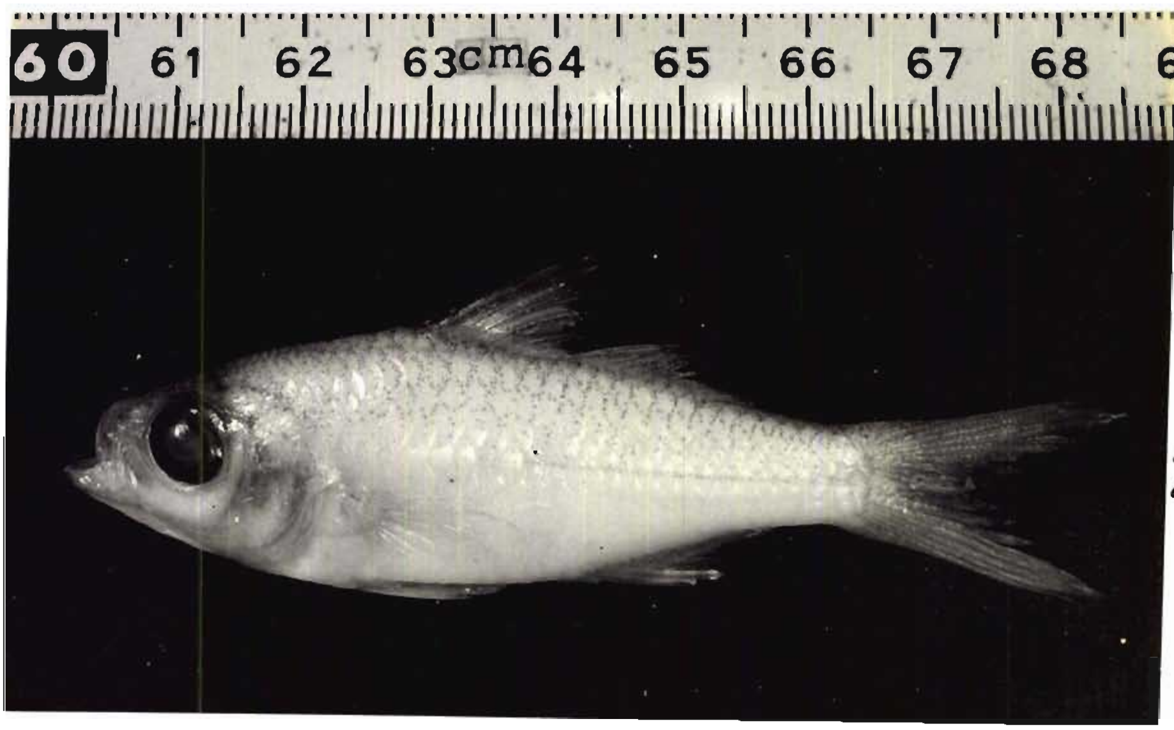
Plate 25.1. _Ambassis commersoni_

2. _Ambassis gymnocephalus_

PLATE 25



1

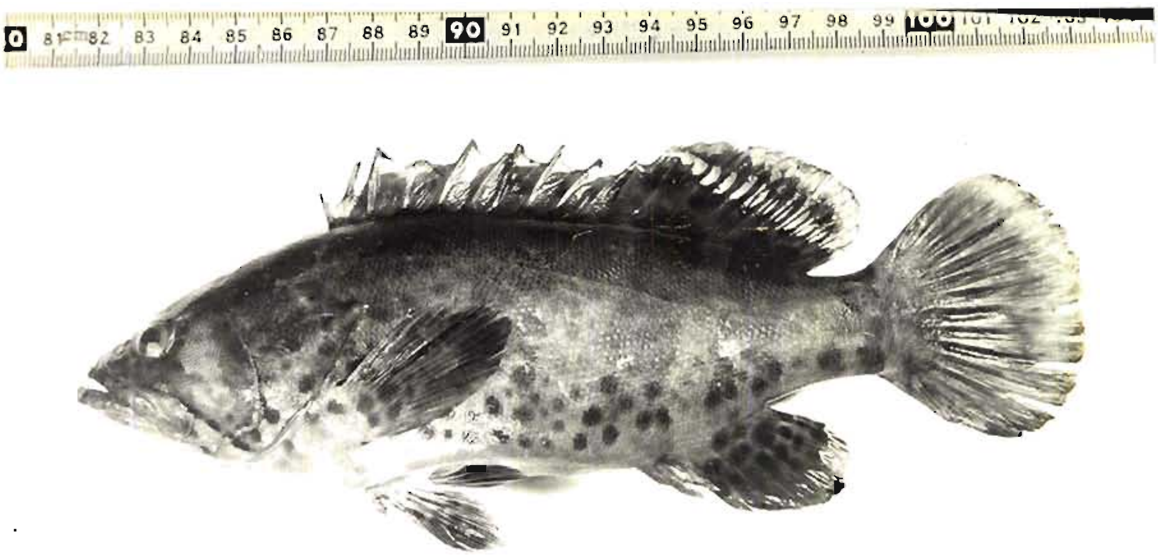


2

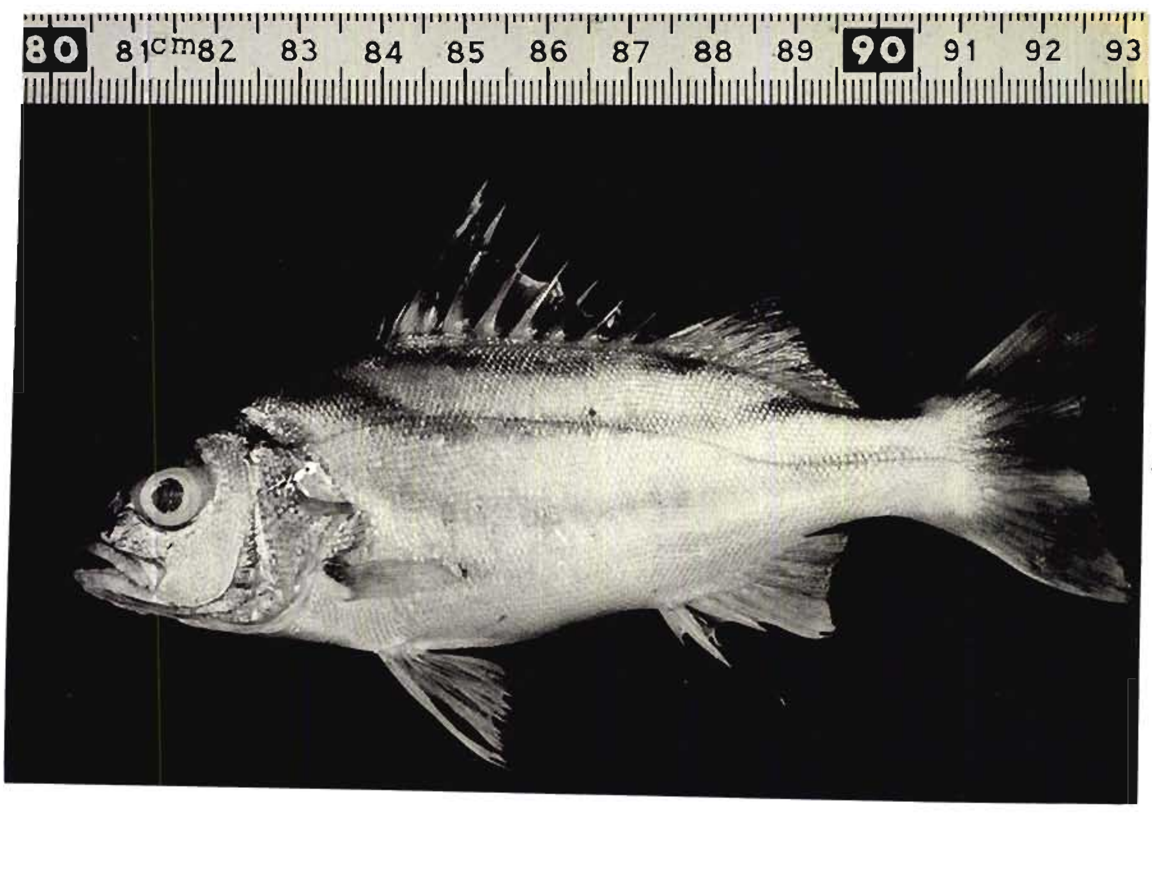
Plate 26.1. *Epinephelus tauvina*

2. *Therapon jarbua*

PLATE 26



1

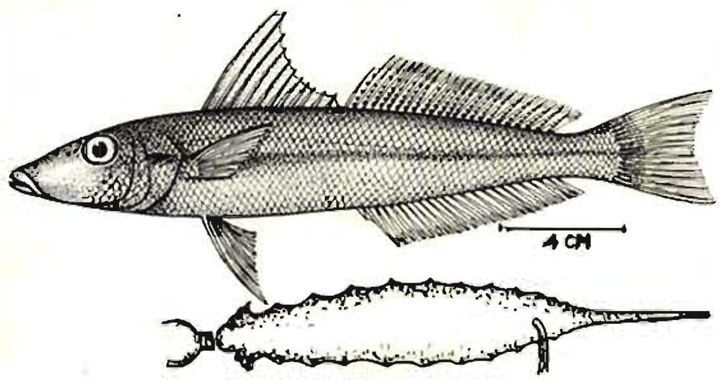


2

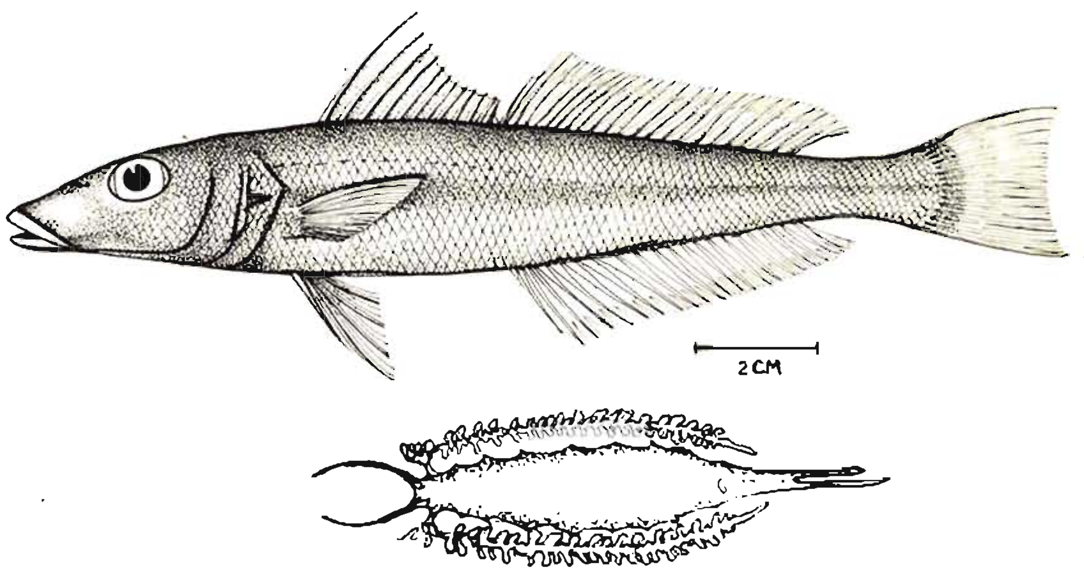
Plate 27.1. _Sillago vincenti_

2. _Sillago sihama_

PLATE 27



1

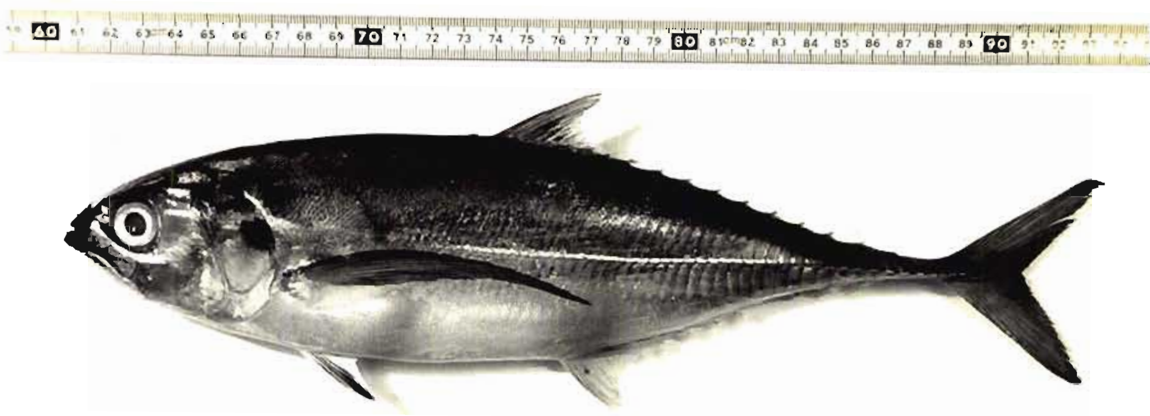


2

Plate 28.1. <u>Megalaspis cordyla</u>

2. <u>Alectis indicus</u>

PLATE 28



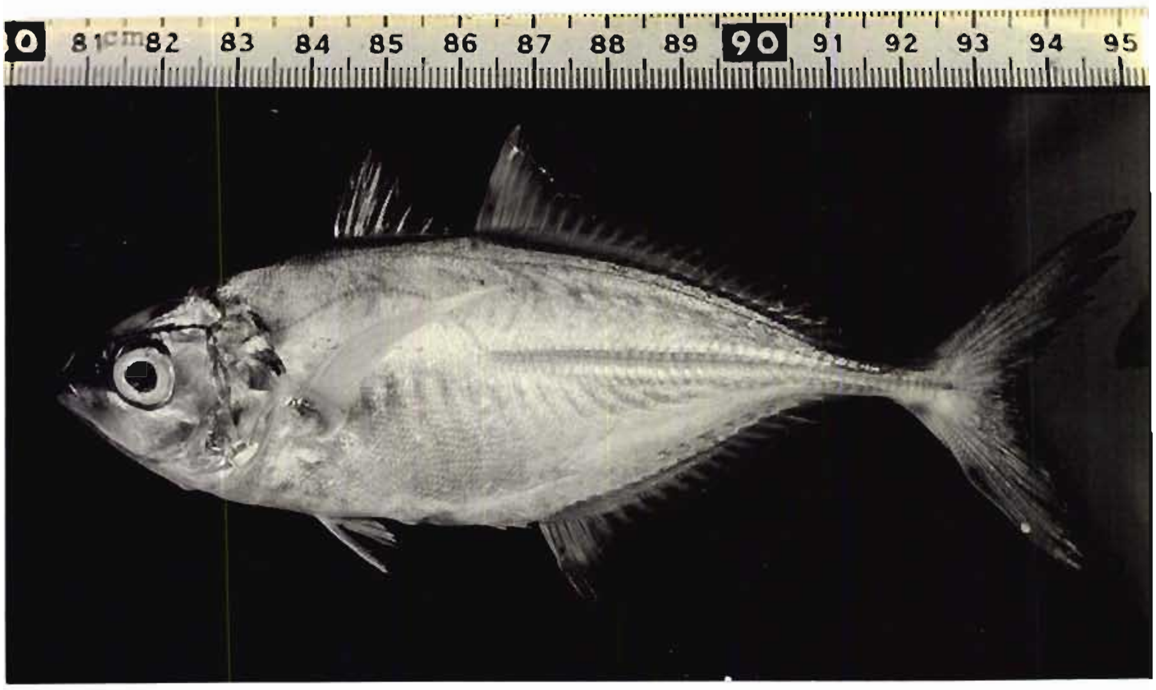
1

2

Plate 29.1. *Alepes djeddaba*

2. *Carangoides praeustus*

PLATE 29



0 81cm 82 83 84 85 86 87 88 89 90 91 92 93 94 95

1

60 61 62 63cm 64 65 66 67 68 69 70 71 72 73

2

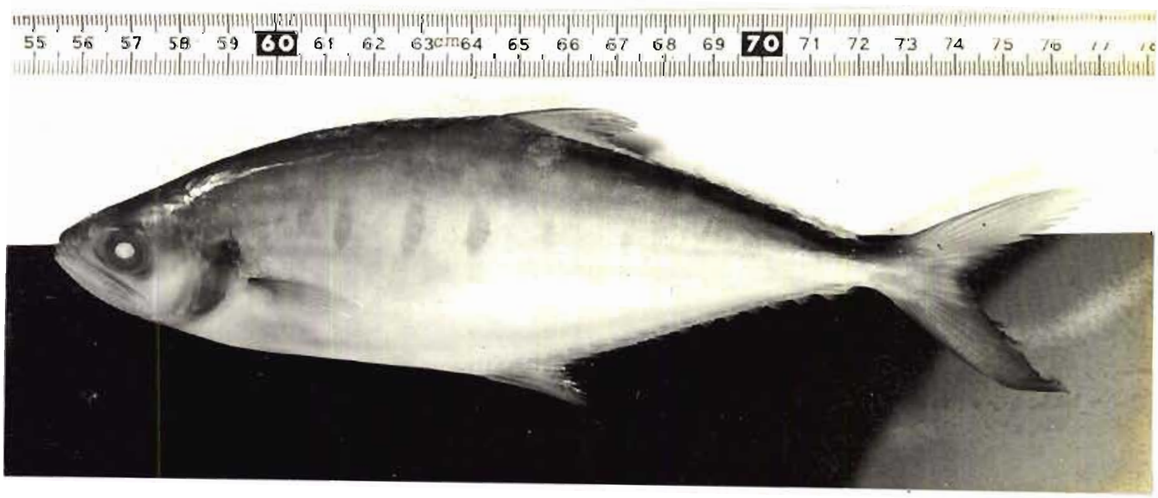
Plate 30.1. *Caranx sexfasciatus*

2. *Scomberoides tala*

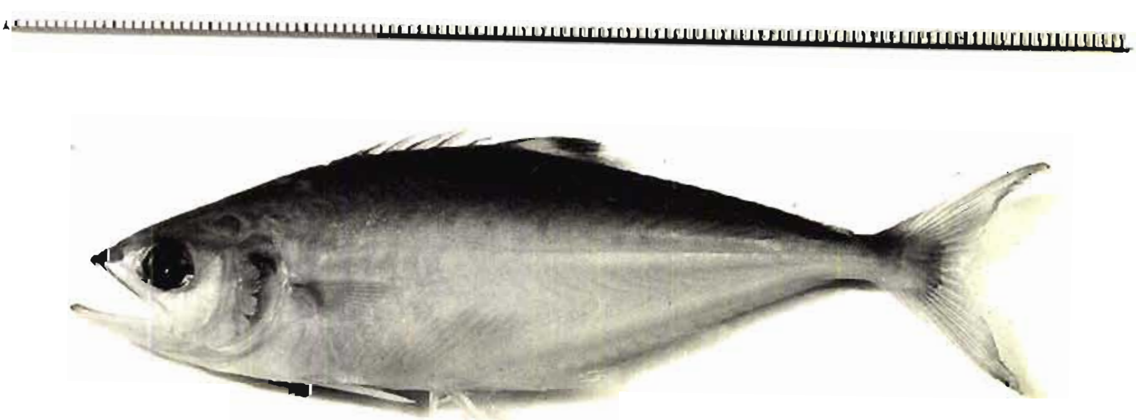
3. *Scomberoides tol*

PLATE 30

1



2



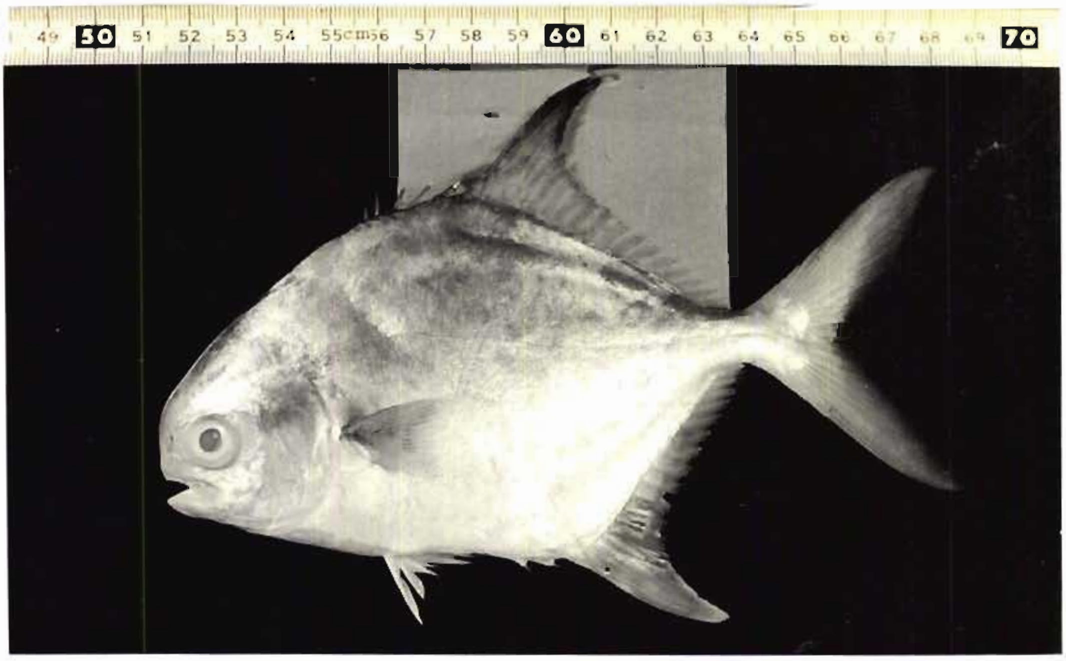
3

Plate 31.1. *Trachinotus blochii*

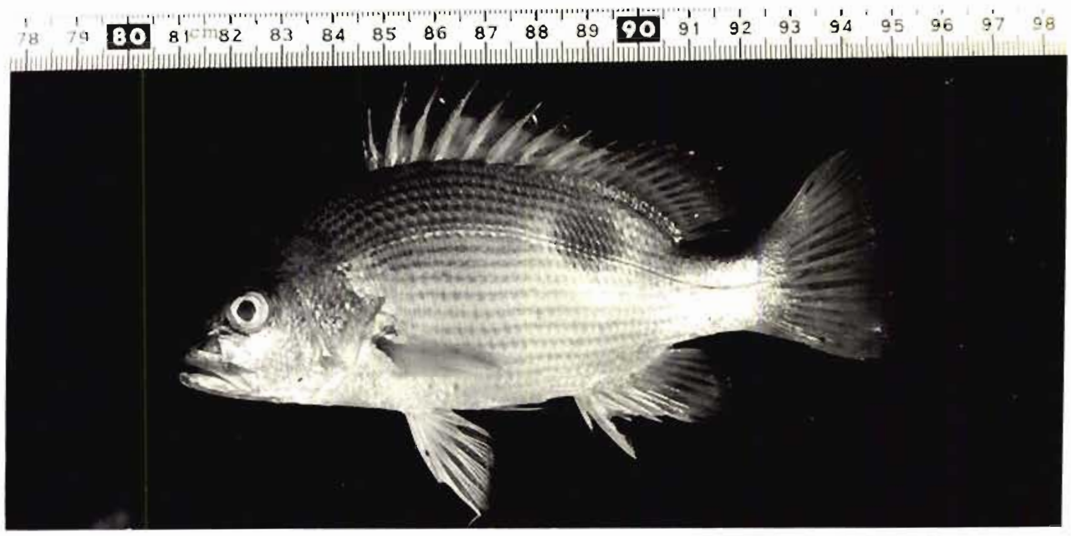
2. *Lutianus johni*

3. *Lutianus argentimaculatus*

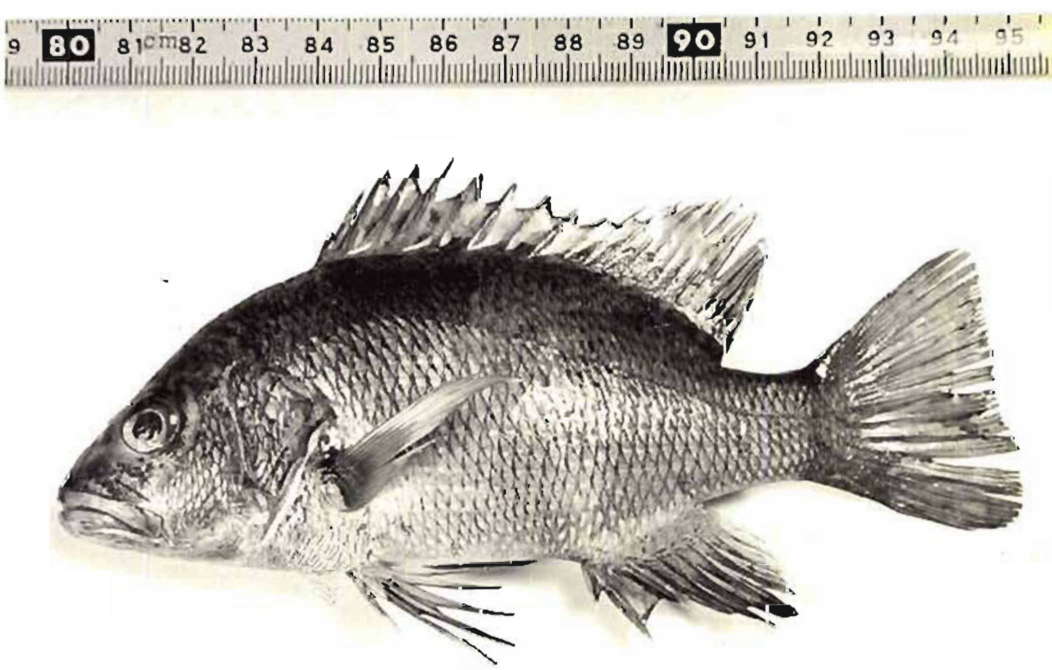
PLATE 31



1



2



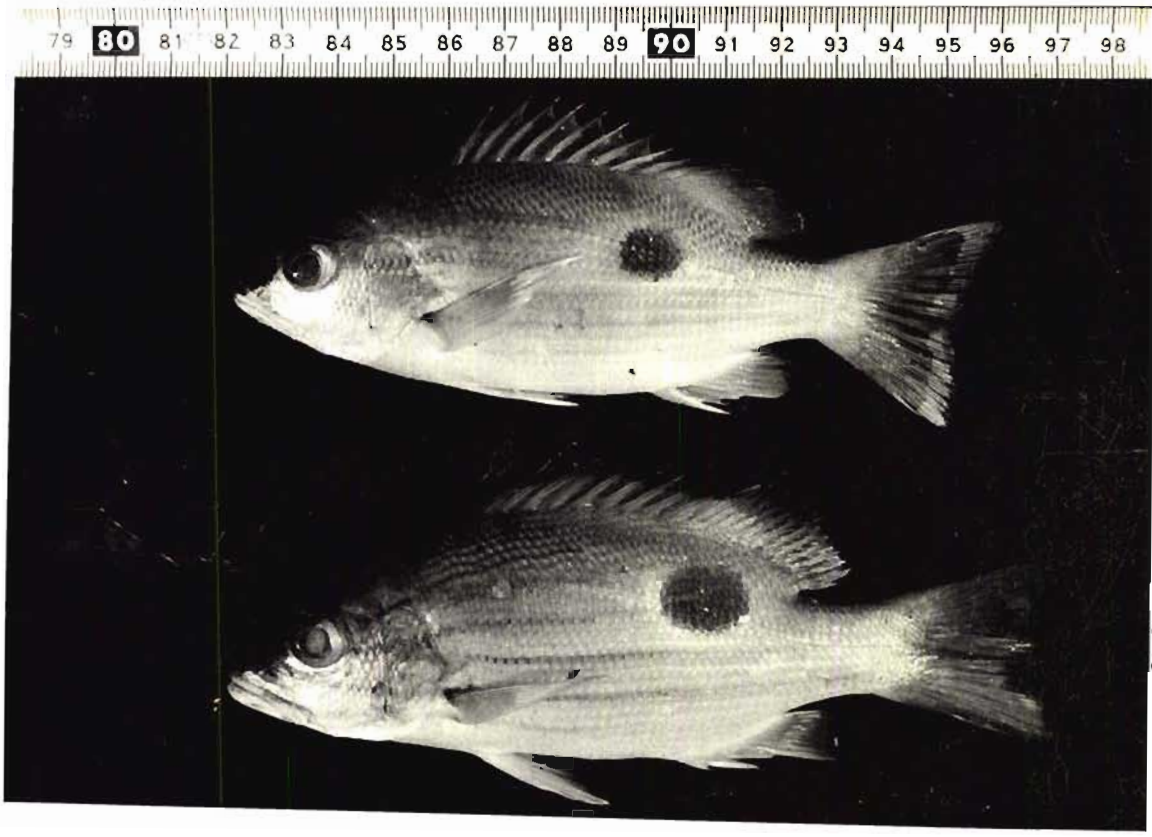
3

Plate 32.1. _Lutianus fulviflamma_

2. _Lutianus russelli_

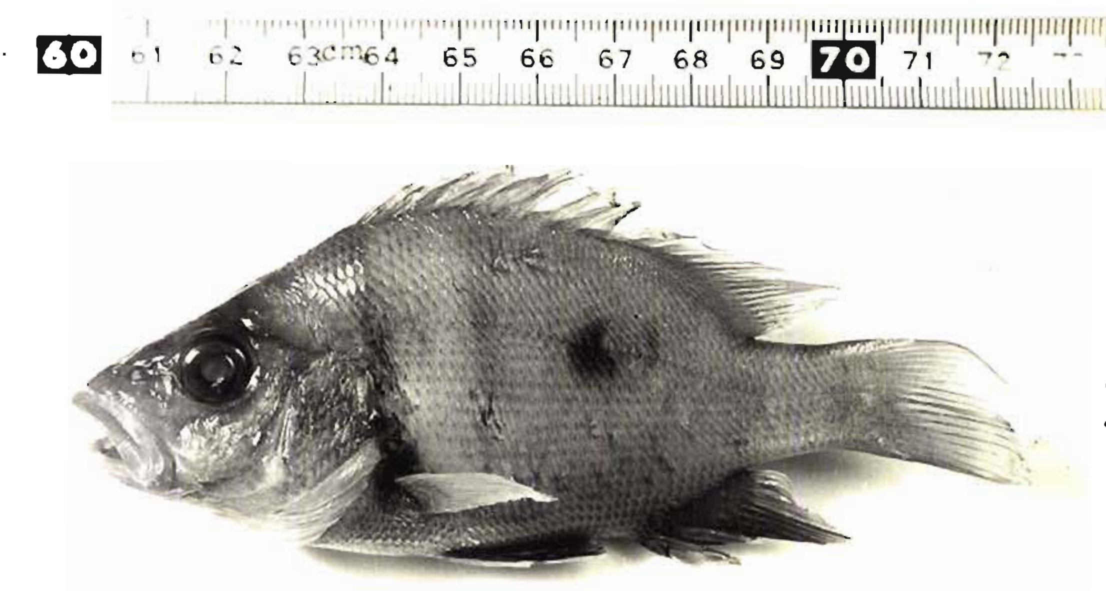
3. _Lutianus rivulatus_

PLATE 32



1

2



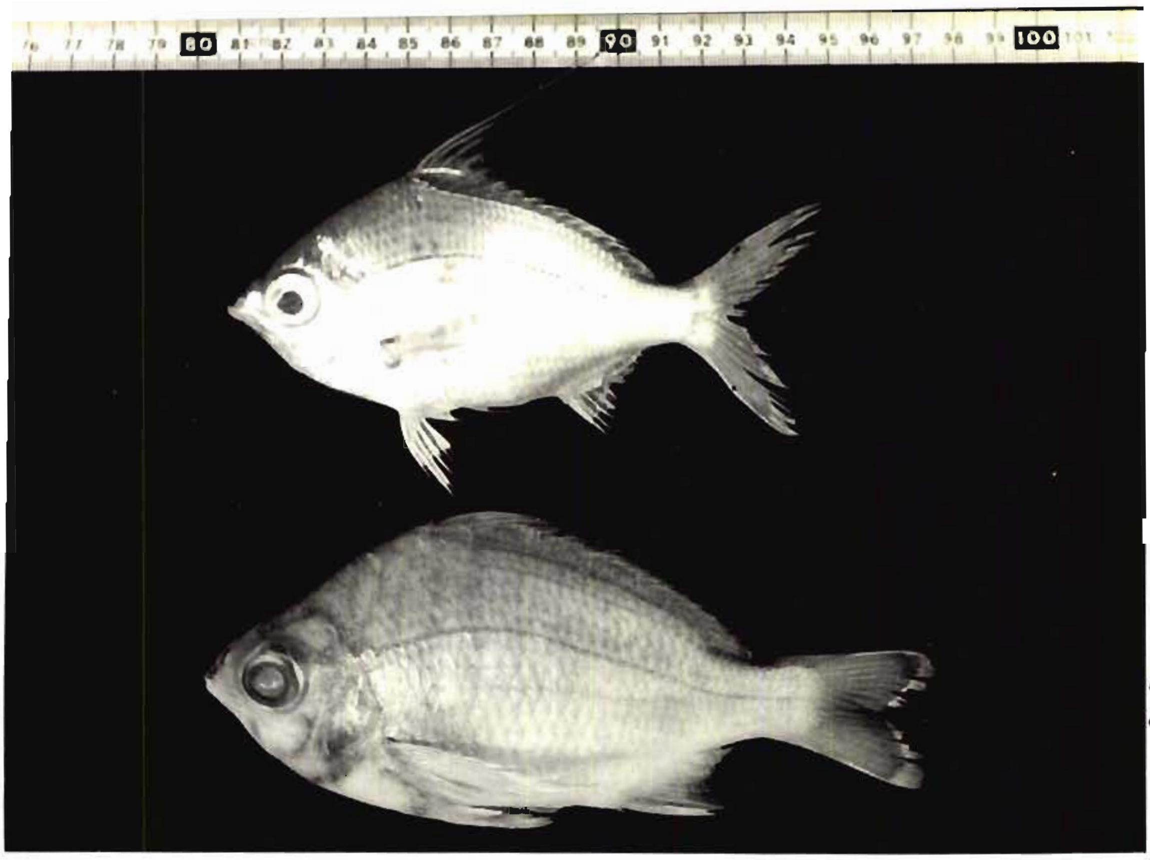
3

Plate 33.1. _Gerres filamentosus_

2. _Gerres abbreviatus_

3. _Gerres setifer_

PLATE 33



1

2

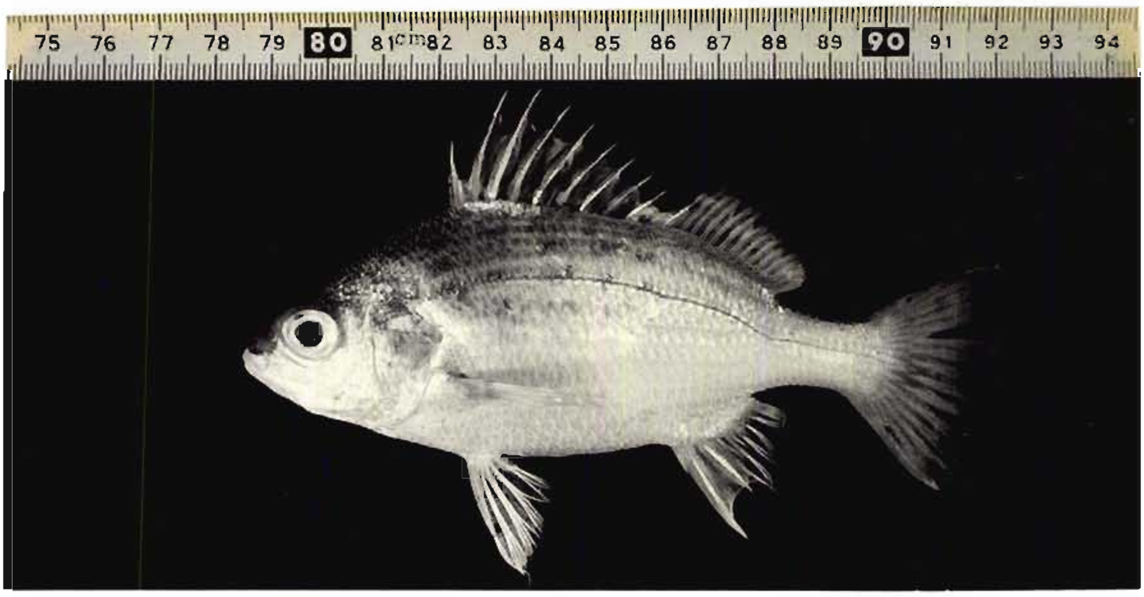
3

Plate 34. 1. *Pomadasys hasta*

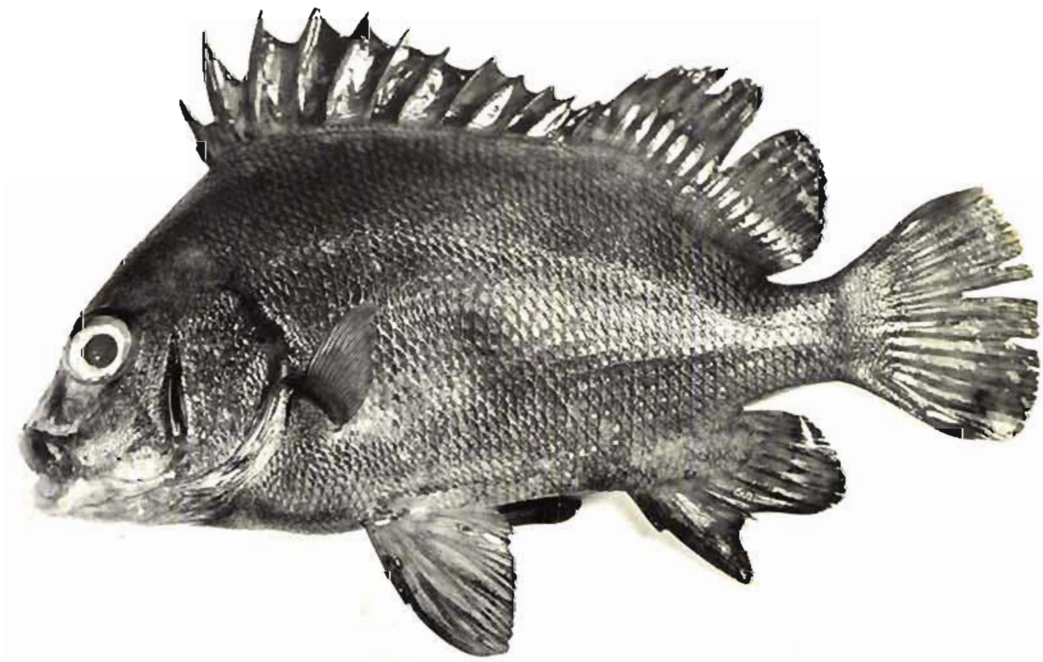
2. *Plectorhynchus nigrus*

3. *Lethrinus microdon*

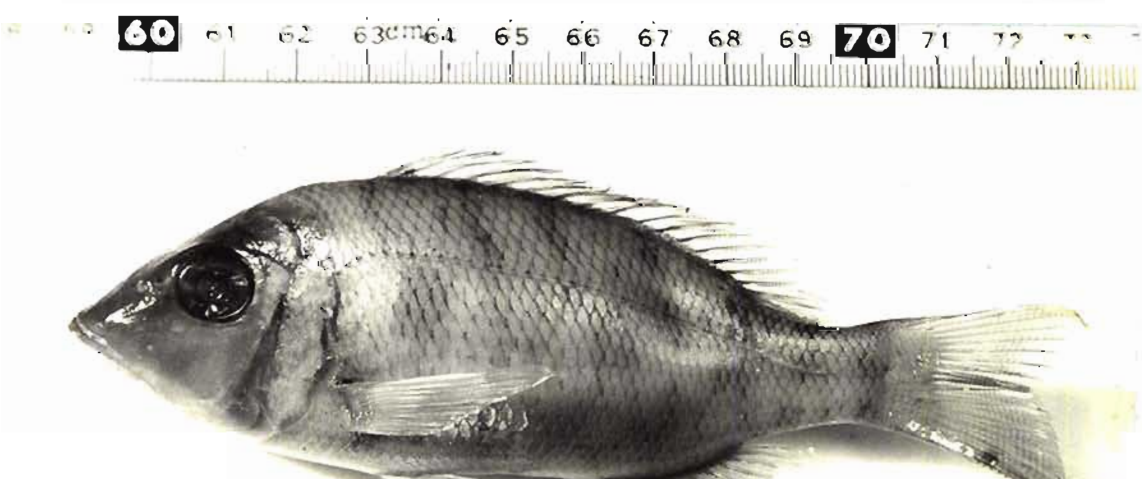
PLATE 34


75 76 77 78 79 80 81 cm 82 83 84 85 86 87 88 89 90 91 92 93 94

1



2

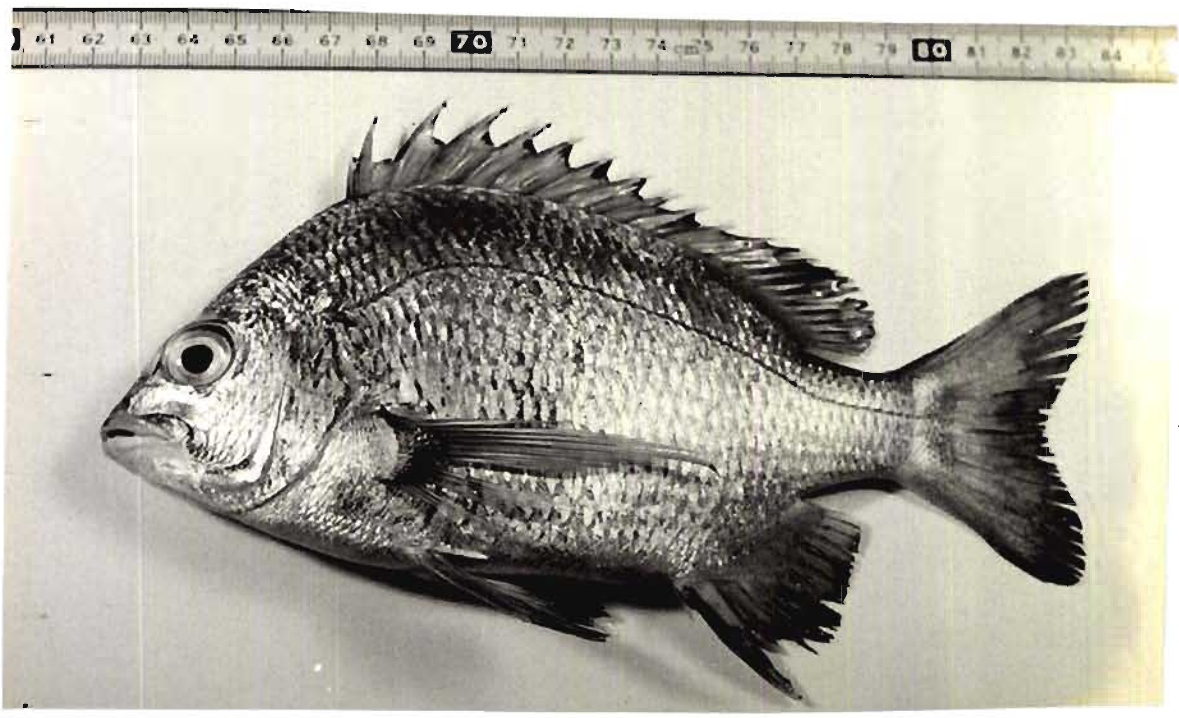

60 61 62 63 cm 64 65 66 67 68 69 70 71

3

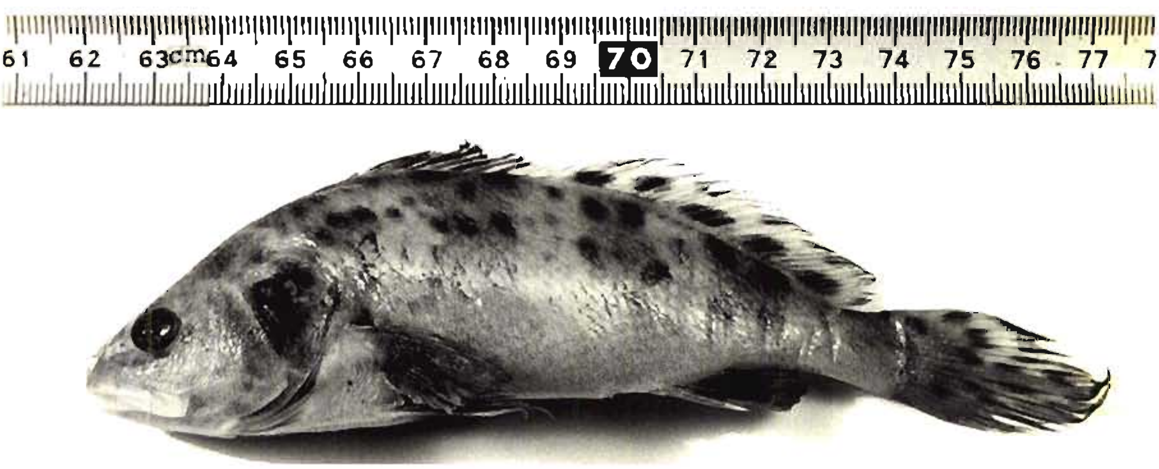
Plate 35.1. *Mylio berda*

2. *Protonibea diacanthus*

PLATE 35


61 62 63 64 65 66 67 68 69 70 71 72 73 74 cm 75 76 77 78 79 80 81 82 83 84

1


61 62 63 cm 64 65 66 67 68 69 70 71 72 73 74 75 76 77

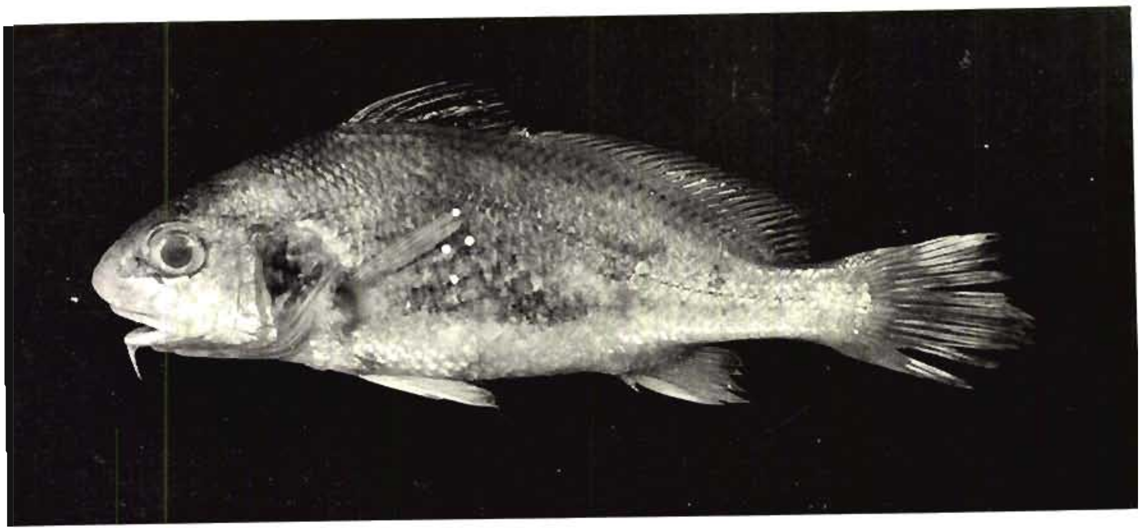
2

Plate 36.1. Dendrophysa russelli

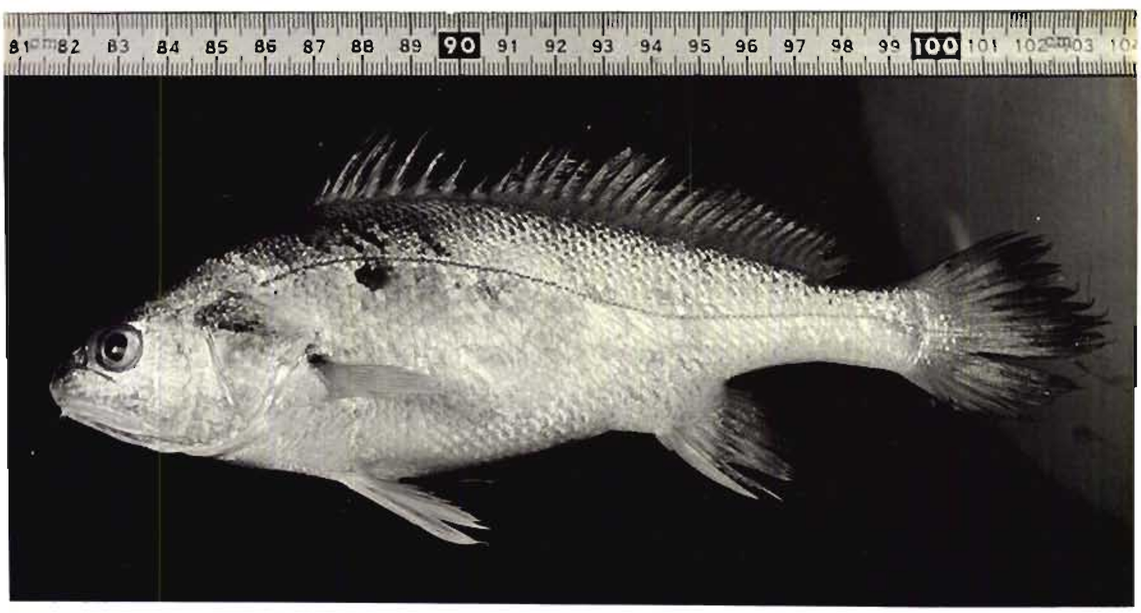
2. Dayscieena albida

3. Johnius (Johnius) belangerii

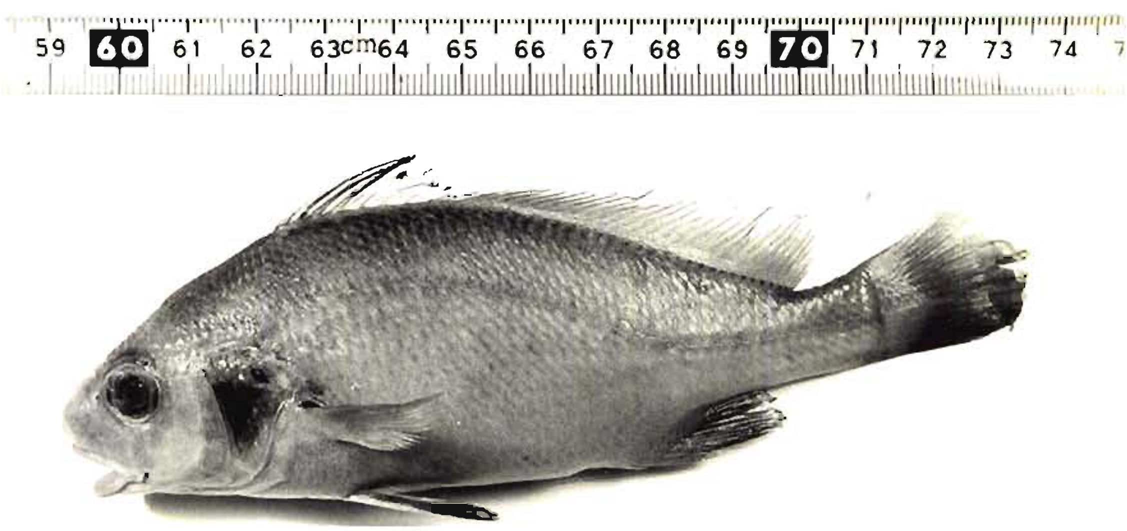
PLATE 36



1


81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103

2


59 60 61 62 63cm 64 65 66 67 68 69 70 71 72 73 74

3

Plate 37.1. Upeneus (Upeneus) sulphureus

2. Upeneus (Upeneus) vittatus

3. Parupeneus indicus

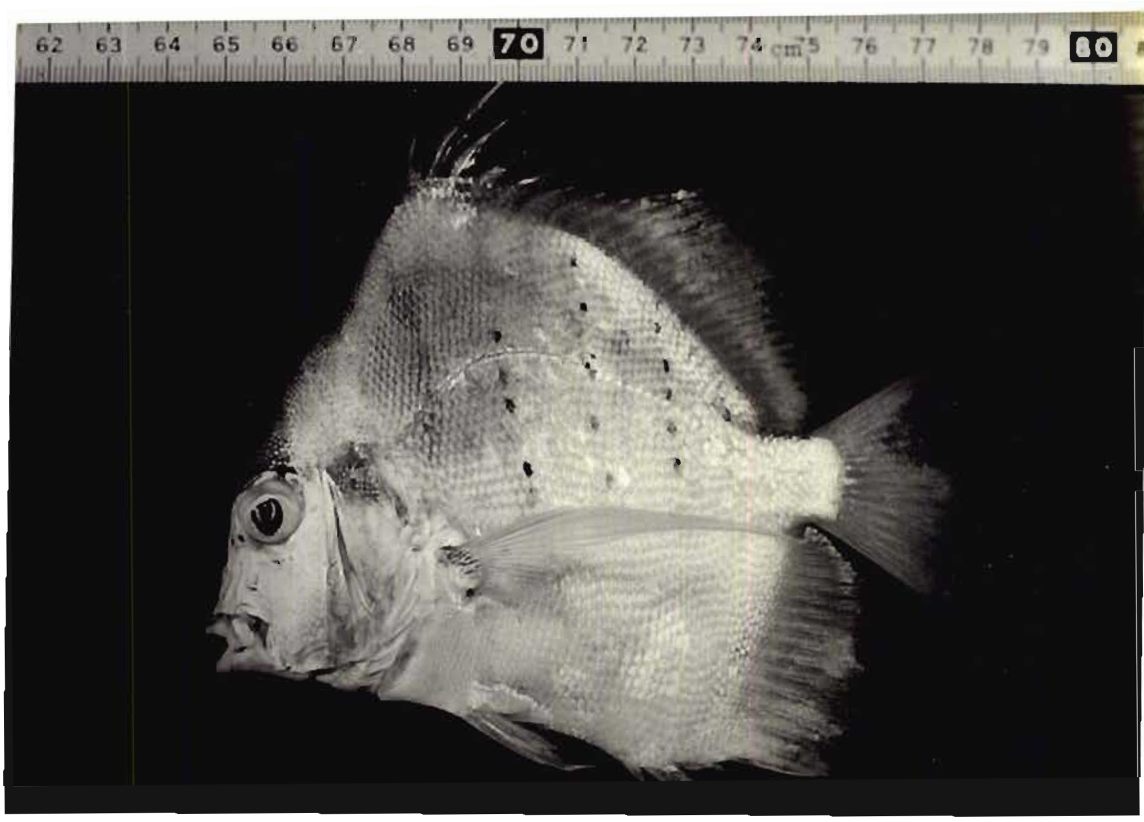
4. Drepane punctata

PLATE 37

1

2

3

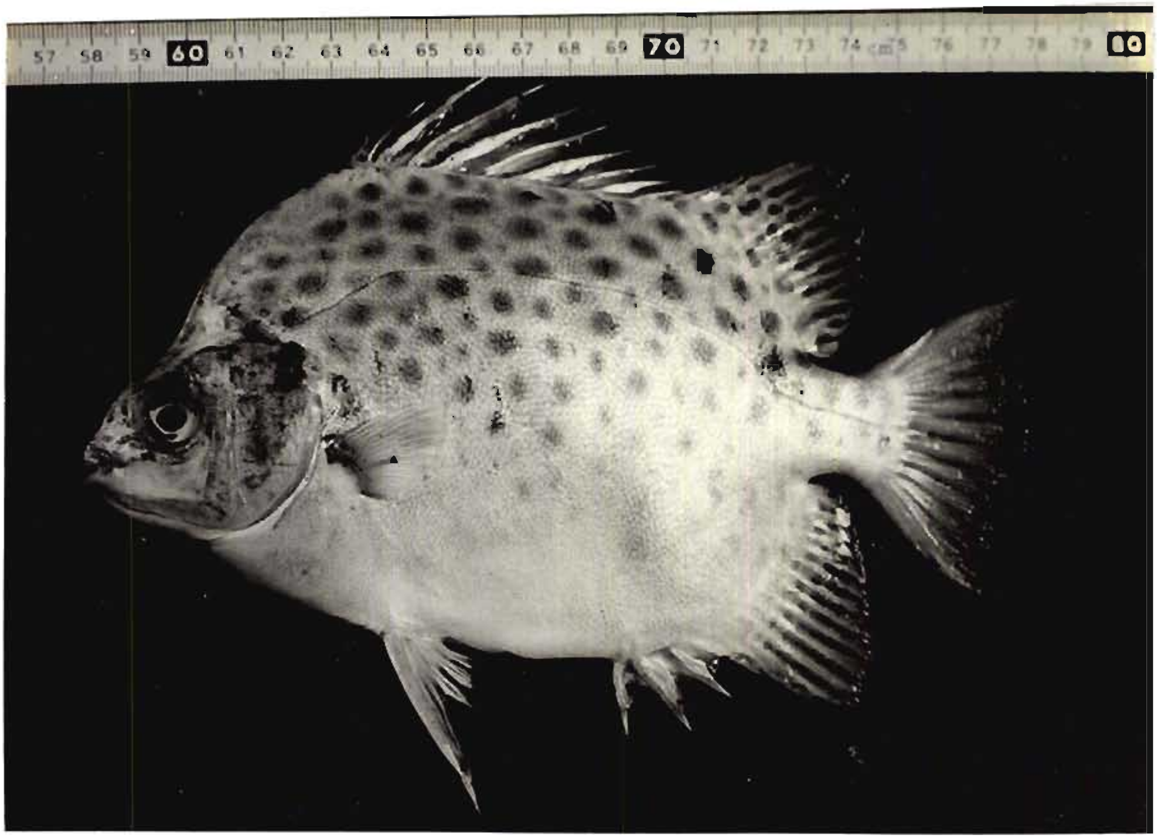


4

Plate 38.1. <u>Scatophagus argus</u>

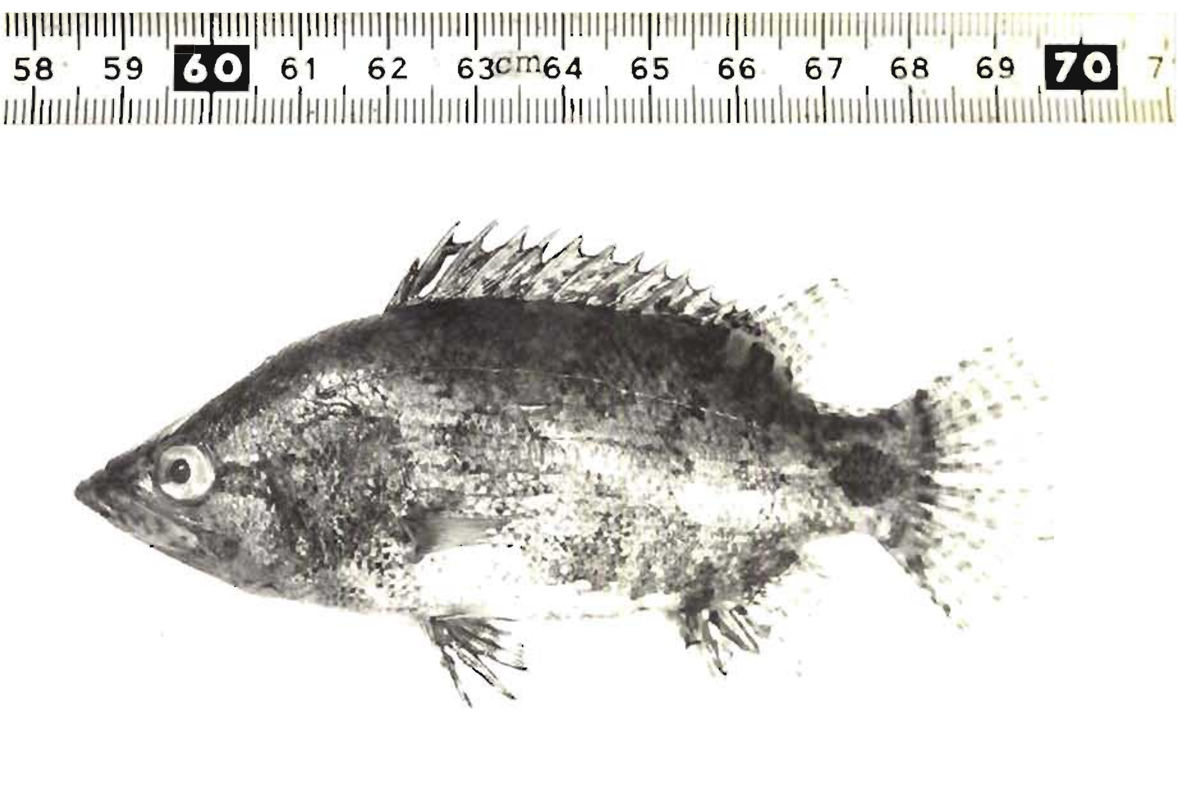
2. <u>Nandus marmoratus</u>

PLATE38



57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 cm 75 76 77 78 79 80

1



58 59 60 61 62 63 cm 64 65 66 67 68 69 70 7

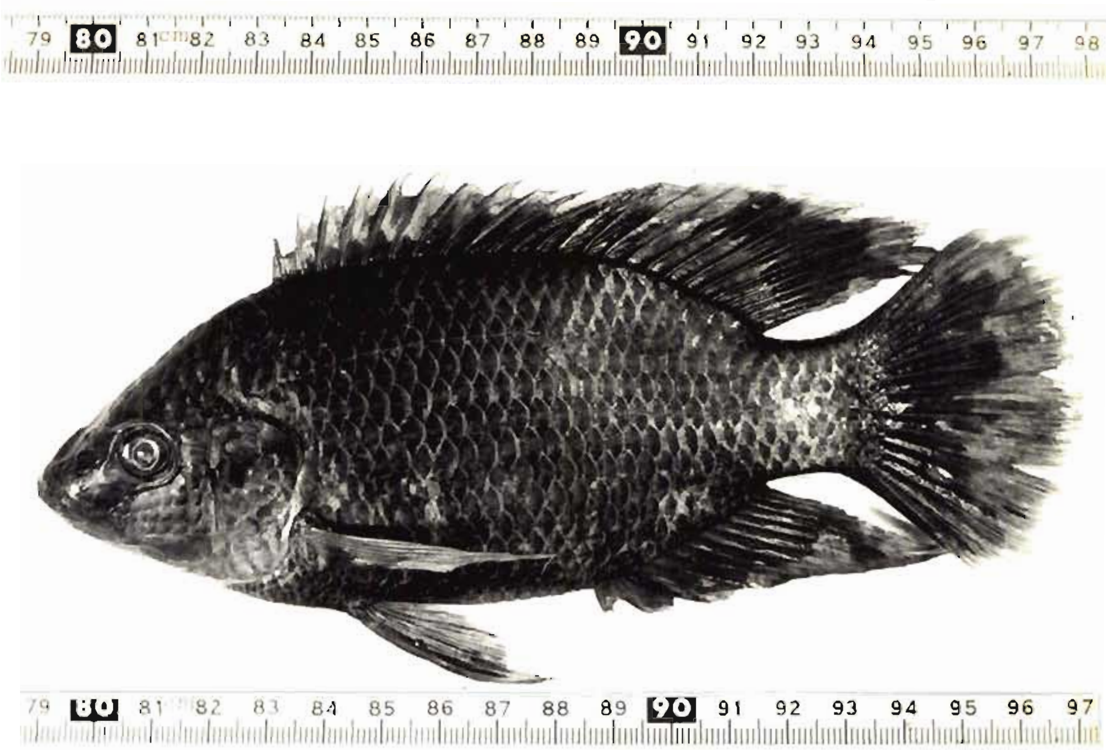
2

Plate 39.1. Sarotherodon mossambicus

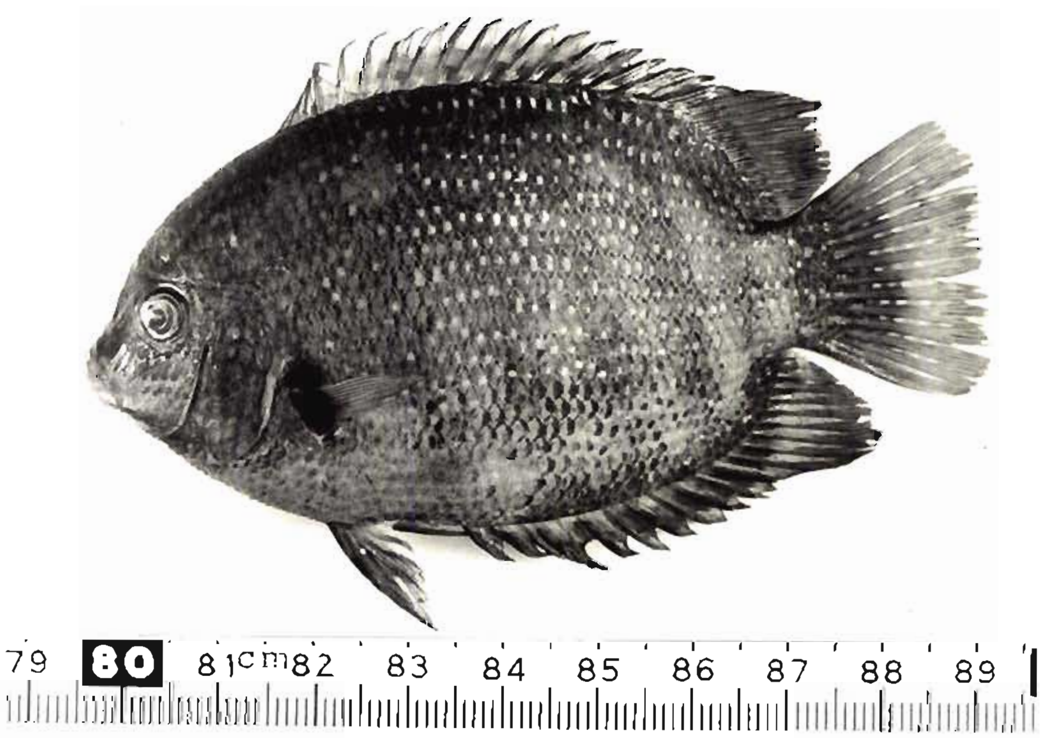
2. Etroplus suratensis

3. Etroplus maculatus

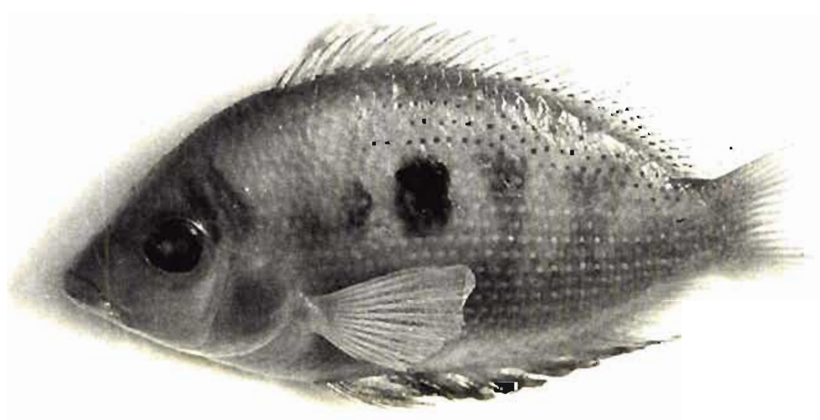
PLATE 39



1



2



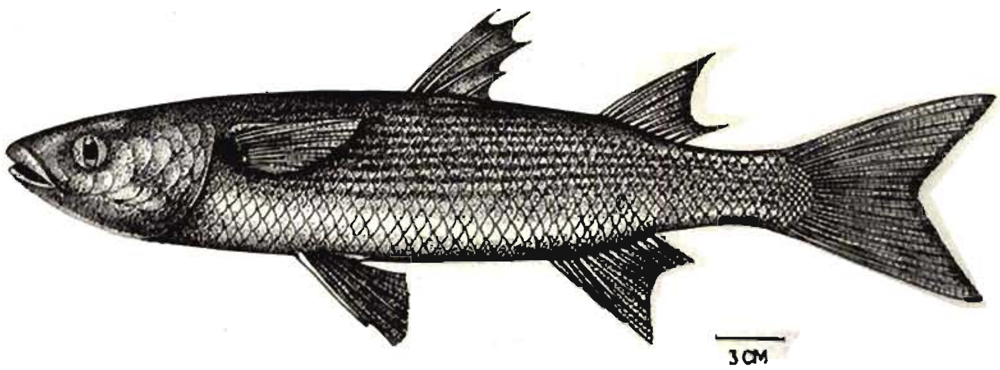
3

Plate 40.1. *Mugil cephalus*

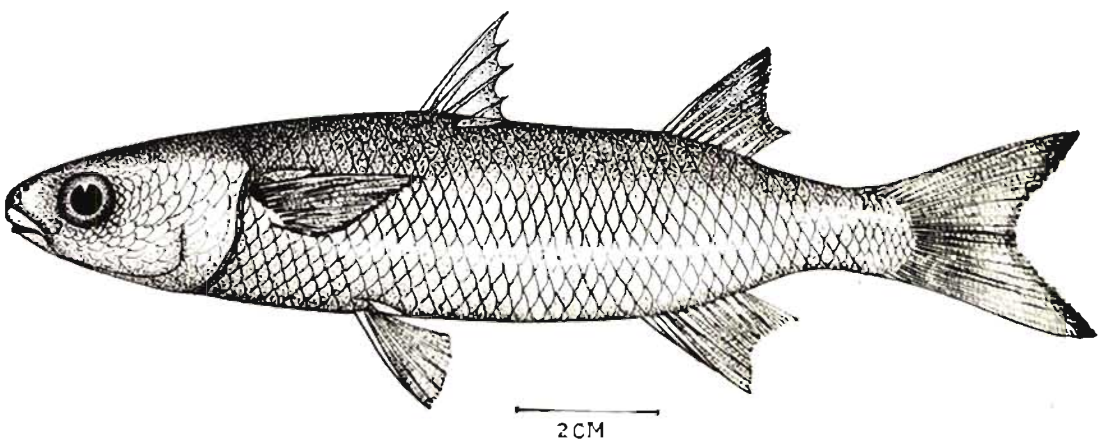
2. *Valamugil seheli*

3. *Valamugil cunnesius*

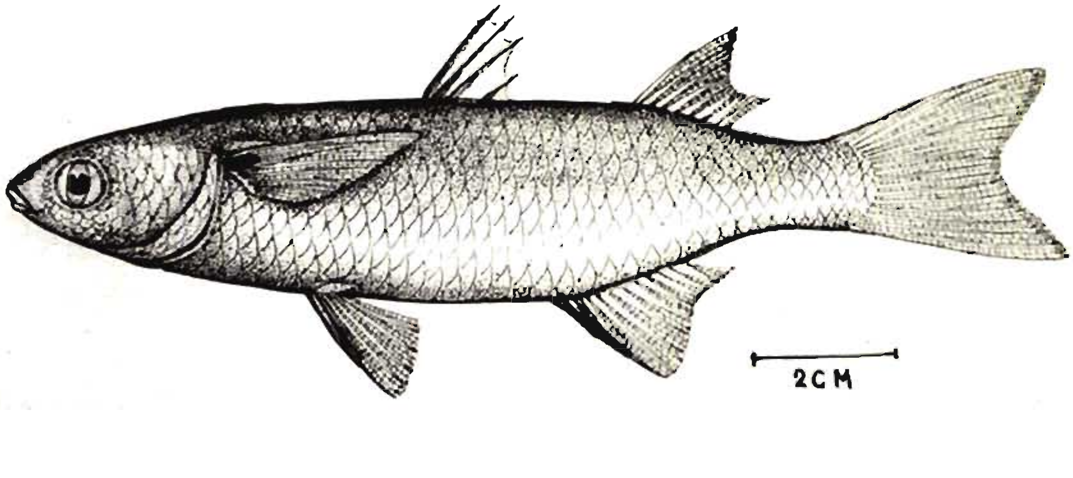
PLATE 40



1



2



3

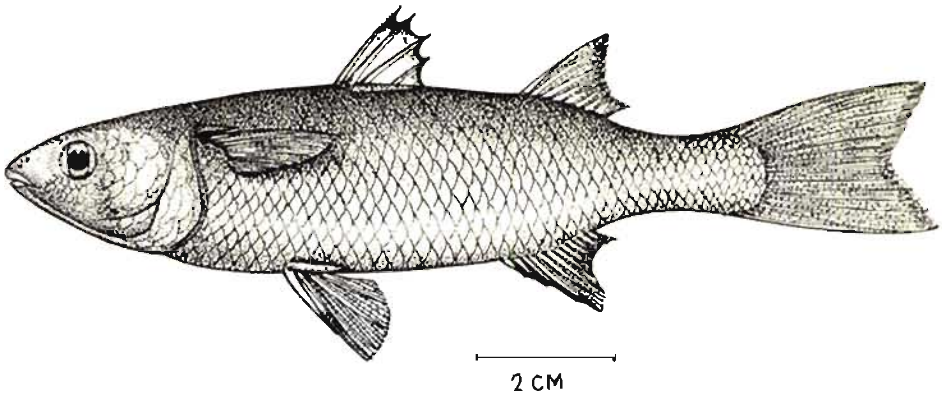
Plate 41.1. _Valamugil speigleri_

2. _Liza macrolepis_

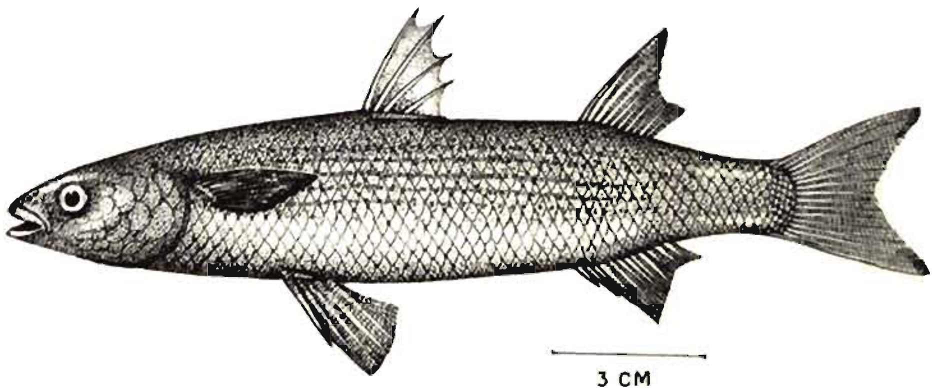
3. _Liza parsia_

4. _Liza subviridis_

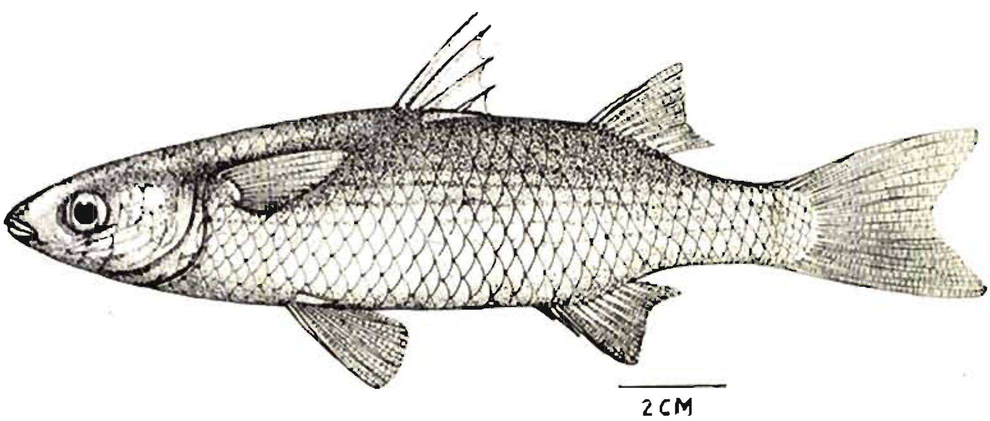
PLATE 41



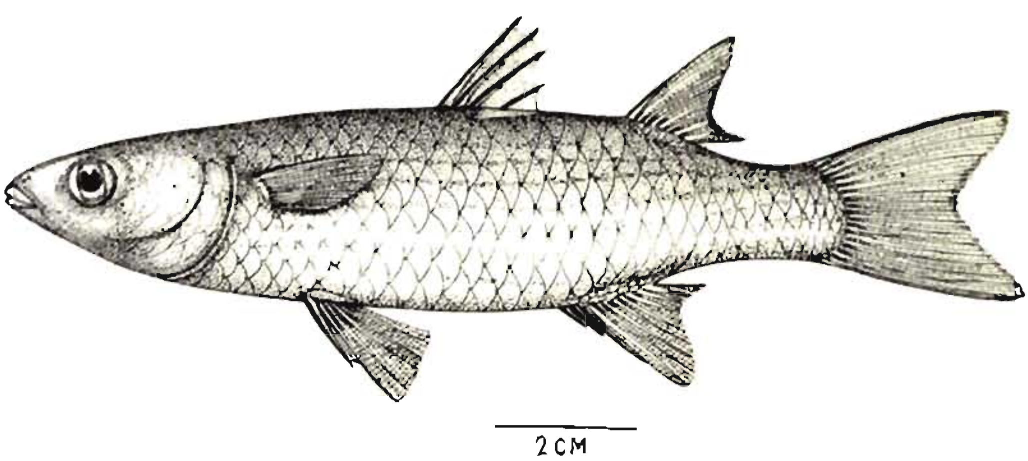
1



2



3

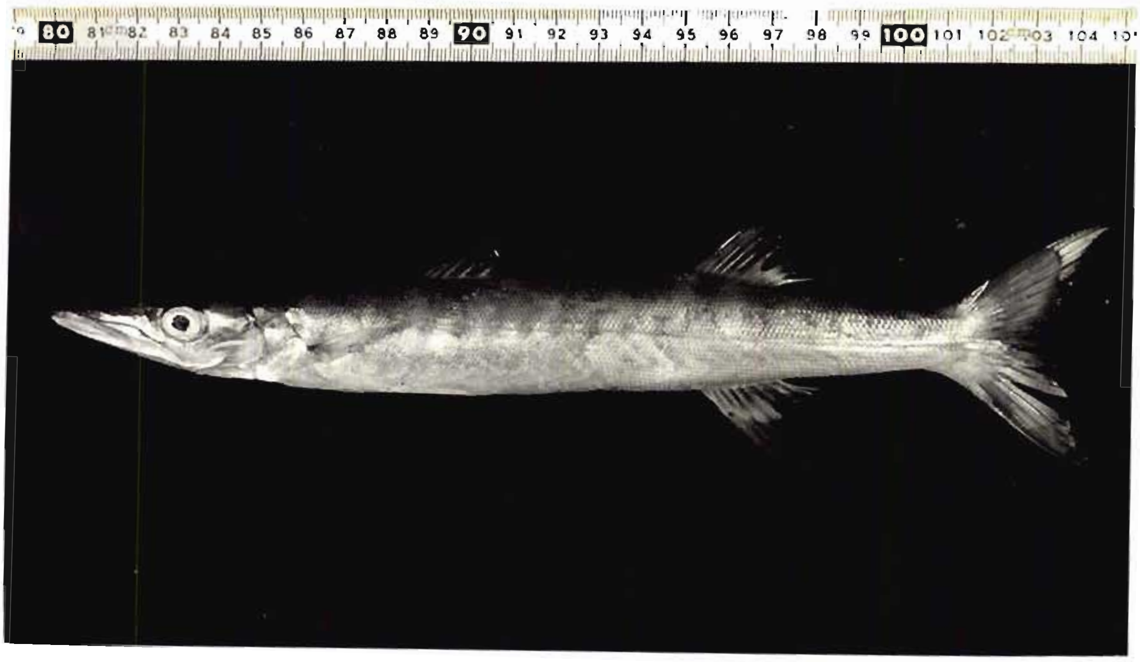


4

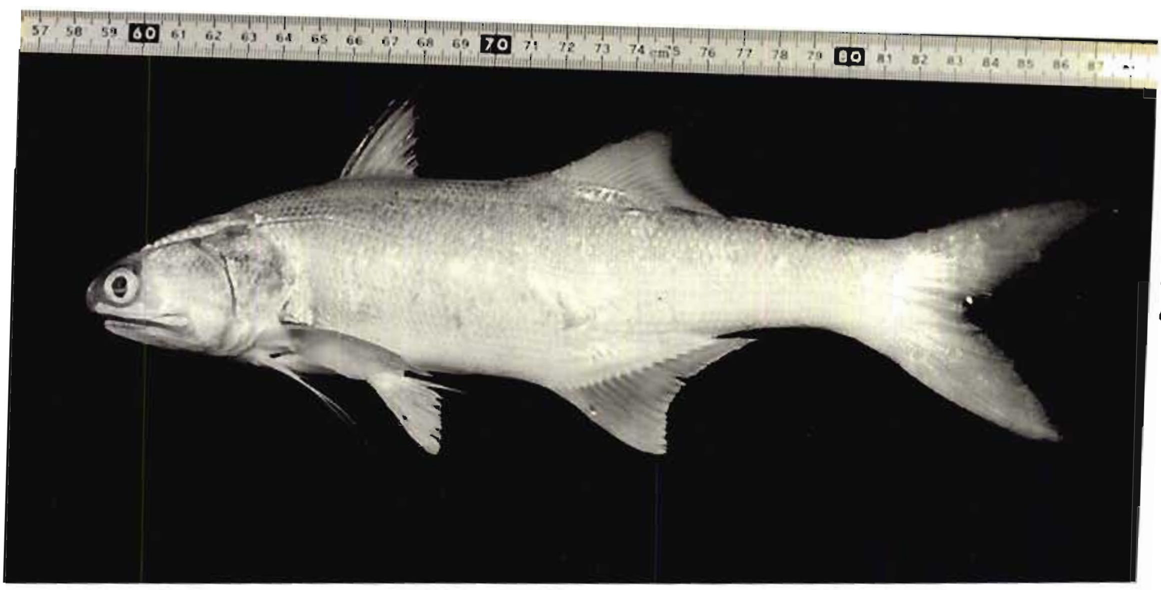
Plate 42.1. _Sphyraena jello_

2. _Eleutheronema tetradactylum_

PLATE 42



1



2

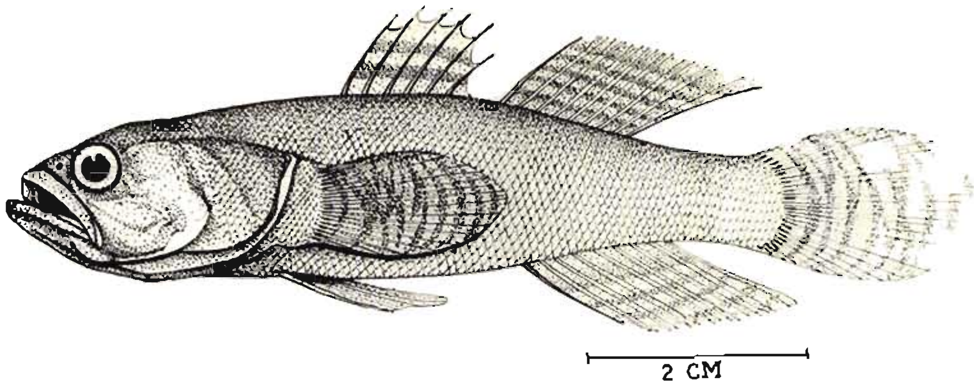
Plate 43. 1. Eleotris fusca

2. Butis butis

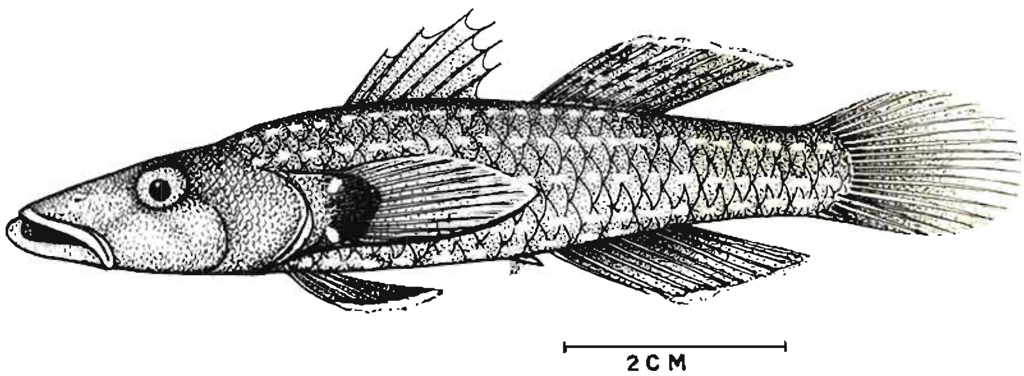
3. Bunaka gyrinoides

4. Stenogobius malabaricus

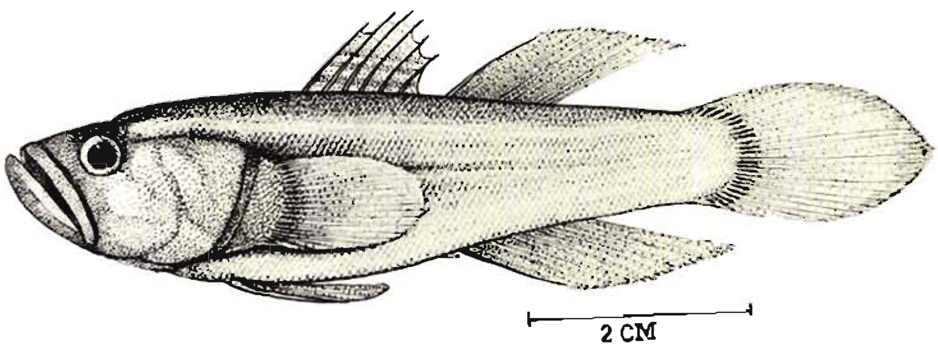
PLATE 43



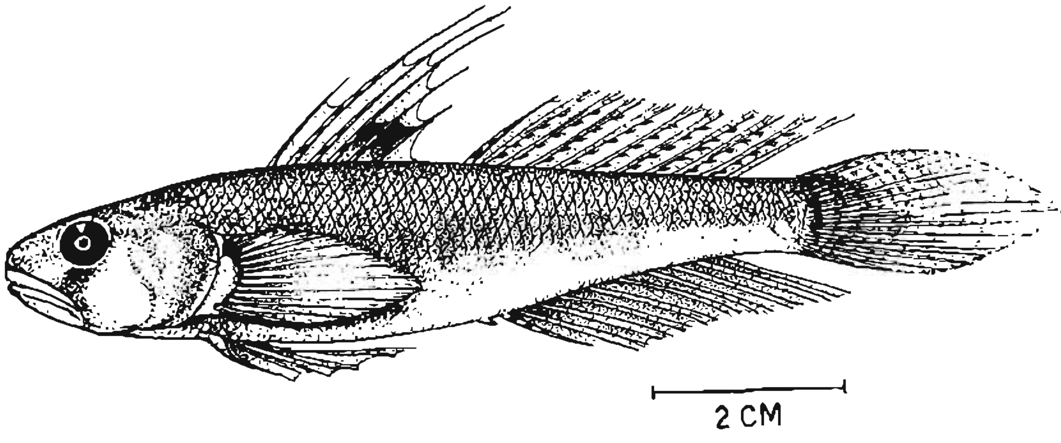
1



2



3



4

Plate 44.1. *Oxyurichthys tentacularis*

2. *Oxyurichthys microlepis*

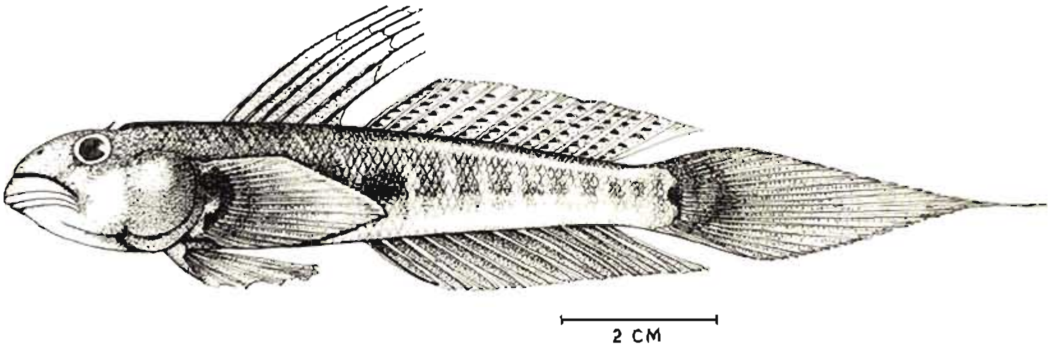
3. *Oxyurichthys nilsseni*

a) Female

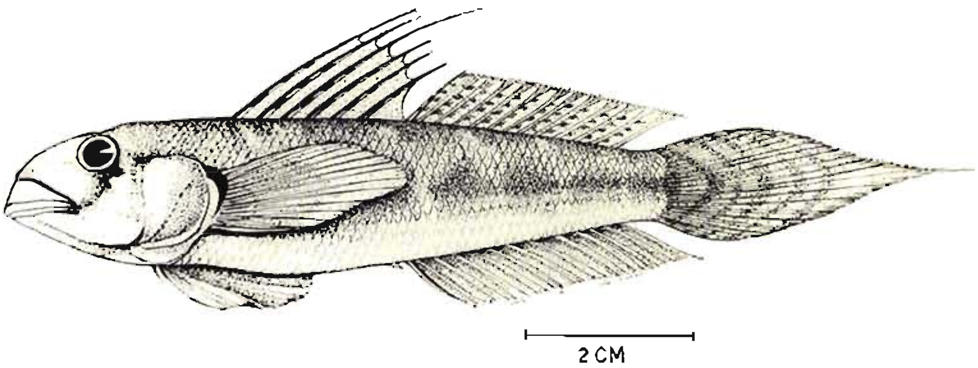
b) Male

After Kurup and Samuel, 1981

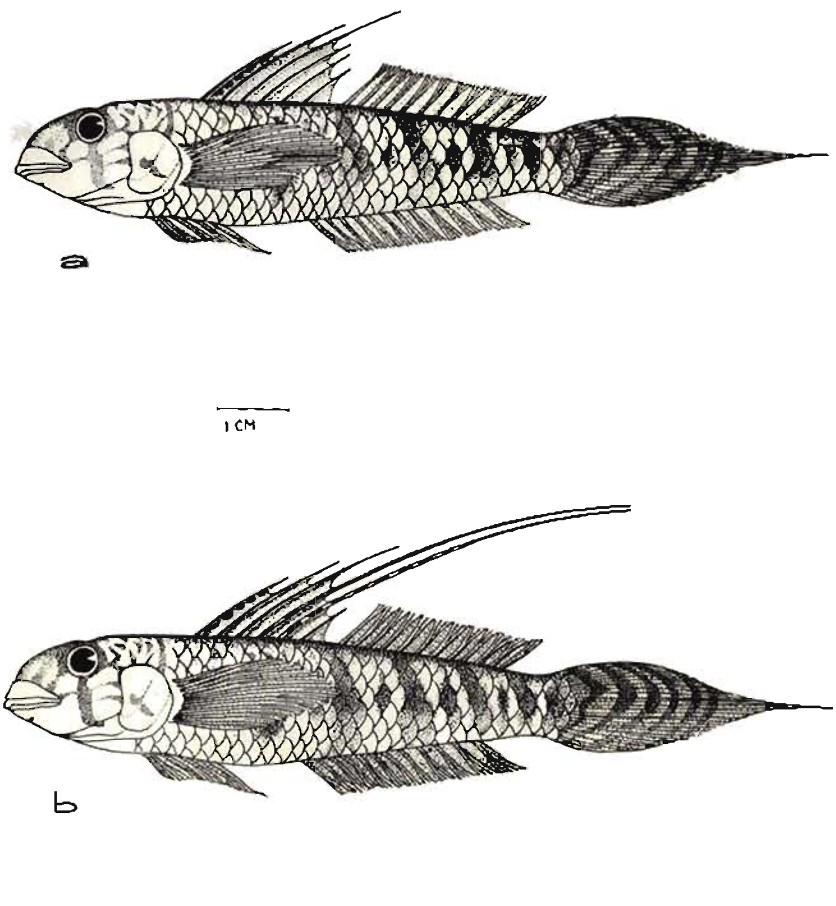
PLATE 44



1



2



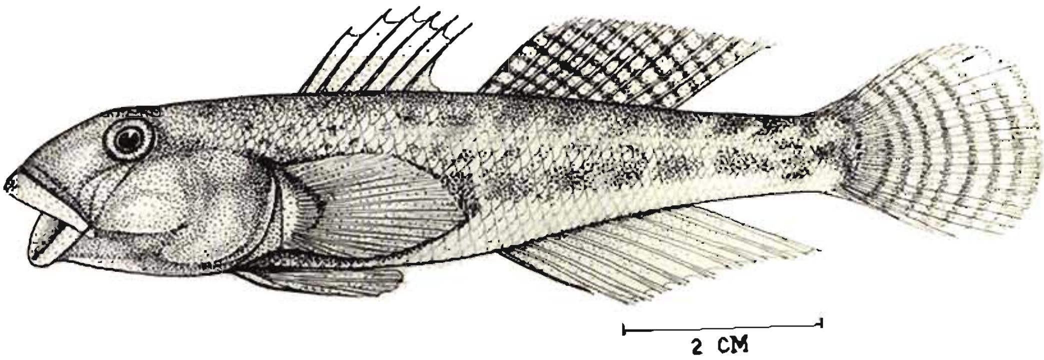
3

Plate 43.1. _Awaous stamineus_

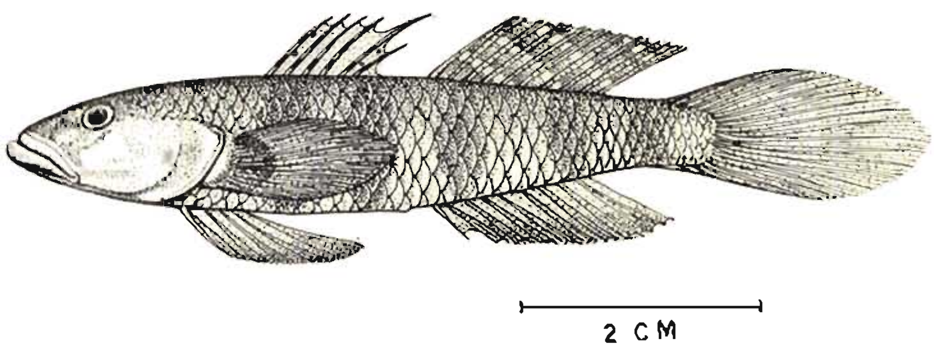
2. _Glossogobius biocellatus_

3. _Glossogobius giuris_

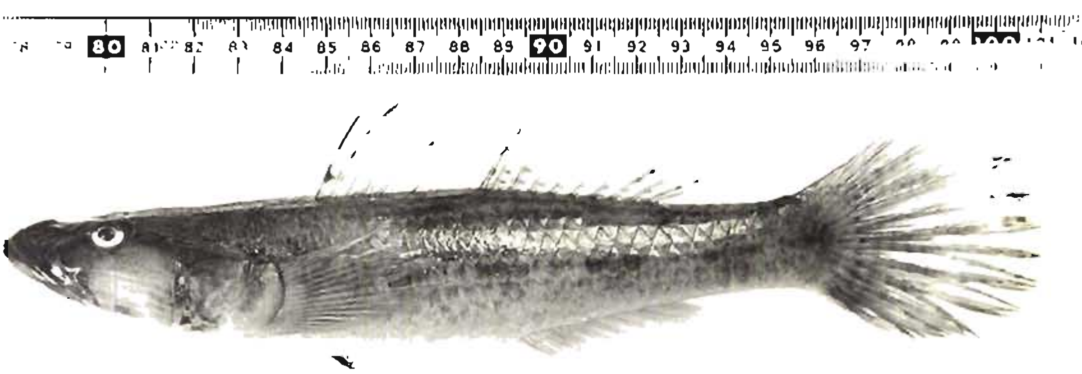
PLATE 45



1



2



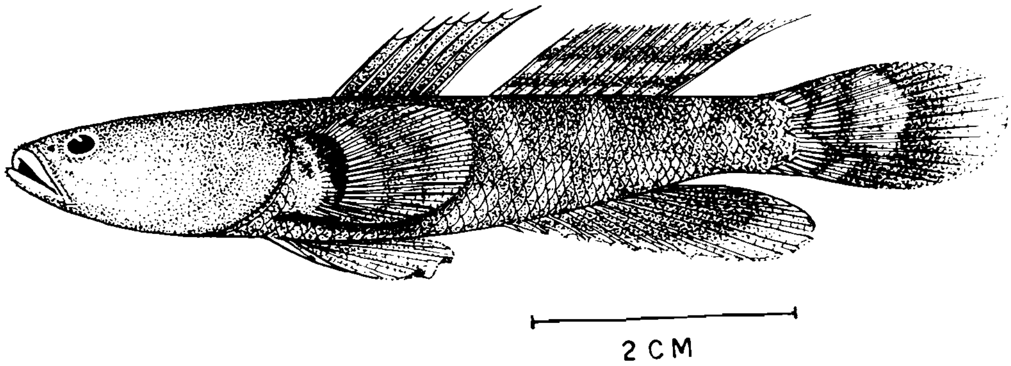
3

Plate 46.1. *Gobiopsis macrostomus*

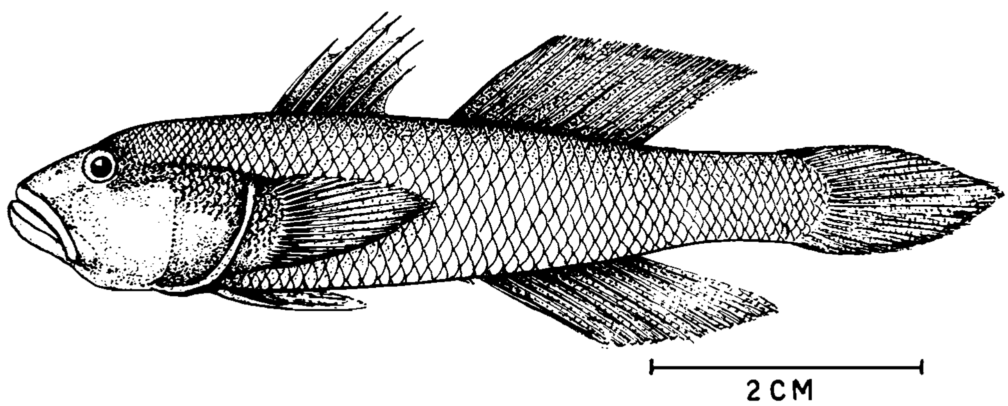
2. *Acentrogobius viridipunctatus*

3. *Acentrogobius caninus*

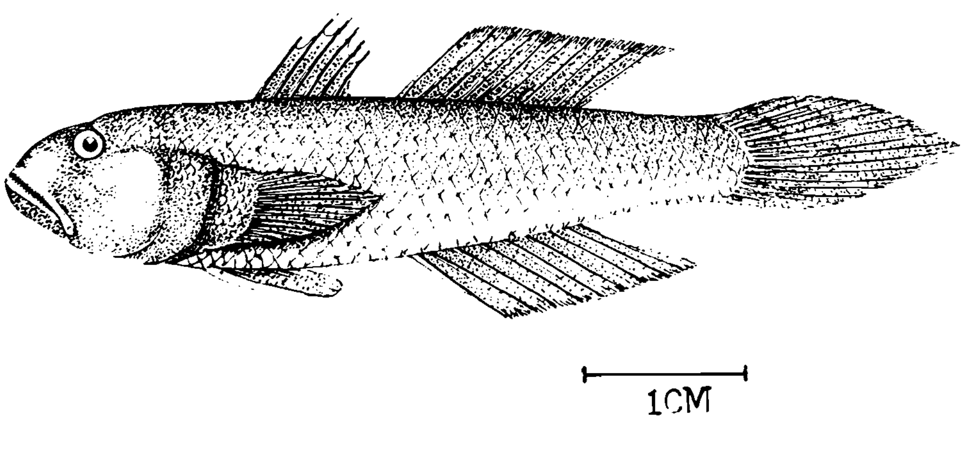
PLATE 46



1



2



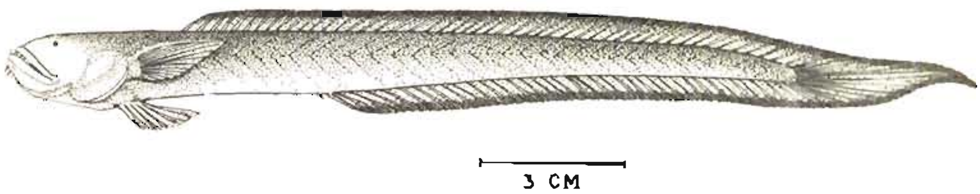
3

Plate 47.1. *Taenioides buchanani*

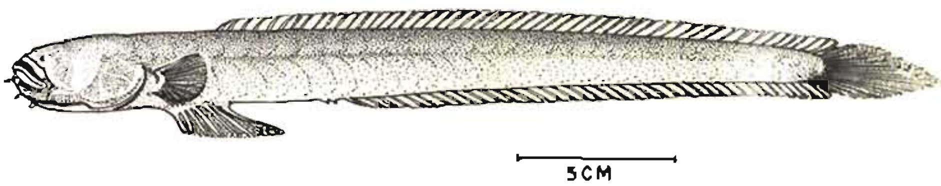
2. *Taenioides cirratus*

3. *Trypauchen vagina*

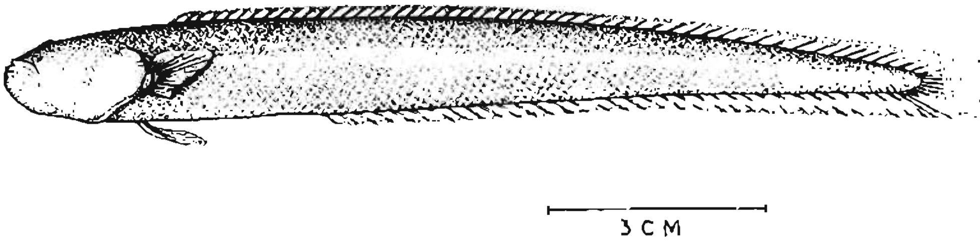
PLATE 47



1



2

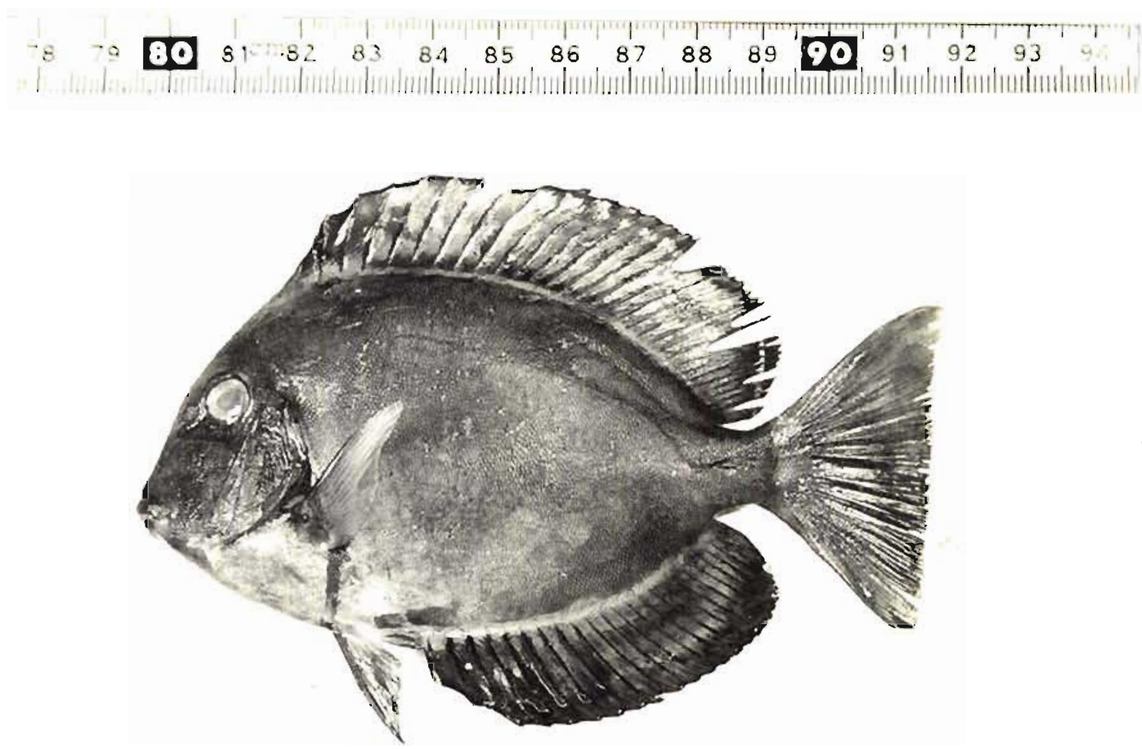


3

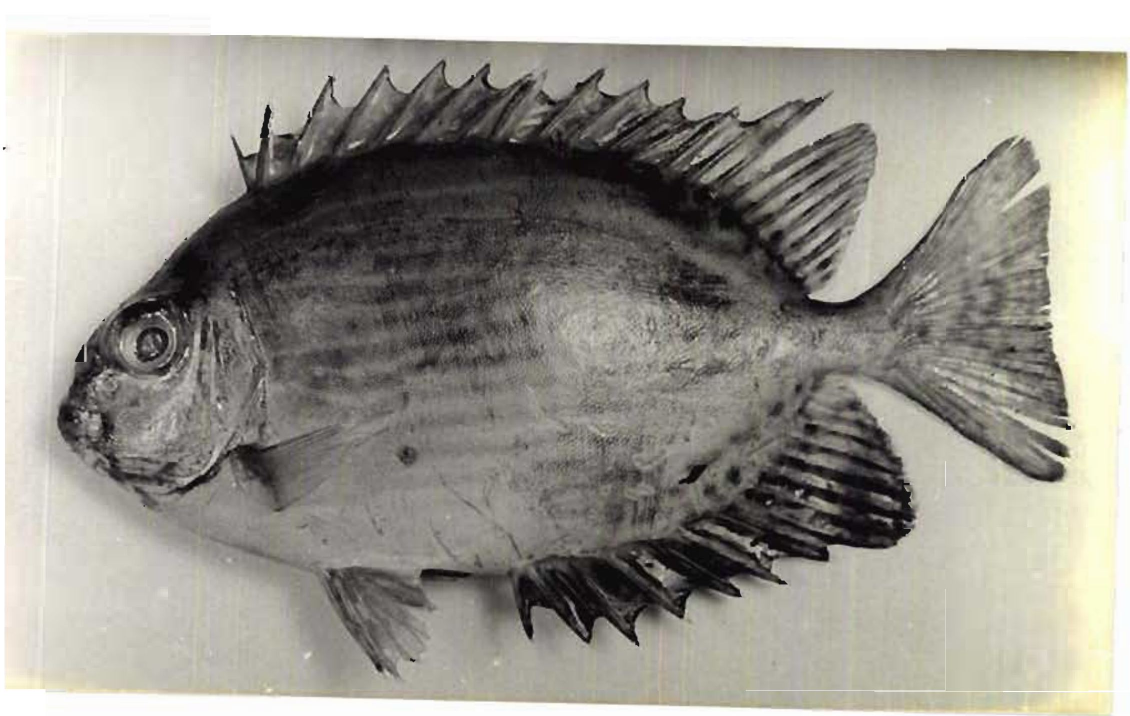
Plate 48.1. *Acanthurus matoides*

2. *Siganus lineatus*

PLATE 48



1



2

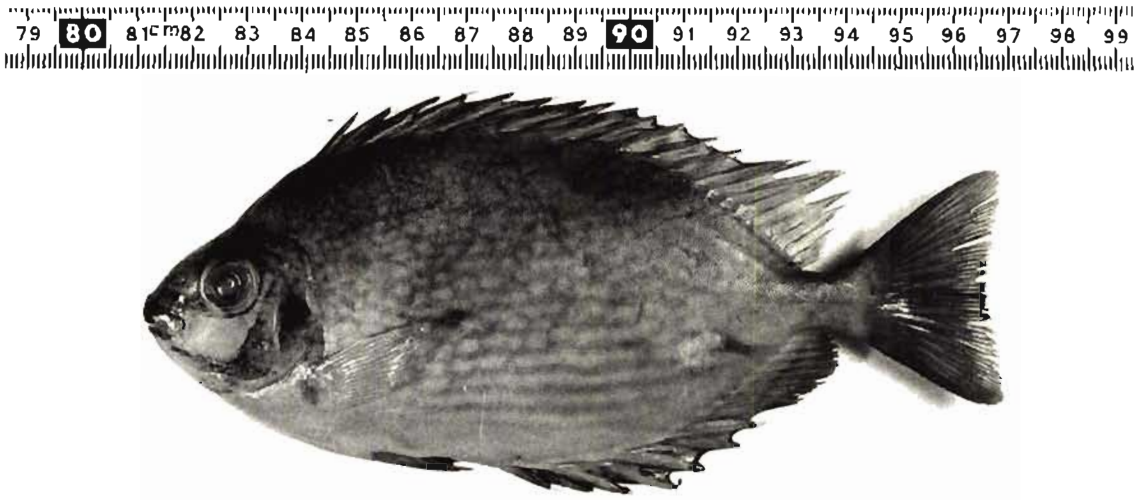
Plate 49.1. *Siganus javus*

2. *Siganus canaliculatus*

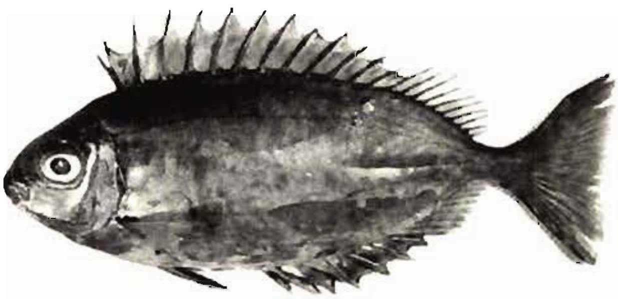
3. *Channa striata*

4. *Anabas testudineus*

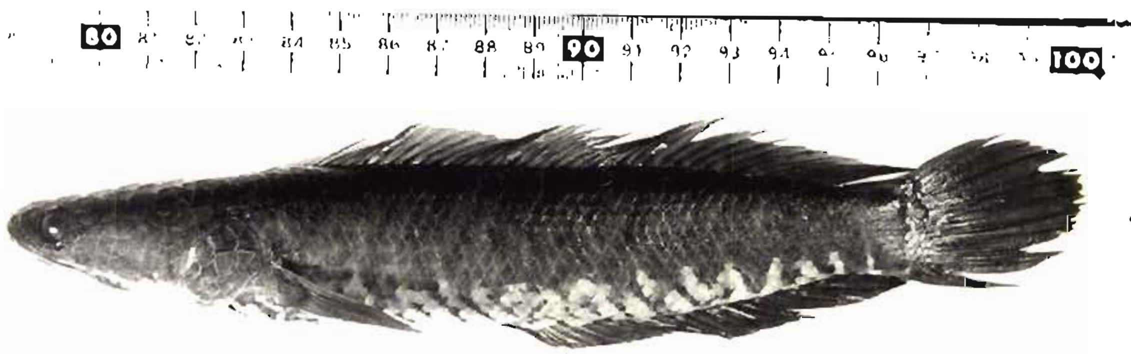
PLATE 49



1



2



3

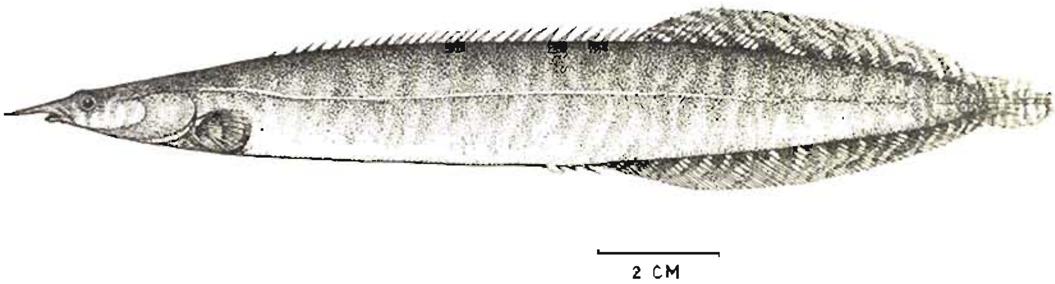
4

Plate 50.1. *Mastacembelus guentheri*

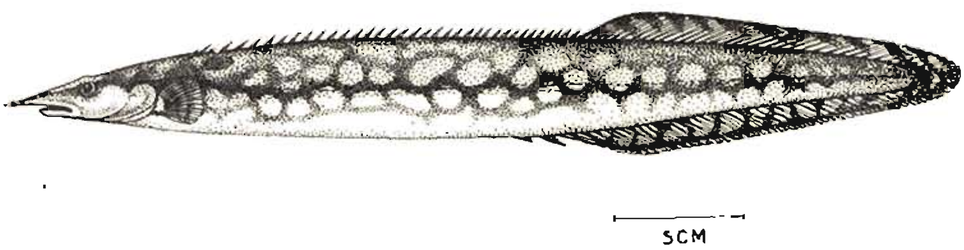
2. *Mastacembelus armatus*

3. *Synbranchus bengalensis*

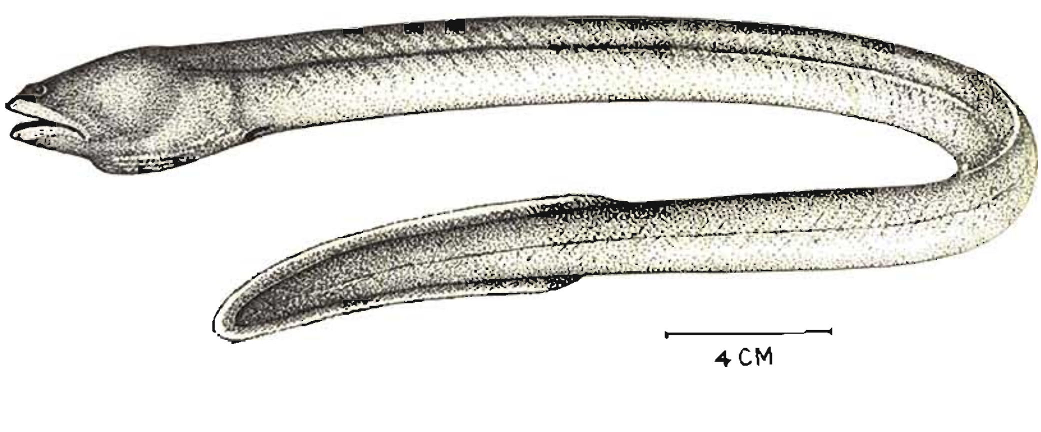
PLATE 50



1



2



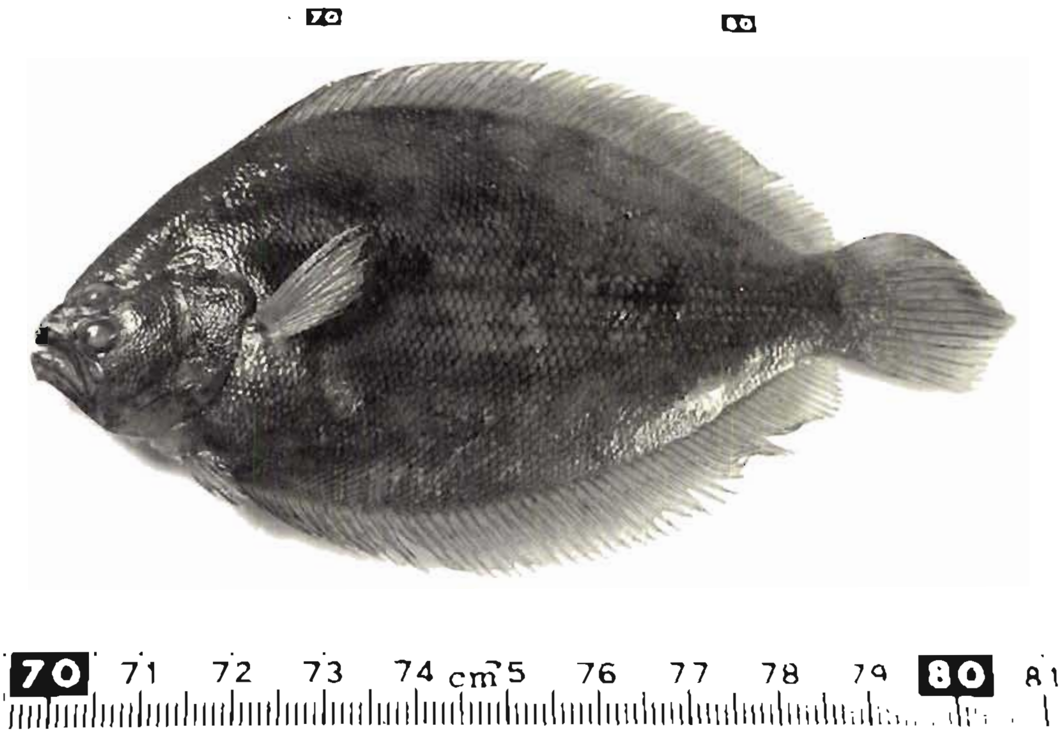
3

Plate 51.1. *Pseudorhombus arsius*

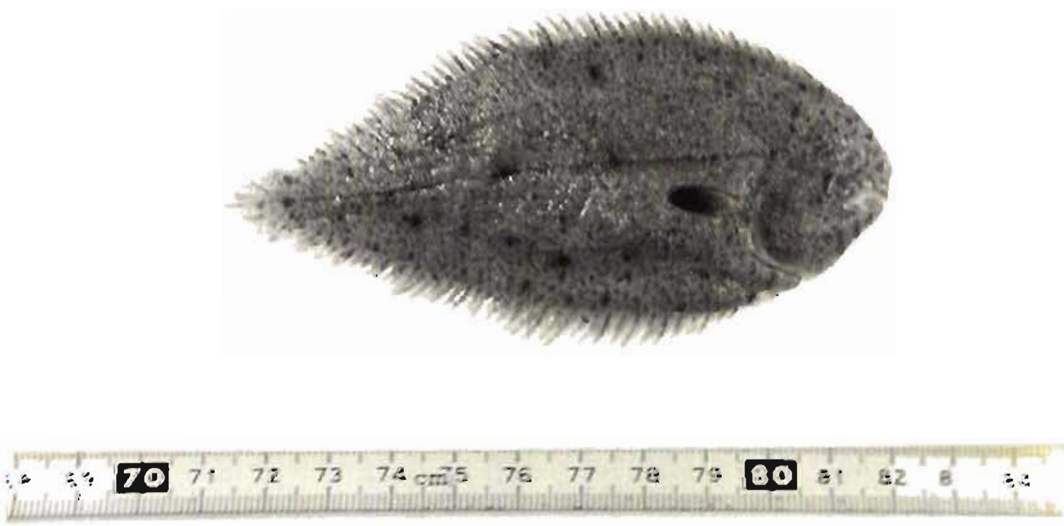
2. *Solea ovata*

3. *Synaptura commersoniana*

PLATE 51


70 71 72 73 74 cm 75 76 77 78 79 80 81

1


70 71 72 73 74 cm 75 76 77 78 79 80 81 82

2

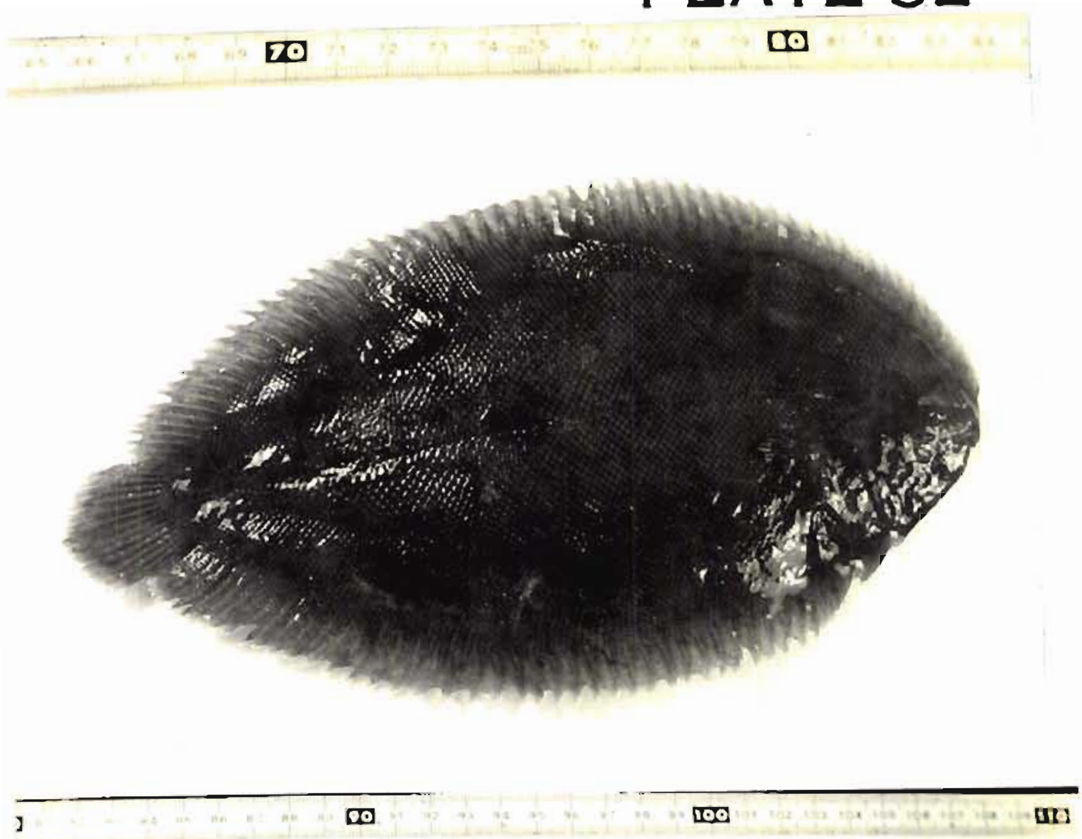
3

Plate 52.1. Brachirus orientalis

2. Cynoglossus bilineatus

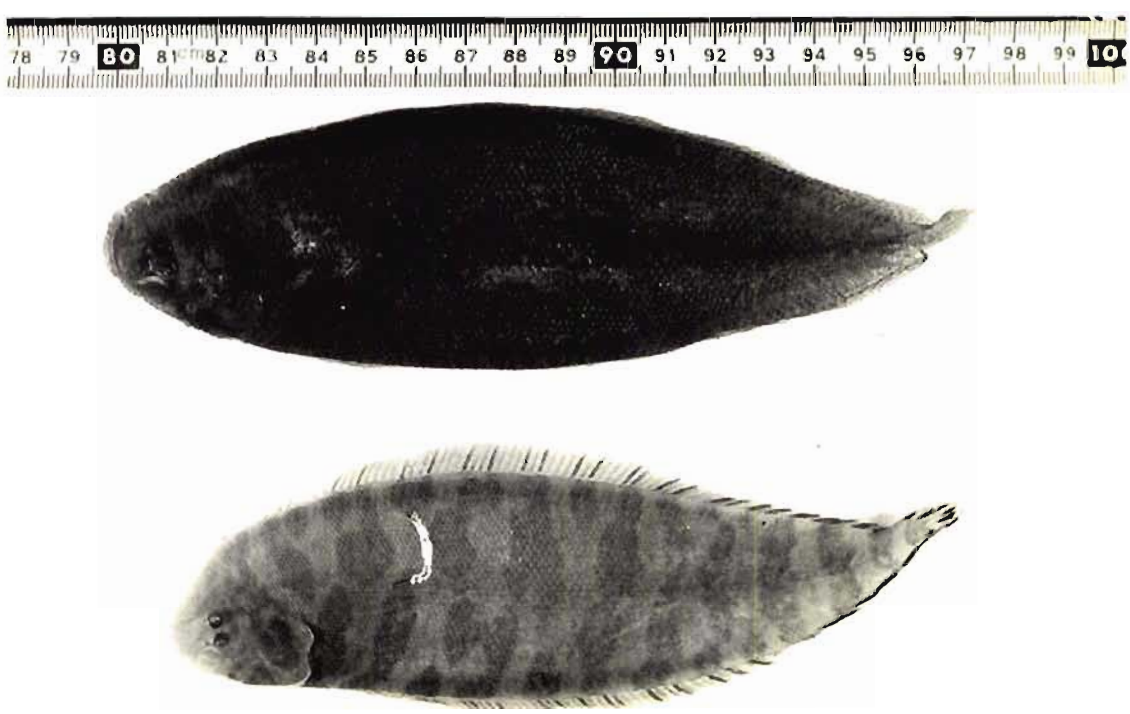
3. Cynoglossus puncticeps

PLATE 52



1

2

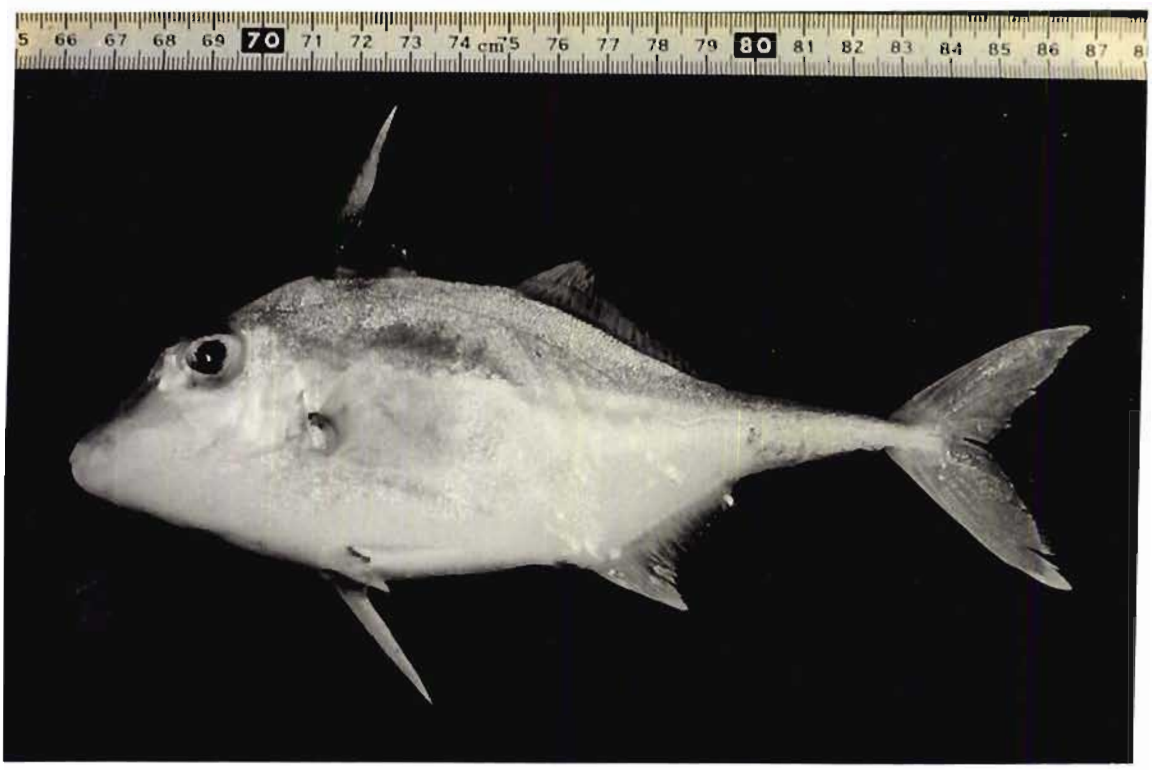


3

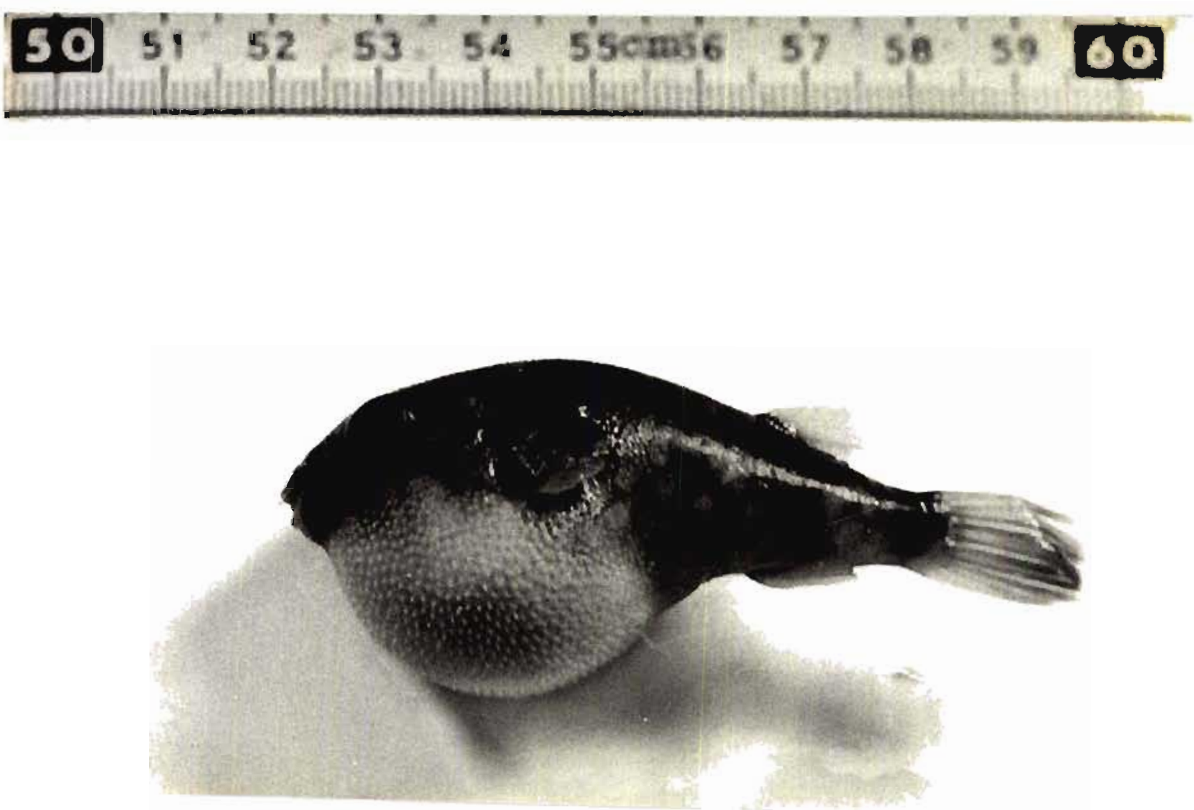
Plate 53.1. *Triacanthus brevirostris*

2. *Chelonodon patoca*

PLATE 53



1



2

Plate 54.1. _Tetraodon fluviatilis_

2. _Tetraodon leopardus_

PLATE 54

1

2

HYDROGRAPHY
and
FISH DISTRIBUTION

3. HYDROGRAPHY AND FISH DISTRIBUTION

3.1. INTRODUCTION

A detailed study on the ecology and distribution of fishes in a brackish water lake is essentially needed for the proper management of parts of the lake for various fish culture practices and fishery development programmes. The distribution and variation in the salinity, temperature and dissolved oxygen have a direct bearing on the occurrence and abundance of the organisms inhabiting the fresh water and marine habitat (Sobhana, 1976). The estuaries and brackish water lakes together constitute a very unique ecosystem where the relationship of the organisms with the environment is more striking than that of any other habitat owing to the physiological requirements of estuarine organisms to get themselves adapted to the widely fluctuating physico-chemical factors. According to Odum (1957) brackish waters are mostly naturally fertile because they are providing with large supplies of nutrients both from rivers and land drainage thus leading them to an efficient nutrient trap. This in turn, ultimately results in the high rate of productivity, which is indicated by the diversity of autotrophs, flora and fauna.

The physico-chemical parameters of almost all brackish water lakes and estuaries of India are properly studied but there is no effort made to relate the distribution and abundance of fish fauna to the fluctuating hydrological conditions of these habitats. Hora (1943, 1953a, 1953b) attempted to relate the distribution and abundance of fish fauna to the variations in the salinity in the river Hooghly. Jhingran and Natarajan (1969) made a proposal for a detailed study of the temperature and salinity distribution with the availability and abundance of fish fauna in the different sectors of Chilka lake. Based on the different physico-chemical and biological conditions prevailing in the Hooghly-Matlah estuarine system, Gopalakrishnan (1971) divided the entire estuary into 5 zones. The fishes inhabiting each zone and its peak period of occurrence were enumerated and he concluded that the marine zone of the estuary has a rich and diversified fish fauna which contributes much to the fishery resources of the estuary. Visweswara Rao (1976) recorded 191 species of non-clupeoid fishes from Godavari estuary of which 112 are euryhaline, 55 species are marine and 24 species belonging to fresh water. Sobhana (1976) studied the effect of physico-chemical factors on the breeding and feeding habits of

Puntius sarana subnasutus in Veli lake, Trivandrum. An attempt to correlate the spawning biology of *Liza parsia* with the prevailing ecological conditions in Cochin estuary was made by Kurup and Samuel (1981f).

Detailed investigations on the physico-chemical parameters of the Vembanad lake were made by a series of workers (Balakrishnan, 1957; George and Kartha, 1963; Ramamritham and Jayaraman, 1963; Cheriyan, 1967; Qasim and Gopinatham, 1969; Josanto, 1971; Wellershaus, 1973; Shynamma and Balakrishnan, 1973; Balakrishnan and Shynamma, 1976). Most of these studies on the physico-chemical parameters of the lake are confined to the northern sector of the lake and do not cover the entire area. Moreover, no attempt has been made so far to study the seasonal and geographical distribution and abundance of fish fauna with the fluctuating hydrological conditions of the entire lake system. Radhakrishnan *et al.* (1982, in press), made a comprehensive study on the seasonal and geographical distribution of the prawn and crab resources in relation to the fluctuating hydrographical features of this entire lake system during the pre-monsoon period. The reports on the distribution and abundance of fishes of Vembanad lake are confined to very few papers (Pillay, 1960; George, 1965; Reghu, 1973; Noble, 1974; Kurup and

Samuel, 1980a, 1980b, 1981c, 1981d, 1981e). Since the physico-chemical parameters of the medium exert a direct influence on the distribution and abundance of fishes of the lake, the present study was undertaken to bring to light the nature and pattern of fish distribution and their abundance in relation to the fluctuating hydrographical conditions of the lake.

The Vembanad lake supports a lucrative fishery, hence diversified fishing methods and devices are adopted by the fishermen for exploiting the various types of fisheries resources. They are variously designed to suit the local conditions and the fishes. Some of them are very selective for a particular species but most of the gears are designed for multispecies catches. Different fishing gears of the Kerala backwaters were described by Hornell (1925, 1938, 1950), Panikkar (1937), Gopinath (1953) and Shetty (1965). After Shetty's preliminary report, there was neither any subsequent work on fishing methods of Vembanad lake, nor any attempt made to classify the gears and fishing devices. A complete description of the gears and fishing methods is omitted since most of them were described in earlier reports. The gears operating in different sectors of the lake are discussed and the nature of the catch composition is also incorporated.

3.1. MATERIAL AND METHODS

The methods adopted for present study were similar to that of Kurup and Samuel (1980a). Fortnightly cruises were made in the estuarine region and monthly cruises were conducted from Alleppey to Thuruthipouram in R.V. Sagitta from October 1978 to September 1980. Fish sampling surveys were conducted from various types of fishing gears with special emphasis laid on species diversity, catch composition and percentage composition of individual species. Fishes were identified upto species level (as discussed in section 2) and the place of collection, time of collection etc. were recorded. The cruise reports also include the tide level, type of fishing gear used, aquatic macrovegetation and habitat of individual species of fishes. The different types of fishing gears were examined with special attention given to gear specification, mesh size and materials used for construction, mode and time of operation, catch composition and man power needed.

The physicochemical parameters were studied along with the fish sampling from the 20 fixed stations (Plate 1) in the lake. Surface water samples were collected using a plastic bucket and the bottom water sampler (Cheriyan, 1967) was used for collecting bottom water samples. The depth was noticed using the plummet and string. Surface and bottom water temperatures were measured on the spot with an ordinary centigrade thermometer. Surface and bottom water samples were collected for analysis of oxygen and salinity. The dissolved oxygen was determined by the Winkler technique, (Strickland and Parsons, 1968). The salinity was estimated by the Mohr Knudsen method (Barnes, 1959).

Based on the salinity characteristics, tidal regimes and nature of fish fauna, the Vembanad lake system has been divided into there sectors viz. northern sector (stations 1 to 12), central sector (stations 13 to 17) and southern sector (stations 18 to 20) (Plate 1).

3.3. Results and Discussion

3.4. Hydrography:

Hydrographical conditions of the estuarine system depend on the interaction of the sea and freshwater, the sea water dominating the system in summer and fresh water during monsoon. seasonal pattern could be seen in the variations of different hydrographical parameters. Nair (1965) distinguished three well defined seasons during his studies in Cochin backwaters, viz. Pre-monsoon (February to May), Monsoon (June to September) and post-monsoon (October to January), which was adopted by various later workers (Pillai *et al.*, 1975; Pillai, 1978). Based on the study of the various physico-chemical parameters of the Vembanad lake, the above well defined seasons were found to be quite suitable and hence adopted in the present work.

3.4.1. Temperature: Monthly mean values of the surface and bottom water temperatures are represented in Plate35. In both years the temperature distribution was found to be more or less of a similar pattern. A steady and steep increase in temperature was noticed from February to April, the maximum temperature during 1978-79 was recorded in March (33.6°C) and in 1979-80 was in April (33.4°C). From June onwards the temperature began to decrease due to the onset of the southwest monsoon, the lowest temperature (25.8°C) was recorded in August in both years. In September a slight increase in temperature values were noticed but in October, again it was found to be declining. From November onwards the temperature was found to be increasing gradually in the entire area.

The variation in temperature values for the entire period of investigation reflects the extent of climatic variations. The fluctuation of temperature is affected mainly due to the southwest monsoon. A bimodal type of temperature oscillation was observed as reported by previous workers (Haridas *et al.*, 1973; Pillai, 1978) in the same area. In general, during the post-monsoon season there was a gradual increase in temperature in the entire area. High temperature was prevalent during the pre-monsoon season and there was a progressive increase in temperature from February to April. The temperature values were found to be falling down with the onset of the south-west monsoon. Sankaranarayan and Qasim (1969) stated that the influx of fresh water into the estuarine system is not the sole factor in bringing down the water temperature, but the intrusion of a tongue of cold water from the Arabian sea may also be a significant factor. According to Ramamirtham and Jayaraman (1963), the incursion of cold upwelled water from the Arabian sea may also result in the decrease in the temperature of the estuary during the monsoon season.

3.4.2. Salinity: The monthly mean value of the surface and bottom water salinity is represented in Plate 56. Salinity fluctuations were very significant in all stations. From February to April, the salinity distribution in most parts of the lake appears to be very stable and the incursion of sea water was noticeable in all stations. The highest salinity values (33.68 and 33.02‰) were recorded in April from station No.2 in 1978-'79 and 1979-'80 respectively. Abrupt changes in salinity values were found in the entire area with the onset of the southwest monsoon, the salinity values were found to be falling down to 0.1‰ in some of the stations during July and August. A slight increase was noticed in September and again it was found to be decreasing in October due to the increase of rainfall. The salinity values gradually increased from November to January eventhough there existed a lot of instability during these months.

The salinity was the most fluctuating parameter in the lake. The horizontal distribution of salinity was significantly influenced by the fresh water discharges from the adjoining rivers, especially during the southwest monsoon season, tidal action from the sea and the rate of the mixing process. High saline conditions could be oubserved near the proximity of Cochin and Azheekode and the values were found to be gradually decreasing towards the interior. The salinity of the northern sector was relatively higher than the central and southern sectors of the lake. The high salinity prevalent in the northern sector is due to the impact of neretic waters entering through the perennial passages at Cochin and Azheekode. In general, the salinity values were found to be increasing steadily from November to the middle of May, and by the end of May, there was a steady decline due to the onset of occasional rain. However, the salinity values did not reach even 4.0‰ in areas south east of Thannirmukkom due to the closing up of the bund during the pre-monsoon periods.

3.4.3. Dissolved Oxygen: Monthly mean values of the dissolved oxygen of surface and bottom water are depicted in Plate 57. The highest oxygen values (5.78 ml/l) was recorded from station No. 19 in June during 1978-'79 and in August (5.80 ml/l) from station No. 20 during 1979-'80. The lowest oxygen values were recorded from station No.5 in both years (1.86 and 1.91 ml/l). In general, lower oxygen values were recorded during the pre-monsoon periods and higher values were noted in the monsoon season. The fluctuation of oxygen values during the post-monsoon season was rather insignificant.

Qasim *et al.* (1969), Haridas *et al.* (1973) and Pillai *et al.* (1975) reported high oxygen values during the monsoon periods from the same area. According to Qasim *et al.* (1969), one of the probable reasons for the high concentration of dissolved oxygen content in the study area during monsoon periods may be the high primary production occurring in the surface layers during the above period. Pillai (1978) reported that the oxygen concentration of the bottom waters of Cochin barmouth showed a decline during the monsoon season which may be due to the decomposition of organic matter and the influx of cold sea water from the upwelled area.

3.3. Fishing Methods:

An attempt was made to classify the fishing gears, which are used in the Vembanad lake into major groups. Both the methods of operation and the details of construction were taken into consideration (Jhingran and Natarajan, 1969; Krishnamurthy and Prabhakara Rao, 1970) for their classification. The criterion employed for the classification of each major class into sub-classes are mainly based on the differences noticed in the gear specifications such as length, width, mesh size, materials used and the mode of operation. It was observed that different terminologies are used for the same type of gears in different sectors of the lake. The different type of fishing gears of Vembanad lake are included in Table 2. Three major categories of methods constitute the fishing operations in the lake viz. (1) net fishing (2) line fishing (3) miscellaneous methods. Five major classes of fishing gears are recorded in the lake viz. drag nets, bag nets, gill nets, fixed (stake) nets and cast nets. Two kinds of line fishing were observed viz., hand line and long line both of which use baited hooks. The miscellaneous methods include mainly hand picking, changala payikkal or pachil and trap fishing.

Among the drag nets, Pattukanni vala, Thirutha vala and Peru vala were extensively used in the northern and central sectors of the lake. The operation of Pattukkanni vala was observed in the proximity of the Cochin habour area. The main catches composed of Mullets, Caranx spp., Gerrids, Cat fishes, Silver-bellies and Siganids. The Thirutha vala was employed for catching exclusively *Mugil cephalus* and was mainly operated in the northern and the northern half of the central sector. The other listed drag nets viz. Neria vala, Paithu vala, Koru vala and Mandu vala were found to be frequently operating in the central and southern sectors. The main catches of these gears were Clupeids, Ambassids, Cat fishes, Sciaenids, Flat-heads, Gobiids and Cichlids.

single type of bag net was found to be used in the Azheekode mouth of the lake during February-April.

This net is similar in design, construction and operation to those of an otter trawl. The main catches composed of Flat-heads, Flat fishes *Pomadasys* spp. etc.

The operation of different types of gill nets in the lake is very common during pre and post-monsoon seasons. Koori vala and Kutti vala were mainly employed in the southern half of central sector and the catches mainly include Cat fishes, Clupeids, Gerrids and *Sphyraena* spp. Ozhukku vala is one of the commonest type of gill nets, which is frequently used in the northern and central sectors of the lake during pre-monsoon season. The catches noticed were Clupeids, Engraulids, Sciaenids, Gerrids, Ambassids, Cat fishes, Eels, Silver-bellies and *Sphyraena* spp. The operation of Karimeen vala is strictly confined in the southern most region of southern sector of the lake. This gear is designed for catching *Etroplus suratensis* and is operated throughout the year. In addition to Pearlspot, Cat fishes, lesser Carps, *Ambassis dayi*, *Brachiurus orientalis*, *Megalops cyprinoides*, Spiny eels etc. were found to be present in the catches. Muraru vala is designed only for catching Half-beaks and Belonids and is extensively used in the southern most region of central sector.

Chinese dip nets were found to be very common in the northern sector and crowded in the barmouths of Cochin and Azheekode. The catches were Mullets, Scatophagus spp., Clupeids, Cat fishes, Carangids, Pomadasys spp. and Sciaenids. Onnu vala is present in the northern and central sectors of the lake and they operate during ebb tide periods. Ambassids, Engraulids, Silver-bellies, Eels, Flat-fishes, Toad fishes etc. constitute the catches.

Cast nets are extensively used in the northern sector and the southernmost region of southern sector. The bulk of the catches from the northern sector was composed of Mullets, Clupeids, Silver-bellies, Flat-heads, Sand whitings, Gobiids, Siganids, Toad fishes and Lutjanids.

The hand line with hook was employed in almost all sectors of the lake. From the northern and central sectors, the main catches were Daysciaena albida, Lutianus argentimaculatus, Tachysurus maculatus, Megalops cyprinoids, Lates calcarifer, Epinephelus tauvina, Lutianus johni and Lethrinus microdon. Tachysurus subrostratus, Ambassis dayi and Megalops cyprinoids comprised the bulk of the catches from the southern sector. Long line with baited hooks were employed for fishing the giant fresh water prawns and crabs.

3.6. <u>Fish distribution</u>:

The Vembanad lake system has all the characteristics of a typical tropical estuary as discussed by so many previous workers (Qasim *et al.*, 1969; Madhupratap *et al.*, 1977). The classification adopted by McLusky (1974) for estuarine organisms based on their salinity tolerance is found to be suitable for classifying the fishes of the Vembanad lake. According to McLusky (1974), the study on the distribution and abundance of fish fauna in an estuarine system is largely a study on the effects of salinity on fishes. The distribution of fish in an estuary may often appear linked in the pattern of salinity distribution since all the physico-chemical and biological factors such as change in specific gravity of the water, temperature, oxygen content, food etc. may be directly or indirectly linked to salinity, and the distribution of fish in relation to salinity may represent the end result of a long chain of responses.

The occurrence, season and frequency of the fishes of the Vembanad lake are summarized in Table 3. Different terminologies are used (Rasmussen, 1973), based on the occurrence of fishes in the lake. Fishes which are undergoing regular migrations from the adjoining sea or rivers are designated as 'migrants'. Some of the fishes enter the lake accidently and they are termed as 'vagrants'. Those fish species which are perennially present in the lake are termed as 'residents', of which most of them constitute the stock of permanent lake fishery resources. The 'frequency' of fishes in the lake is given mainly based on their relative abundance in the catches in the given months. Of the 139 species of fishes reported from the lake, 45 species (32.37%) can be characterised as residents, 68 species (48.94%) undertake regular migrations to the lake from the inshore area of the sea, 9 species (6.47%) have migrations from the adjoining rivers, 17 species (12.23%) enter the lake only accidently either from the sea or from the rivers. 42 species of fishes were found to be commercially important.

The fishes which inhabit the different sectors of the lake are classified according to the classification by McLusky (1974).

3.6.1. Oligohaline fishes (Stations 18, 19 and 20)

These are mainly fresh water species, some of which are capable of tolerating a salinity upto 5‰.

The fresh water species of fishes were not found to be crossing the salinity barrier and penetrate the middle and coastal reaches of the estuary during pre and post-monsoon seasons. During the monsoon seasons, the entire lake system will have nearly fresh water and these oligohaline fishes found to be inhabiting nearly all the stations eventhough their abundance is very scarce. The salinity values of the station Nos. 18,19 and 20 were not found to be exceeding 3.5‰ and most of them are permanent inhabitants of these localities.

List of oligohaline fish species of Vembanad lake

1. Anguilla bicolor bicolor
2. Amblypharyngodon mola
3. Puntius filamentosus
4. Puntius amphibius
5. Puntius sarana
6. Labeo dussumieri
7. Mystus (M.) malabaricus
8. Mystus (M.) oculatus
9. Horabagrus brachysoma
10. Wallago attu
11. Ompok bimaculatus
12. Heteropneustes fossilis
13. Xenentodon cancilla
14. Ambassis dayi
15. Ambassis thomassi

16. *Nandus marmoratus*

17. *Stenogobius malabaricus*

18. *Channa striata*

19. *Anabas testudineus*

20. *Mastacembelus guentheri*

21. *Mastacembelus armatus*

22. *Tetraodon leopardus*

Almost all fresh water fishes listed here from the Vembanad lake were reported from the various river systems of Central Travancore (John, 1936; Hora and Law, 1941; Silas, 1949). So it may be presumed that these fishes undertake regular migrations from the southernmost region of the Vembanad lake to the adjoining rivers viz. Pamba and Achancoil. As given in Table 3 some of the fresh water species were noticed only very accidently from the lake and hence it may be noted that these fishes cannot be included in the list of regular migratory fishes.

Of the 22 species listed under oligohaline fishes, 6 species are commercially important. Among the lesser carps *P. filamentosus* and *P. sarana* were found to be abundantly present from October to March. *L. dussumieri* supports a good fishery from August to December. The occurrence of *W. attu* was noticed in moderate numbers in almost all months. *A. dayi* supports a fishery in this oligohaline zone and seems to be endemic to this region since there is no positive report from other parts of India or world. _A. bicolor bicolor_ was available in limited numbers during almost all the months.

3.6.2. True estuarine fishes:

These fishes are true estuarine organisms which are adapted themselves to tolerate a wide range of salinity fluctuations. This group of fishes really constitutes the major stock of permanent lacustrine fishery resources and are present throughout the year in all the sectors of the lake.

Based on their geographical distribution pattern in the lake, they were classified into three distinct categories.

(a) Fishes inhabiting all zones:

These groups are extremely tolerant to wide salinity fluctuations from traces to 33.8‰ and hence they can very well inhabit all regions from the marine to the fresh waters zones. During the non-monsoon seasons, most of them were recorded from almost all the stations in moderate numbers, but during monsoon seasons they were not abundant.

List of estuarine fish species inhabiting all zones

1. *Tachysurus maculatus*
2. *Ambassis gymnocephalus*
3. *Gerres filamentosus*
4. *Gerres setifer*
5. *Daysciaena albida*
6. *Scatophagus argus*
7. *Etroplus suratensis*
8. *Liza parsia*
9. *Glossogobius giuris*
10. *Brachiurus orientalis*

(b) Fishes inhabiting all zones except stations 6,18,19 and 20:

This is another well defined group of resident species, whose perennial distribution is rather confined to high saline areas of the lake. During the monsoon and the post-monsoon seasons, the occurrence of these fishes were almost limited to the mouth and lower reaches of the estuary. During the pre-monsoon season these fishes were collected from all stations of the lake except 6,18,19 and 20.

List of estuarine fish species inhabiting high saline areas

1. *Austrobatrachus dussumieri*
2. *Strongylura strongylura*
3. *Platycephalus crocodilus*
4. *Therapon jarbua*
5. *Sillago vincenti*
6. *Sillago sihama*
7. *Caranx sexfasciatus*
8. *Lutianus argentimaculatus*
9. *Dendrophysa russelli*
10. *Mugil cephalus*
11. *Valamugil cunnesius*
12. *Liza macrolepis*
13. *Cynoglossus puncticeps*
14. *Chelonodon patoca*

(c) **Fishes inhabiting the gradient zone** (Station 4,5,13, 14,15,16,17):

This zone is otherwise termed as 'transition zone' where the mixing up of fresh water with sea water takes place. The fishes inhabiting this zone are true brackish water forms. The salinity fluctuation in this zone is reported as 2-25‰. (McLusky, 1974). This group of fishes can withstand wide fluctuations in salinity but their occurrence were not noticed in the mouth and the lower reaches of the estuary during the pre-monsoon season. The penetration of these fishes into the oligohaline zone is often recorded during the pre-monsoon season. The relative abundance of these fishes were high in the non-monsoon seasons, but during the monsoon season they were reduced into traces.

<u>List of estuarine fish species in the transition zone</u>

1. *Megalops cyprinoides*
2. *Mystus* (*M.*) *gulio*
3. *Tachysurus subrostratus*
4. *Hyporhamphus* (*H.*) *xanthopterus*
5. *Hyporhamphus* (*H.*) *limbatus*
6. *Sarotherodon mossambicus*
7. *Etroplus maculatus*
8. *Oxyurichthys tentacularis*
9. *Oxyurichthys microlepis*
10. *Oxyurichthys nijsseni*
11. *Glossogobius biocellatus*

Most of the true estuarine species which inhabit all the sectors of the lake are commercially important since their dominance is observed in the catches throughout the year. The relative abundance of these true estuarine species inhabiting different sectors of the lake has a direct relationship with the prevailing salinity. A critical evaluation on the occurrence and abundance of these fishes in the lake shows that the different species flourished in the different sectors of the lake in the specific season as shown below. _I. maculatus_ inhabits all the zones throughout the year eventhough their occurrence in the southern sector of the lake is rather sporadic. This species was found to be the only dominent species during August to November in all sectors of the lake and hence the bulk of the catches from the lake was composed of _I. maculatus_ during the above periods. _G. filamentosus_ and _G. setifer_ dominate the gears from the northern sector during the pre and post-monsoon seasons. _D. albida_ was noticed as the most thriving species in the mouth and lower reaches of the estuary from October to May. The fishes ranging from 200.0-700.0 mm SL were very common during this period. The dominance of _S. argus_ was noticed at Cochin barmouth area during the pre-monsoon season. _E. suratensis_ constitutes a thriving fishery in the southern sector and the southermost area of central sector during the entire year. The main fishery in these sectors are now dependent on the availability and abundance of _E. suratensis_. _L. parsia_ was abundantly noticed from Cochin as well as Azheekode barmouth areas during September to February. The occurrence of _G. giuris_ was noticed in moderate numbers from the northern sector, but big sized ones were always recorded from the southern sector in limited numbers. *P. orientalis* was found to be present in all sectors of the lake during all the months and it really constitutes a minor fishery in the southern sector from June to November.

Among the 14 species of fishes listed under these fishes which inhabit high saline zones, 8 are commercially very important. The maximum availability of *S. strongylura* was noticed from November to March from the mouth and lower reaches of the estuarine regions of Cochin and Azheekode. *M. cephalus*, *L. macrolepis* and *V. cunnesius* constitute a thriving fishery in the proximity of Cochin and Azheekode barmouths during September to February. *S. sihama* and *S. vincenti* appeared predominantly in the northern sector of the lake during December to March. The occurrence and abundance of *D. russelli*, *L. argentimaculatus* and *C. sexfasciatus* were relatively more in the northern sector than in the other sectors of the lake.

11 species of typical brackish water fishes are recorded from the lake, of which 5 species are commercially important. *I. subrostratus* constitute an important fishery in the southern half of the central sector and southern sector of the lake. The occurrence of this species was

noticed in all months in moderate numbers, the maximum landing was recorded from August to February. The occurrence and abundance of _H._ (_H._) _xanthopterus_ in the lake was reported by Kurup and Samuel (1980b). _H._ (_H._) _limbatus_ also evinced similar trends in distribution pattern to that of _H._ (_H._) _xanthopterus_, the maximum availability was noticed from January to May from the southernmost region of central sector. Stray occurrences were also observed in the proximity of Azheekode barmouth. The dominance of _E._ _maculatus_ was observed in the central sector during November to April when typical brackish water habitat prevails in these regions. The availability of _S._ _mossambicus_ was noticed to be increasing from March to June when most of the Pokkali fields were connected with the lake after harvesting.

3.6.3. _Marine fishes:_

Based on the salinity tolerance, marine fishes inhabiting the lake are classified into two categories.

(a) Euryhaline marine fishes

(b) Stenohaline marine fishes

(a) _Euryhaline marine fishes:_ These are marine species which extend into estuaries, and some of them may reach even a salinity of 5‰ . The euryhaline marine fishes were very common in the lake during post and pre-monsoon seasons. Most of the species were found to be inhabiting all the stations except 6,18,19 and 20 during the pre-monsoon period. By the end of September these marine fishes appeared in the mouth of the lake and penetrated into the interior parts of the lake along with the gradually increasing salinity gradient. Of the 38 species listed under this category, almost all of them were collected from September to May from all the stations of the lake except 6,18,19 and 20.

List of euryhaline marine fish species in the Vembanad lake

1. *Dasyatis* (*P.*) *sephen*
2. *Elops machnata*
3. *Muraenesox bagio*
4. *Pisodonophis boro*
5. *Escualosa thoracata*
6. *Nematalosa nasus*
7. *Anodontostoma chacunda*
8. *Ilisha sirishai*
9. *Ilisha melastoma*
10. *Stolephorus commersonii*
11. *Stolephorus waitei*
12. *Stolephorus insularis*

13. *Thryssa mystax*

14. *Thryssa purava*

15. *Thryssa kammalensis*

16. *Chanos chanos*

17. *Zenarchopterus dispar*

18. *Strongylura leiura leiura*

19. *Tylosurus crocodilus crocodilus*

20. *Gambusia affinis patruelis*

21. *Atherina duodecimalis*

22. *Platycephalus indicus*

23. *Lates calcarifer*

24. *Ambassis commersoni*

25. *Epinephelus tauvina*

26. *Carangoides praeustus*

27. *Lutjanus johni*

28. *Pomadasys hasta*

29. *Drepane punctata*

30. *Liza subviridis*

31. *Sphyraena jello*

32. *Eleutheronema tetradactylum*

33. *Awaous stamineus*

34. *Acentrogobius viridipunctatus*

35. *Acentrogobius caninus*

36. *Siganus javus*

37. *Siganus canaliculatus*

38. *Pseudorhombus arsius*

39. *Triacanthus brevirostris*

Of the 39 euryhaline marine fish species reported from the lake, 11 species were noticed as commercially important. During the pre and post-monsoon periods these euryhaline fishes were found to be dominating among the catches of the northern and central sectors of the lake. Most of the euryhaline fishes make their appearence in the mouth and lower reaches of the estuary by the middle of September when salinity shows a slight increase after the heavy rainfall during the southwest monsoon. Among the commercially important species, *A. chacunda*, *S. commersonii*, *T. mystax*, *T. kammalensis*, *T. purava*, *E. tauvina*, *L. johni* and *P. hasta* appeared in the first week of September. The appearence of *S. leiura leiura* was noticed only in October where as *L. calcarifer* and *L. subviridis* were found to be present during December. By April-May, most of these euryhaline species were collected from all the above mentioned stations.

A critical evaluation of the distribution pattern of euryhaline fishes in the lake show that some of them are very specific and unusually abundant in some parts of the lake, eventhough their occurrence was noticed from the northern and central sectors. Fishes of the genus *Thryssa* were found to be unusually abundant in between Thevara and Arookutty regions of the lake, along with big sized specimens of _I. muraya_ is worth mentioning. The abundance of _E. thoracata_, _C. chanos_, _L. subvaridis_ and _P. argius_ were invariably in the northern sector. Regular occurrences of _L. calcarifer_ was found to be rather confined to the rocky areas of the transition zones, eventhough its sporadic availability was observed from other parts of the lake. The presence of _O. affinis natruelis_ was noticed only twice, during March and April from the stations 4 and 5 when relatively high salinity was prevalent in these stations. Based on the gathered information from the fishermen it is understood that the appearence of _O. affinis natruelis_ in the proximity of these stations were noticed only during the past two years and they are named 'African Poochatti'. But there is neither any positive report about the introduction of this species into the natural waters of Kerala nor its occurrence from the south Indian waters. So the present report from the Vembanad lake is very important. The exact distribution of this species could not be understood from the collections and its needs further investigation.

(b) _Stenohaline marine fishes_: During the pre-monsoon season, the physico-chemical parameters of the mouth and lower reaches of Cochin and Azheekode regions are very similar to that of the adjacent sea. So the coastal inshore marine fishes have regular as well as accidental migrations to the estuary. The availability of most of these stenohaline marine fishes were rather confined to stations 1,2,3,8,9,10 and 11. They were not found to be present in those areas where salinity values were less than 25‰ and all of them completely disappeared from the estuary soon after the onset of southwest monsoon. The frequency of occurrence of most of these stenohaline marine fishes in the mouth and adjacent areas of the estuary were rather sporadic and they do not constitute any local fishery.

<u>List of stenohaline marine fish species in the Vembanad lake</u>

1. *Dasyatis* (*H.*) *uarnak*
2. *Thyrsoidea macrurus*
3. *Dussumieria acuta*
4. *Sardinella* (*S.*) *longiceps*
5. *Sardinella* (*C.*) *gibbosa*
6. *Stolephorus indicus*
7. *Thryssa setirostris*
8. *Saurida undosquamis*
9. *Rhynchorhamphus georgii*
10. *Megalaspis cordyla*
11. *Alectis indicus*
12. *Alepes djeddaba*

13. *Scomberoides tala*

14. *Scomberoides tol*

15. *Tachinotus blochii*

16. *Lutianus fulviflamma*

17. *Lutianus russelli*

18. *Lutianus rivulatus*

19. *Gerres abbreviatus*

20. *Plectorhynchus nigrus*

21. *Lethrinus microdon*

22. *Mylio berda*

23. *Protonibea diacanthus*

24. *Johnius* (*J.*) *belangerii*

25. *Upeneus* (*U.*) *sulphureus*

26. *Upeneus* (*U.*) *vittatus*

27. *Parupeneus indicus*

28. *Vlamugil seheli*

29. *Valamugil speigleri*

30. *Eleotris fusca*

31. *Butis butis*

32. *Bunaka gyrinoides*

33. *Gobiopsis macrostomus*

34. *Taenioides buchanani*

35. *Taenioides cirratus*

36. *Trypauchen vagina*

37. *Acanthurus matoides*

38. *Siganus lineatus*

39. *Synbranchus bengalensis*

40. *Solea ovata*

41. *Synaptura commersoniana*

42. *Cynoglossus bilineatus*

43. *Tetraodon fluviatilis*

Among the 43 species of stenohaline fishes reported from the lake, the regular occurrences of the following species were recorded from the mouth and lower reaches during the pre-monsoon season: *A. djeddaba*, *I. blochi*, *J. belangerii*, *V. seheli*, have some importance in the local fishery resources of the lake. The appearance of *S. longiceps* in shoals were noticed from the mouth of the Cochin estuary during March and April. The occurrence of other listed stenohaline species in the lake is so irregular and sporadic and hence they can be considered only as species which can be listed in the ichthyo-fauna of the lake. Some of the species like *D. uarnak*, *S. gibbosa*, *T. setirostris*, *S. undosquamis*, *H. georgii*, *A. indicus*, *S. tol*, *L. rivulatus*, *G. abbreviatus*, *U. vittatus*, *U. sulphureus*, *E. cyprinoides*, *P. lineatus* and *S. commersoniana* enter the estuary very accidently and they are occasionally collected. Other listed species undertake short or long term migrations from the inshore coastal areas into the estuary during the late pre-monsoon season.

In the present study, the distribution and abundance of the fish fauna of Vembanad lake was correlated with the prevailing three important physico-chemical parameters viz. temperature, salinity and oxygen. The distribution and abundance of fishes in the Vembanad lake is mainly dependent on the prevailing environmental conditions, the most important among them are salinity and annual floods (Kurup and Samuel, 1980a). Of the hydrographical factors studied, salinity was found to be the most fluctuating one and it has a direct bearing on the distribution and abundance of fishes in the lake. The salinity varied from traces in monsoon season to 33.8‰ in the pre-monsoon season. With the onset of the southwest monsoon the salinity is steeply reduced to traces in almost all stations due to the heavy floods which results in not only the complete elimination of the diversity of lacustrine fish fauna but also the abrupt reduction of the total fish landings from the lake. Panikkar (1969) stated that the estuarine fauna of the southwest coast of India suffers from partial or complete distruction during the southwest monsoon periods. A total distruction of species diversity as well as the total biomass of the other biotic factors such as phytoplankton (Gopinathan, 1972; Joseph and Kunjukrishna Pillai, 1975), zooplankton (Nair and Tranter, 1971; Menon *et al.*, 1971;

Haridas *et al.*, 1973; Rao *et al.*, 1975; Silas and Parameswaran Pillai, 1975; Madhupratap and Haridas, 1975) and benthos (Desai and Krishnan Kutty, 1967; Pillai, 1977) during the monsoon season were already reported from the Cochin estuary.

From September onwards brackish water habitat was gradually extending to larger areas of the lake, so that euryhaline marine species were found to be appearing in the mouth and the lower reaches of the estuary. From November onwards the increase in salinity values in the lake was noted as rather steady and the penetration of sea water was extending into the far interior regions of the lake. Along with the gradually increasing salinity gradient, the fish species diversity was also found to be remarkably increasing in the catches. From the present study it is understood that November to February is the season when ideal habitat is prevalent in the lake to result in the maximum landings of fishes. On comparison with the pre-monsoon season, the species diversity is less but fairly good catches were recorded during November to February. Silas and Parameswaran Pillai (1975) reported that in Cochin backwaters, the maximum fishery occurs during intermonsoon months of October to April.

The pre-monsoon is dry and the maximum salinity in the lake was recorded in the month of April. The entire area of the lake except the southern sector of the lake became saline and rich in animal life during this period. About 90% of the common species occurring in the estuary registered their peak of abundance during this period (Rao *et al*., 1975). During the pre-monsoon season, the physico-chemical characteristics of the Cochin and Azheekode areas of the lake are very similar to that of the adjacent sea and so most of the marine stenohaline fishes immigrates from the coastal inshore areas for utilizing this highly productive area as its feeding ground. The maximum number of marine fishes were found from the high saline parts of the lake; the number was found to be decreasing with the decrease in salinity gradients. With the onset of the southwest monsoon these stenohaline fishes were found to be emmigrating from the lake.

The penetration of marine and fresh water organisms into an estuary is often a function of the rate of the changes of salinity, rather than the precise salinity at any one point (McLusky, 1974). Recent reviews on the effect of salinity on marine and brackish water invertebrates and fishes have been published by

Pearse and Gunter (1957), Moor (1958) and Kinne (1966). Kinne (1966) has supported the frequently reported view that salinity is the 'ecological master factor' controlling the life of estuarine animals. The enumeration of the trends of the distribution pattern of different species of fishes in the lake reveals that the majority of fish species show their maximum occurrence during the high saline periods of the year. After the monsoonal decline in diversity and abundance, different species recorded a recovery during the period of rapidly increasing salinity. This, of all the environmental factors which influence the Vembanad lake, the most significant one appears to be the salinity variation which exerts considerable influence on the type of fish fauna and its distribution and abundance in the lake.

Of the 139 fish species described in this thesis, 22 species are fresh water and oligohaline in habitat, 35 species are true estuarine in habitat and 82 species are marine migrants. Among the 35 species of true estuarine fishes, 10 species can inhabit almost all stations, 14 species can inhabit only the high saline parts of the lake and the typical brackish water fishes is represented by 11 species. Of the 82 species of marine migrants, 39 species are euryhaline and 43 are strictly stenohaline in habitat.

Temperature is the next important environmental parameter which may have some bearing on the distribution of fish fauna in the lake. Temperature changes may also lead to changes in the distribution pattern of fishes both seasonally and geographically. The relationship between the distribution of fish species and temperature is very strong (Nikolsky, 1963). The temperature distribution in 20 stations is more or less uniform during the post and pre-monsoon seasons. A decrease was noticed during the south west monsoon. The lowest temperature was recorded in August and the highest temperature was during the pre-monsoon season. In general, temperature values showed a very gradual increase from the post-monsoon onwards and attained peak values in the pre-monsoon months and then a sudden fall was noticed in July due to the continuous rain. Relatively high temperature prevalent in the lake during pre-monsoon period was found to be adversely affecting the total fish landing from the lake. The fluctuation of temperature is significant from the pre-monsoon to the monsoon periods and this may probably have some effect in the seasonal distribution and abundance of fishes in the lake. According to Rounsefell

(1975) marine fishes are very sensitive to even minor changes in temperature. It was observed that the stenohaline marine fishes completely vanished from the lake immediately after the onset of the southwest monsoon. The sudden change in temperature may also be a reason for their abrupt disappearance.

The abrupt changes in temperature was also related to the appearance of some of the fishes in the lake during June-August. Fishes such as *T. cirratus*, *T. buchanani*, *T. vagina*, *E. fusca*, *O. macrostomus*, *B. butis* and *B. gyrinoides* appeared in the proximity of Cochin and Azheekode barmouth areas by the end of June. The sudden appearance of these bottom dwelling fishes in the catches may be due to the abrupt decrease in the bottom temperature due to the heavy floods. *A. dussumieri* was relatively abundant during the monsoon and post-monsoon periods than during the pre-monsoon season.

The concentration of dissolved oxygen content ranged from 1.86-5.80 ml/l in the study area. Higher values were recorded from the southern and central sectors of the lake. The oxygen concentration was high during the monsoon season. In general, it did not show much marked fluctuation. The availability of dissolved oxygen is an important factor for the survival of animals since the various metabolic activities are dependent on it. The oxygen requirements of aquatic organisms vary between species and between age groups or develemmental stages of the same species, and also dependent on the activity of the organism. A number of studies on the requirements of oxygen in fresh water fishes were conducted (Rounsefell and Everhart, 1953; Davison *et al.*, 1959) and reported that the minimum oxygen required ranges from immeasurable traces for golden shiner, *Notemigonus crysoleucas* to 2.2 ppm in the Atlantic salmon, *Salmo salar*. Generally, warm water fishes have lower thresholds of tolerance (Rounsefell, 1975). Whitworth and Irwin (1961) observed that species of the family Cyprinidae and Poecilidae were found to exist comfortably at an oxygen level of 1 ppm and large numbers survived at oxygen level of 0.45 ppm.

From the above observation it is clear that the oxygen content does not act as a limiting factor for fish distribution in the Vembanad lake. Generally, the lake is shallow and there is sufficient discharges of fresh water from the adjoining rivers, the mixing may always enrich the oxygen content in all stations and hence it may not act as a limiting factor.

In several areas of the Indo-Pacific region, fishes of marine origin move into estuaries and form local fisheries of considerable importance. Since most of the fishes are known to perform short or long term migrations, it becomes necessary for fishery biologists to consider the distribution of populations in the estuaries and adjoining seas simultaneously (Jhingran and Natarajan, 1973). The data on species composition and their occurrence and abundance in the Vembanad lake revealed that most of them are either of marine origin or has a close affinity with the marine species. Majority of the fish species of the lake either immigrates regularly or perform short range movements from the inshore areas of Arabian sea into the lake and back depending on the conditions prevailing in the lake. The occurrence and abundance of marine fishes in the lake is mainly dependent on its occurrence in the inshore areas of Cochin. Gopalakrishnan (1973) and Jhingran and Natarajan (1973) have also reported that the fishery resources of Hooghly-Matlah estuarine system and Chilka lake respectively have a direct relationship with the fishery resources of the adjacent inshore areas of Bay of Bengal. According to Pillay (1967) the estuaries of the Indian Ocean coastal zone support a varied fish fauna but for a tropical region it is rather poor in species composition.

Vembanad lake is the largest brackish water system of the southwest coast of India which not only serves as an adequate feeding ground for fishes and crustaceans but also provides an ideal habitat for a heterogenous assemblage of several fish species. The northern sector of the lake is a typical nursery ground for a variety of fishes, which in the larval and juvenile stages are voracious plankton feeders. The lake is reported as one of the most productive areas in the southwest coast of India (Qasim *et al.*, 1969; Pillai *et al.*, 1975). The species diversity and the total biomass of the phytoplankton, zooplankton and benthos were reported as very rich in the study area especially during the pre and post-monsoon seasons (Desai and Krishnan Kutty, 1967); Gopinathan, 1972; Haridas *et al.*, 1973; Silas and Parameswaran Pillai, 1975; Madhupratap and Haridas, 1975; Pillai, 1978). The regular occurrence of marine migratory fishes starts by the beginning of the post-monsoon periods and during the entire non-monsoon seasons these fishes are found to be flourishing in the mouth and lower reaches of the estuary and constitute a thriving fishery. Based on the availability and biomass of plankton and benthos during the non-monsoon periods and the regular occurrence of marine migratory fishes in the lake, it may be presumed that the lakeward migration of these fishes are mainly for utilizing th this highly productive area as their feeding ground. The majority of the migratory fauna uses estuaries as a feeding ground (Barnes, 1976). According to Margalef (1963), the species diversity in a lake increase with increasing oligotrophy.

The distribution of fishes within any water body shows a zonal pattern, both longitudinal and transverse due to behavioral adjustments (physiological adaptations) for optimal water currents, temperature and chemical concentrations. The study on the distribution and availability of fishes of the Vembanad lake showed that they evince different patterns of distribution both seasonally and geographically. The lake is permanently connected with the Arabian sea, and there is a regular ingress and egress of marine fishes into and from the lake. The distribution of fishes in the different sectors of the lake shows that there exists specific trends in the distribution pattern. The marine fishes are found to be dominating in the northern sector of the lake and this is due to the invariably high saline conditions prevailing in this sector owing to the presence of two natural passages to the Arabian sea. Typical brackish water conditions are prevalent in the central sector in most of the months and hence true brackish water species are found to dominate in this sector. The complete absence of euryhaline as well as stenohaline marine species was noticed from the area beyond

Thannirmukkom bund (southern sector) even in the pre-monsoon season. This is only due to the closure of the Thannirmukkom bund during the pre-monsoon periods, which not only prevents the salt water penetration but also the ingress of migratory marine fishes into the southern sector of the Vembanad lake. Before the construction of the bund, the salinity values of this sector reached 23.0‰ (Josanto, 1971), but during the present investigation it was observed that the salinity values do not go beyond 3.48‰ in any of the seasons. Before the construction of the Thannirmukkom bund, the southern sector of the lake provided an ideal habitat for heterogenous assemblages of euryhaline marine fishes, crustaceans and true estuarine fishes which ultimately constituted a diversified and abundant fishery resource (K.S.S.P., 1975). But, under the changed habitat, not only the diversity of fish species but also the entire fishery resources of this region were completely depleted and the fishery is now dependent on the availability of a very few estuarine and fresh water species such as E. suratensis, I. maculatus, A. dayi etc. Moreover, the regular migrations involved in the biological cycle of several fresh water species of fishes and crustaceans which are permanently residing in the lake are adversely affected by the bund with the result that most of them showed a decline in their abundance.

Another interesting observation noticed during the present investigation is that some of the fishes which inhabit the gradient zones are not at all found to be present in the mouth and lower reaches of the estuary during the pre-monsoon season. possible explanation is that this group of fishes can readily adapt to the gradual changes in the salinity, but they may not be able to tolerate rapid salinity fluctuations prevailing in the mouth and lower reaches of the estuary. Whitfield and Blaber (1979) stated that the possible explanation for the absence of Sarotherodon mossambicus in open estuaries may be due to the high densities of marine piscivorous fishes in this zone. The above statement may also be attributed as a reason but requires detailed investigation on the food and feeding habits of the marine piscivorous fishes of the estuary.

The occasional migration of some of the pelagic marine fishes into Cochin backwaters has been reported by many earlier workers (George, 1965; Reghu, 1973; Noble, 1974). Pillay (1960) reported the occurrence of Hilsa ilisha in shoals from Cochin backwater. However, the presence of H. ilisha was not seen in any of the sectors of the lake during the present investigations. The unusual fishery of the Mackerel, Rastrelliger kanagurta was reported in the month of February when high salinity prevailed in Cochin backwater (George, 1965). The occurrence of Sardinella longiceps in shoals was reported from Cochin backwater during the months from August-September when the salinity was as low as 2.96×. (Reghu, 1973). But, during the present study, the occurrence of S. longiceps was not encountered from any part of the lake during the monsoon season. The sporadic occurrence of small sized S. longiceps was observed from December onwards and they were found in shoals in the months from February to April. The occurrence of R. kanagurta was also reported in the monsoon season (Noble, 1974) but the above species was not observed from the lake during the period of investigation. From the above reports it may be presumed that the lakeward migration of these pelagic species are rather irregular and their regular occurrence in the lake cannot be expected, eventhough they are very abundant in the inshore areas of Arabian sea. Shetty (1965) listed 98 species of fishes in his preliminary survey report on the fishes of the Vembanad backwaters, of which 41 species are found to be present in the present collections. Thus, of the total 150 species of fishes recorded from the Vembanad lake during the present investigation, 41 species agree with Shetty's report and the remaining 109 species except *S. longiceps* are new additions to the fish fauna of the Vembanad lake.

Vembanad lake has a rich and diversified fish fauna when compared to other brackish water lakes and estuaries of India. Among the major brackish water lakes of India, Chilka lake has a water spread area of 1165 sq. km. in the flood season and the total number of fishes hitherto recorded is 152 (Jhingran, 1982). Pulicat lake has a total area of 461 sq. km. and the total number of fish species recorded is 65 (Chacko *et al.*, 1953). Among the open estuaries, the largest and most extensive is the Hooghly-Matlah estuarine system with a total area of 3100 sq. miles (Pillay, 1967). A total of 172 species of fishes has been reported from the estuary of which 73 occupy the fresh water zone and 99 the higher saline zone (Jhingran, 1982). The next largest estuarine system in extent is that of the Godavari with an area of 18,000 ha, having 33 species of clupeoid fishes (Babu Rao, 1976) and 191 species of non-clupeoid fishes (Visweswara Rao, 1976). The ichthyo-fauna of the Vembanad lake in comparison with those of other brackish water lakes and estuaries of India is rich and diversified, eventhough it has only a water spread area of 256 sq. km.

Concern about the impact of mans activities on the estuarine environment has greatly intensified in recent years with phenomenal population growth, industrialization and new technological developments. As a result, the disposal of industrial and domestic wastes into this area, it poses one of the major aspects of environmental deterioration. Instances of pollution perils leading to mass mortalities of fishes and loss of fishery resources are available in some estuaries of India like Kulti near Calcutta, the Cooum in Tamil nadu and Chaliyar in Kerala (Gopalakrishnan *et al.*, 1973).

Incidence of mass mortality of shoaling specimens of *Ambassis gymnocephalus* due to ammoniacal effluents discharged from the industrial complex at Kalamassery has been reported from Eloor (station No.6) (Unnithan *et al.*, 1977). During the present investigation it was observed that the impact due to the disposal of various industrial effluents from the nearby factories virtually converted the biotope of Eloor-Varapuzha regions into a barren contaminated zone. Mass mortalities of fishes were frequently observed during March and April from the above area. The fish species which were observed in the instances of mortalities were *Stolephorus commersonii*, *Tachysurus maculatus*, *Mystus gulio*, *Etroplus suratensis*, *Ambassis gymnocephalus*, *Puntius filamentosus*, *Gerres* *filamentosus*, *Ehirava fluviatilis*, *Hyporhamphus* (*H.*) *limbatus* etc. The reason for the mass mortalities of fishes during the pre-monsoon season may be the reduction in water discharge from the adjoining rivers with the result that the effluents dumped from the factories may not get diluted and washed away as in the monsoon season. A large scale fish mortality was observed on the 5th of June 1980 in the area between Thevara and Cochin barmouth. This was due to the disposal of factory effluents from FACT through the Champakkara canal, which joins the lake at Thevara. The entire fish fauna of the above area was destroyed and the water surface was rather covered by dead fishes. 31 fish species of permanent inhabitants of the lake were collected from the dead fishes.

Many parts of the lake has been used as an ideal site for retting of coconut husks. The impact of various associated changes like noxious gas formation, smell and depletion of oxygen may deteriorate and environment. Aziz and Nair (1978) conducted a survey on the population of the retting zones of the backwaters of Kerala and reported that the retting zone of the backwaters have virtually become barren eventhough certain species are caught during monsoon months. During the present study also, very few species of fishes were found to be present in the retting zones of the Vembanad lake. So the impact of husk retting also has some bearing on the distribution and abundance of fish fauna in the lake, which in turn affects the fishery resources of the lake.

3.7. An appraisal of the detrimental factors on the fishery resources

The Vembanad lake and its wide environs support a good fishery of prawns, fishes, crabs and molluscs. This water body was well known for its capture and culture fisheries. As the lake spreads through four districts of Kerala viz. Alleppey, Kottayam, Ernakulam and Trichur, it directly supports fairly good numbers of fishermen who are involved in exploiting the various fishery resources. The shallow and well protected nature of the lake permit the fishing operations during all the seasons by conventional and traditional methods. The vast clam beds support the lime industries located in the suburbs of Cochin. Moreover, this highly productive aquatic biotope also serves as a huge seed reservoir for extensive fish culture practices. Due to rapid urbanization and industrialization, recent engineering works and man made hazards, the ecology of this water body has changed much with the result that the fish production has declined. Qasim and Madhupratap (1979) enumerated the ecological changes that have occurred in the Cochin backwaters during the last ten years and concluded that the man made changes have caused much damage to the ecology of the backwaters.

The fishery resources of the lake is vulnerable to the problems due to various kinds of pollution. Industrial effluents are discharged into the lake from the factories located along the industrial belt of Kalamassery and Udyogamandal. The Eloor-Varapuzha regions has now changed into a virtually barren area and mass mortalities of fishes are frequently reported during the pre-monsoon season. Many parts of the lake are used for husk retting and this may deteriorate the environment. Oil pollution exists in the harbour area. The lake receives large quantities of sewages from Cochin and nearby areas. Studies conducted by the regional centre of the National Institute of Oceanography revealed the deterioration of prawn wealth in Cochin backwaters. The finding of Gore _et al._ (1979) have indicated an intense faecal contamination in the backwaters resulting in a high density of coliform bacteria in the water and in the sediments. The fishes and bivalves collected from the backwaters were found to contain a rich population of these coliforms, rendering them unsuitable for human consumption)(Qasim and Madhupratap, 1979). If the above hazards are allowed to continue, this highly productive biotope may turn into a barren one in the near future.

The impact of Thannirmukkom bund on the local fishery deserves special mention. The bund not only acts as a barrier for the entry of saline water but also prevents the ingress of marine fishes and prawns into the southern sector of the Vembanad lake with the result that the fishery resources of the southern sector of the lake is totally depleted. Moreover, due to the closure of the bund, the intermingling of fishes of the two distinct biotopes is not possible and the regular spawning migration involved in the biological cycle of many fresh water and estuarine species are interrupted. The closure of the bund also results in the stagnation of the water body and the consequent deterioration of quality. About 1000 tonnes of pesticides are used in the Kuttanad area every year for the paddy cultivation (K.S.S.P., 1978). The leached pesticides from the paddy fields accumulate in this stagnant water body and result in health hazards. Faecal contamination and its stagnation is another adverse consequence of the bund, human excreta deposited in the southern part of the lake and its accumulation do not get washed away due to the closure of the bund. This not only affects the population of the lake but also result in health hazards for the people due to the consumption of these fishes which are mainly infected by *E. coli* and *Streptococci*.

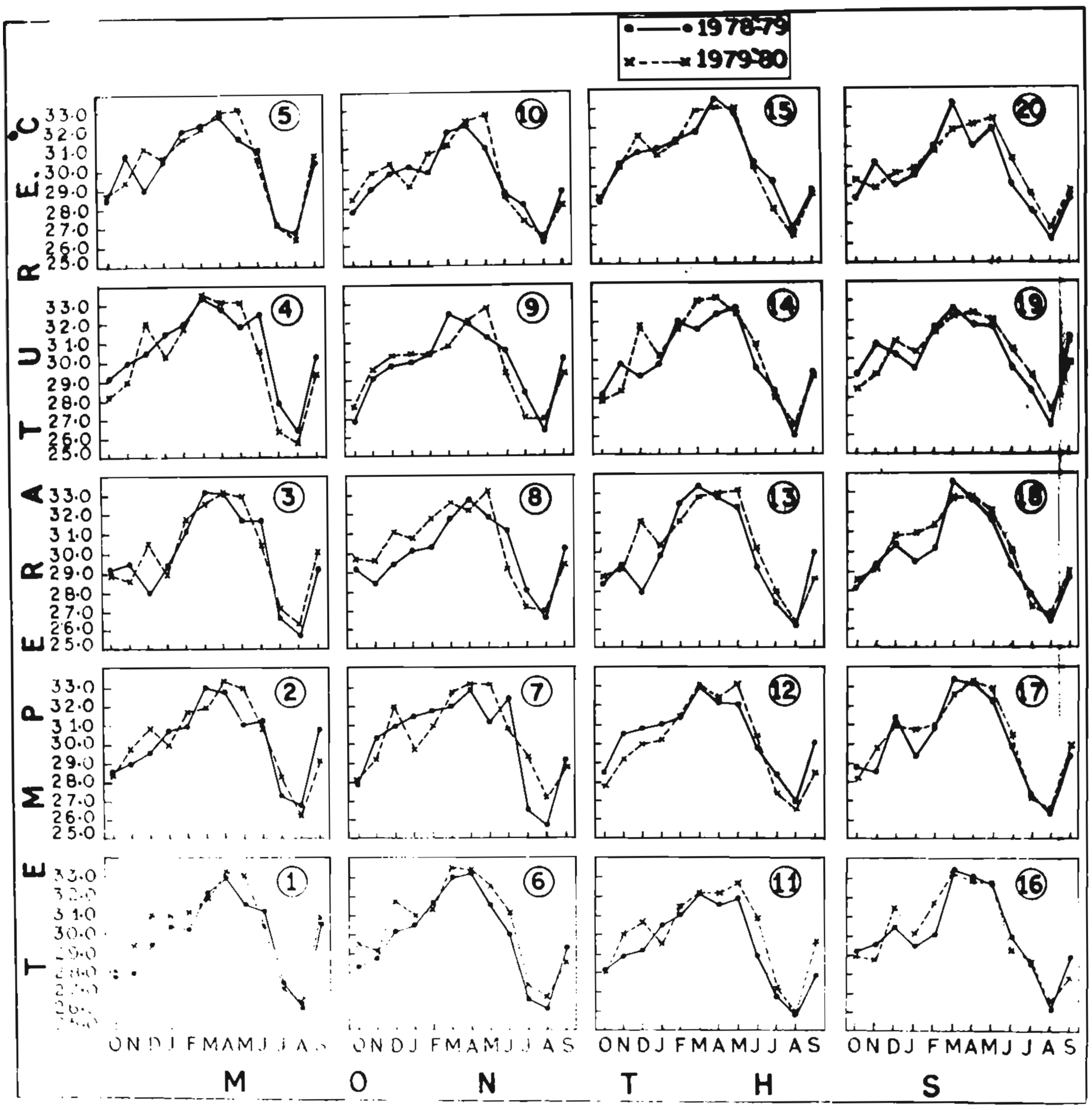
The main channel leading to the harbour at Cochin is periodically dredged and maintained at a particular depth. It was noticed that the marine fishes were comparatively less during the periods of dredging. This may be due to the inhospitable sound relayed from dredgers which may frighten the migratory fishes. Heavy siltation occurring in the backwaters (Gopinathan and Qasim, 1971) resulting from the dumping of dredged materials were used for the formation of several small islands in the harbour area. These islands and other reclamation works really reduces the nursery and feeding grounds of many fishes and crustaceans and hence leads into depletion of fauna.

The prolific spreading of *Salvinia auriculata* known as 'African payal' and *Eichornia* spp. during the monsoon and post-monsoon periods act as a hindrance to fishing activities. From July to October the problem becomes very acute due to the spreading up of these macrovegetations over the water surface like a green carpet rendering not only fishing operation almost impossible but also reduces light penetration which directly affects the primary productivity. Samuel *et al.* (1975) reported that the presence of *S. auriculata* may also lead to oxygen depletion due to the formation of a thick mat-like covering on the surface which prevents the mixing of atmospheric oxygen with water and also due to the decay of dead parts of leaves.

It is appropriate here to indicate some measures of conservation for the development of fishery resources of the Vembanad lake. By examining the stake net catches, it is observed that the majority of the catch composition represents individuals less than 20 mm in length. So the mesh size of the cod end of the stake net should be limited to 40 mm and above. So that the result will ultimately benefit the fishermen. The resources of *Chanos chanos* has been noted as getting depleted in the lake and hence procurement of young ones is essentially needed through induces breeding techniques. The seaward spawning migration of the economically important fishes of the lake has been reported (Kurup and Samuel, 1981f), especially during December to April. These breeders can be protected by restricting the fishing during the above period in the barmouth areas. The fishery resources of the southern sector of the lake can be improved by introducing the Indian major carps.

Plate 55. Monthly temperature (^{o}C) values (mean value of the surface and bottom waters) at stations 1–20 during October 1978 to September 1980 (station number inside the circle)

PLATE 55



1978-79
1979-80
TEMPERATURE °C
MONTHS
ONDJFMAMJJAS
33.0
32.0
31.0
30.0
29.0
28.0
27.0
26.0
25.0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

Plate 36. Monthly salinity (‰) values (mean value of the surface and bottom waters) at stations 1–20 during October 1978 to September 1980 (station number inside the circle)

PLATE 56

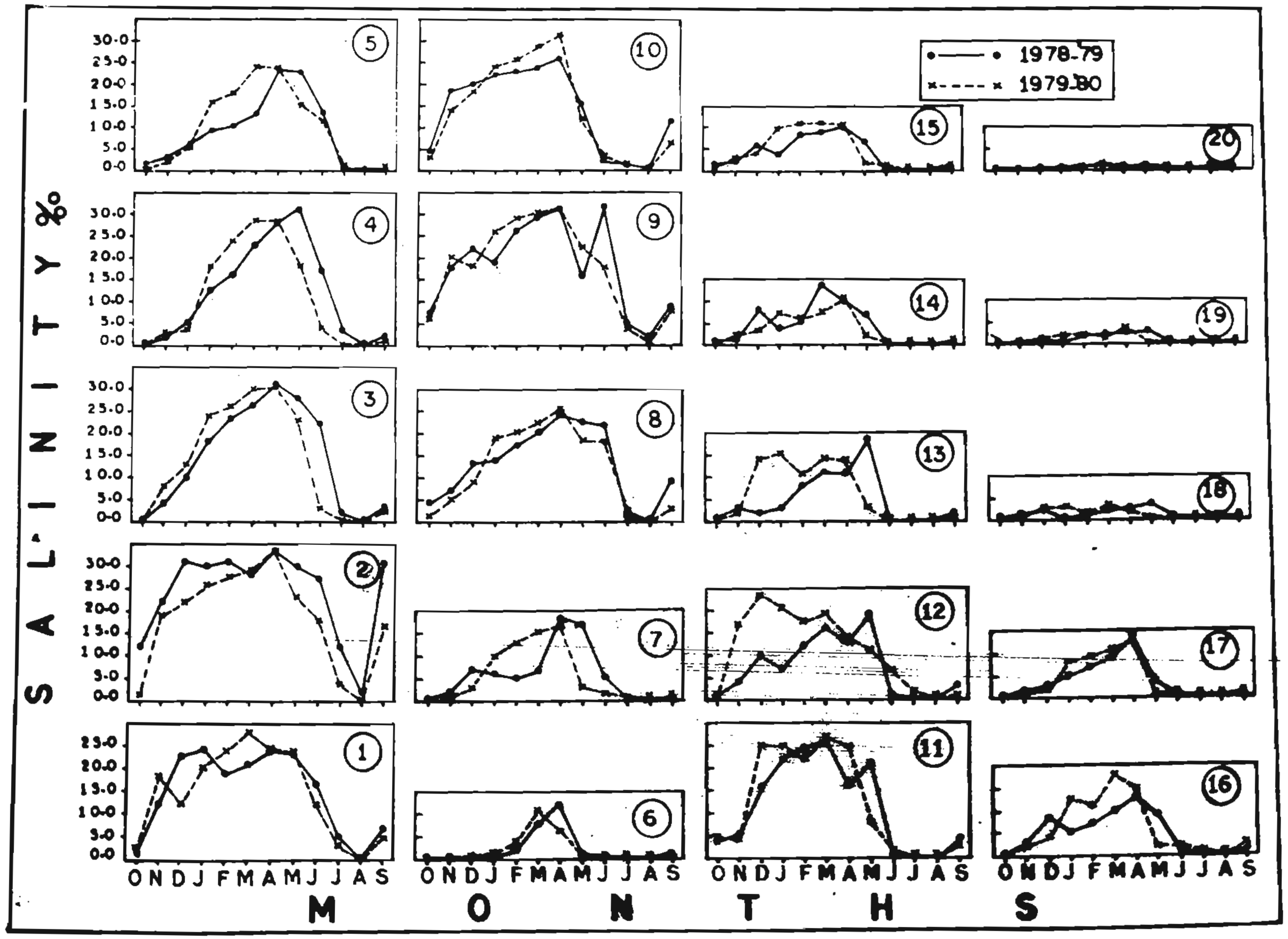
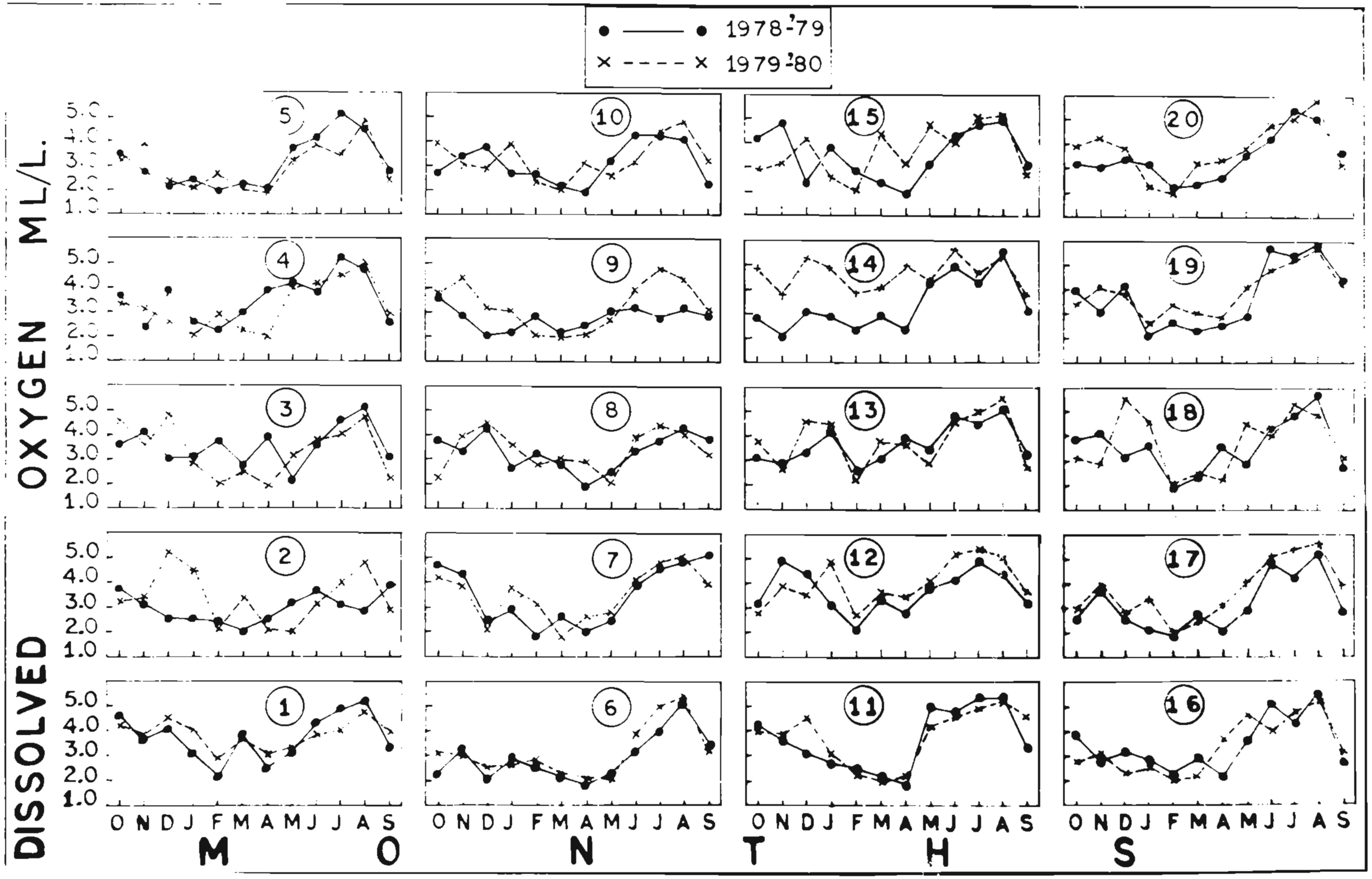


Plate 37. Monthly dissolved oxygen (ml/l) values (mean value of the surface and bottom waters) at stations 1-20 during October 1978 to September 1980 (station number inside the circle)

PLATE 57



1978-'79
1979-'80
DISSOLVED OXYGEN ML/L.
5.0
4.0
3.0
2.0
1.0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
O N D J F M A M J J A S
MONTHS

BIOLOGY
of
Daysciaena albida (Cuvier)
and
Gerres filamentosus Cuvier

4. BIOLOGY OF DAYSCIAENA ALBIDA (CUVIER) AND GERRES FILAMENTOSUS CUVIER

4.1. FOOD AND FEEDING

4.1.1. INTRODUCTION

A detailed knowledge of the food and feeding habits of fishes of any water body is a pre-requisite to improve its fishery potential. Trophic relationships of economic and uneconomic species of fishes will also be useful in understanding their role as prey, predator or competitor. Food is an important factor regulating the various activities of the fish and hence the abundance of the stock, fish migration etc. are directly related to the availability of food. Moreover, knowledge on the food and feeding habit of fishes and its trophic relationship are of paramount importance in any type of fish farming ventures.

In the present study, the food and feeding habits of two commercially important food fishes of Vembanad lake viz. *Daysciaena albida* (Cuvier) and *Gerres filamentosus* Cuvier are discussed. The food and feeding habits of these two species of fishes were not subjected to intensive studies. The available literature on the food and feeding habits of D. albida are those of Gopinath (1942), Mookerjee et al. (1946), Chacko (1949) and Bal and Bapat (1949), which dealt mainly with qualitative accounts on a few specimens with casual remarks. The food and feeding habits of other Sciaenids were studied by Kutty (1967), Suseelan and Nair (1969) and Jayaprakash (1974). The food habits of G. filamentosus were reported by Job (1940), Chacko (1949) and Prabhakara Rao (1968). The food and feeding habits of other Gerrids were investigated by Chacko (1949), Basheeruddin and Nagappan Nayar (1961), Prabhakara Rao (1968) and Patnaik (1971).

4.1.2. MATERIAL AND METHODS

The materials for the present study were collected fortnightly from the different type of fishing gears (as discussed in section 3) of the Vembanad lake. A total of 426 specimens of D. albida (97 juveniles, 329 adults) and 615 specimens of G. filamentosus (164 juveniles, 451 adults) were examined. The specimens were brought to the laboratory, standard length of each specimen was recorded, the sex and stage of maturity were noted. The stomach was then removed and examined in fresh condition as far as possible or else preserved in 5% formalin for subsequent study. Special attention was given to regurgitation problem and such regurgitated empty stomachs were not included in the present study.

The most common methods employed for stomach content analyses are volumetric (Job, 1940), point (Swynnerton and Worthington, 1940) and index of preponderence (Natarajan and Jhingran, 1962). Pillay (1952) suggested that the method to be adopted must depend entirely on the particular diet of the fish. The qualitative analyses of the gut contents of the two species selected for the present study showed that both of them are omnivorous in feeding habit, the point method of Swynnerton and Worthington (1940) as reviewed and modified by Venkataraman (1960) and adopted by Nair and Sobhana (1980) was found to be suitable in evaluating the different food organisms.

The food items were identified upto generic level or groups depending on their state of digestion. For evaluating the preference of food consumed, the different food items were assessed by a general examination and listed under the categories swarms, plenty, common, few, little and rare; due consideration being given to the size of food organism as well as its abundance. Points 50,40,30,20,10 and 5 were allotted to each category. Points were allotted to the stomach also depending upon the degrees of their fullness and the points gained by each food item were either proportionately increased or decreased to the total allotted to the stomach and then summed up. The summations of the points obtained by each food item for each month were then scaled down to percentages to show the composition of the food items for different months. This method is essentially a volumetric one and is preferred to many others as it had the advantage of giving roughly both the quantitative and qualitative data without the need for very detailed counts (Venkataraman, 1960). The feeding intensities of adult fishes during different months were ascertained by classifying the stomach into gorged (50 points), full (40 points), 3/4 full (30 points), 1/2 full (20 points), 1/4 full (10 points), traces (5 points) and empty (0 point).

4.1.3. RESULTS AND DISCUSSION

A. *Daysciaena albida*

(1) Food composition:

Prawns, teleosts, juvenile crabs, amphipods and isopods formed the major part of the diet. Prawns, both penaeids and non penaeids formed the major food item. Among penaeid prawns, *Metapenaeus* spp. and *Penaeus* spp. were very common and the non penaeid group was represented by *Acetes* spp. Post larval stages of *Metapenaeus* spp. and *Penaeus* spp. were noticed from the stomach contents of *D. albida* in most of the months. Altogether 4 species of teleosts were noticed viz. *Stolephorus* spp., *Thryssa* spp., *Trypauchen* spp. and *Cynoglossus* spp. The occurrence of fish larvae were noticed in traces in some of the months. Juvenile crabs, isopods (*Cirolana* spp.), amphipods (*Corphium* spp., *Photis* spp.) were found to be present in all months and were dominant constituents of the stomach contents. Teleost remains (body muscles, scales, vertebrae, eyes and other bones) and prawn remains (shell, appendages and body muscles) formed appreciable quantities in the gut contents. Other items of food that are identified from the gut contents of *D. albida* were Crab larvae (zoea and megalopa), Cumaceans (*Eucoma* spp.), Nereid polychaetes (*Alciopina* spp.), Mysids (*Mesodopsis* spp.), Bivalve molluscs (*Perna* spp., *Donax* spp.), *Squilla* spp., Stomatopod larvae (*Alima*), *Lucifer* spp., Higher aquatic plants, Diatoms (*Coscinodiscus* spp., *Nitzschia* spp., *Skeletonema* spp.) and *Lucifer* spp.

(ii) Food of juveniles and adults:

The food of juveniles and adults were analysed separately to study variations, if any. The results (Table 4) showed that juveniles feed mainly on planktonic forms like post larvae of prawns, crab larvae, amphipods, isopods and nereid polychaetes. The food items which are consumed in lesser quantities are fish larvae, cumaceans, mysids, higher aquatic plants and diatoms. The other food items such as bivalve molluscs, *Lucifer* spp., crustacean and teleost remains were encountered very occasionally. Fishes like Stolephorus spp. and Trypauchen spp. were found to be present very sporadically in the gut contents of juvenile fishes.

Adults were sexed and their stomach contents were separately analysed. Since there was not much variation in the food of males and females, the data were pooled together and presented in table 4. Prawns and post larval stages of prawns formed the major food items. Among teleostean fishes, Stolephorus spp., Thryssa spp., Trypauchen spp. and Cynoglossus spp. were consumed in appreciable amounts in the months of March, May, August, September and December. The occurrence of Squilla spp. in the diet was noticed very sporadically. Juvenile crabs, isopods, amphipods, cumaceans, nereid polychaetes, other aquatic plants and diatoms were found to be present very frequently. Fish larvae, crab larvae, stomatopod larvae, mysids, bivalve molluscs and Lucifer spp. were noticed only in traces and occasionally.

(iii) Seasonal variations in the food of juveniles and adults:

Seasonal variations in the food of juveniles and adults of D. albida are presented in table 4.

Post larvae of prawns, juvenile crabs, crab larvae, amphipods, isopods, cumaceans, nereid polychaetes, mysids, aquatic plants and diatoms formed the food of juvenile fishes during most of the months. Fish larvae were recorded in the months of January to April, June, August and October to December. The occurrence of bivalve molluscs were noticed in January, February, April, May and October to December. Other planktonic forms listed in table 4 were also found to be present sporadically. The occurrence of _Stolephorus_ spp. in traces was noticed in January. _Trypauchen_ spp. constituted an important food item of juveniles during June to September.

In adults, prawns and fishes are the most dominant items of food materials. High percentages of prawns were encountered in almost all months, especially in March, April, June, September, October and November. Post larvae of prawns were found to be present throughout the period, their occurrence was relatively high in January, February, July and November. Among fishes, _Stolephorus_ spp. and _Thryssa_ spp. were recorded from January to May, August, September, October and December. _Trypauchen_ spp. was noticed in appreciable quantities during June to September. Besides this, _Cynoglossus_ spp. was also recorded in March, May, August and December in lesser percentages. The percentage occurrences of isopods and amphipods were rather high during the monsoon season (June to September), eventhough they were present throughout the year. Among the other food items, juvenile crabs, crab larvae, nereid polychaetes, higher aquatic plants and diatoms were found to be present in traces in all months. The occurrence of Squilla spp. was recorded in January, April, May, November and December in very small percentages.

(iv) Feeding intensity:

The percentage occurrence of feeding intensities for *D. albida* is shown in table 5. In general, the percentages of gorged, full and 3/4 full stomachs were less when compared to other categories. The occurrence of gorged stomachs were completely absent in February and from July to November. Percentage occurrence of gorged and full stomachs were relatively higher in April, May and June. Percentage of empty stomachs were low during January to June. During July to December their percentages were as high as 39.85 in September.

(v) Feeding in relation to breeding cycle:

The occurrence of empty stomachs were encountered in most of the months except in March. Relatively high percentages of empty stomachs were noticed from July to

Table 5. Percentage occurrence of stomachs in different degrees of fullness in adults of _D. albida_ during January - December, 1980.

	Gorged	Full	3/4 full	1/2 full	1/4 full	Trace	Empty
January	5.34	14.13	17.24	29.13	27.24	13.79	14.26
February	-	13.33	23.33	16.67	20.00	16.67	10.00
March	2.13	16.15	18.18	28.18	24.24	12.13	-
April	4.25	12.50	9.36	11.36	12.50	34.38	15.62
May	8.33	22.22	8.33	19.44	16.66	11.11	13.88
June	19.62	7.40	17.40	18.51	18.51	7.40	11.11
July	-	4.16	-	17.82	20.83	37.33	20.83
August	-	2.14	5. 71	14.28	18.00	29.85	32.00
September	-	-	-	17.82	22.85	19.58	39.85
October	-	3.22	9.68	16.58	19.35	25.35	25.80
November	-	-	-	12.50	25.00	37.50	25.00
December	2.71	8.57	6.42	14.28	28.57	33.57	5.85

November, which was the major spawning period of this species (discussed in section 4.3). The feeding intensities in juveniles were more or less uniform in all months, and it was normally high during July to November. Thus the lower feeding intensity of mature fishes can be correlated with the spawning activity of the fish (Carr, 1907; Todd, 1915). The mature gonads will occupy more space in the body cavity of the fish and as a result the stomach will be pressed resulting in less feeding and higher occurrences of empty stomachs (Nair and Sobhana, 1980).

D. albida is predominantly a carnivore and its principal diet consists of prawn, prawn larvae and teleost fishes. The stomach contents revealed that it swallows the organism as a whole. The stomach is well developed and can accommodate bigger sized organisms. The nature of food contents proved that it feeds on both demersal as well as pelagic animals. Although it is a voracious carnivore, any cannibalistic tendency is not observed during the present study. The fish became more icthyopagous with age. The present study shows that there is selectivity in feeding in juveniles and adult fishes of D. albida, both of them prefer prawn and prawn larvae as the principal diet. Teleosts constitute the second important food item for adults where as amphipods, isopods and crab larvae form the second major category of food items of juveniles. The percentages of prawn in the gut contents of adult fishes were very high during pre-monsoon (February to May) and post-monsoon (October to January) periods. Amphipods, isopods and juvenile crabs dominated in the monsoon season. Among teleost fishes, *Trypauchen* spp. is available during monsoon season (June to September) and it was found to be consumed in moderate quantities during monsoon months.

Mookerjee (1946), Chacko (1949) and Bal and Bapat (1949) reported that the main food items of *D. albida* are prawns, fishes and bivalve shells. In general, it is a carnivore and predacious in its feeding habitat. The present observation on the food habit of *D. albida* is in agreement with the other available reports. The occurrence of *Trypauchen* spp., *Cynoglossus* spp., *Thryssa* spp. and other listed zooplankters, aquatic plants and diatoms are recorded anew besides those reported earlier from the stomach contents of *D. albida*, during the present investigation.

On comparison the food of *D. albida* with that of other Sciaenids, it is noticed that the food composition does not very much from other related species. Karandikar and Thakur (1951) observed that Sciaenids are carnivorous and feed on fishes, crustaceans, molluscs and annelids. Prawns and fishes formed the major food items of *Pseudosciaena diacanthus* (Venkatasubba Rao, 1963). Rajan (1964) reported that in *Pseudosciaena coibor* of Chilka lake, prawns constituted the dominant item of food in adults and amphipods as the main food of juveniles. Jayaprakash (1974) stated that *Otolithoides brunneus* is a macrophagous carnivore and that it feeds mainly on small teleosts and prawns. During the present study on the food and feeding habits of *D. albida* in Vembanad lake, it is observed that this species is also a macrophagous carnivore, and that the food is mainly composed of prawns and teleost fishes during the non-monsoon periods and amphipods in the monsoon season. The occurrence of pelagic fishes like *Stolephorus* spp. and *Thryssa* spp., bottom dwelling fishes like *Trypauchen* spp. and *Cynoglossus* spp. and demersal animals like crabs, amphipods, isopods and bivalve molluscs in the gut contents of *D. albida* proved that it is both a subsurface as well as a bottom feeder.

B. *Gerres filamentosus*

(i) Food composition:

The results of the gut contents analyses of *G. filamentosus* shows that amphipods, isopods, polychaetes, juvenile crabs, filamentous algae and diatoms contribute to the bulk of the food items of this species. Amphipods (*Phronima* spp., *Grandidierella* spp. and *Eriopisa* spp.) and isopods (*Cirolana* spp. and *Synidotea* spp.) were found to be present throughout the year in the gut contents in high percentages. Polychaetes (*Diopatra* spp. and *Ancistrosyllis* spp.), juvenile crabs and bivalve molluscs (*Perna* spp. and *Modiolus* spp.) were not represented in all months. Filamentous algae and diatoms (*Coscinodiscuss* spp., *Biddulphia* spp., *Nitzschia* spp. and *Skeletonema* spp.) were found to be present in all the months eventhough their percentages were very low. Other items of food identified from the gut contents of *i. filamentosus* were Ostracods (*Cypridina* spp.), Mysids (*Mesopodopsis* spp.), semi digested matter, Crustacean remains, Gastropods, Copepods, Cirripeds, Decapod larvae, Hirudinea and Detritus matter.

(ii) Food of juveniles and adults:

In order to find out the variation in the food of juveniles and adults, their stomach contents were analysed separately. From the results (Table 6) it is clear that the preference of the juveniles is always towards planktonic forms mentioned above. But in general, the food of juvenile does not vary much in group or genera from that of adults, but the percentages of polychaetes, juvenile crabs and bivalve molluscs were less in juvenile fishes. Similarly, the percentage contribution of food items viz. diatoms, ostracods, mysids, copepods, decapod larvae etc. were found to be comparatively higher in juvenile fishes. So it can be stated that the size of the food consumed by the fish increases with an increase in size of the fish. This can be confirmed by noticing the fact that smaller planktonic food items were found in appreciable quantities in the gut of juvenile fishes.

The food of adults were studied separately. The gut contents of male and female fishes did not show much difference, hence the data were combined and presented in table 6. In addition to Amphipods and Isopods, Polychaetes were also found to be consumed in high amounts by the adult fishes. Moreover, juvenile crabs, bivalve molluscs and detritus were also encountered in appreciable percentages. Filamentous algae and diatoms were noticed only in traces, but found to be present in all months. Ostracods, Mysids, Copepods, Cirrepedes, Decapod larvae and Hirudineans were noticed only in traces and their occurrence were reported very sporadically. The food items of adults fishes consist of relatively big sized organisms and most of them belong to demersal groups of animals.

(iii) Seasonal variation in the food of juveniles and adults:

Seasonal variation in the food of juveniles and adults of *S. filamentosus* are presented in table 6.

The juveniles feed on amphipods, isopods, bivalve molluscs, ostracods, filamentous algae, diatoms and detritus matters in almost during all months. The occurrence of polychaetes were encountered in March, April and from October to December. Juvenile crabs were also represented in January to March, July and September to December. The occurrence of other planktonic food items viz. mysids, copepods, cirrepedes, decapod larvae and hirudineans were rather irregular and were found to be present throughout the year.

The adults also, like juveniles, were found to feed mainly on amphipods and isopods in appreciable quantities in all months. Polychaetes and juvenile crabs formed the next important food items and their occurrence were noticed in high percentages from the gut contents of adults almost in all months. The regular occurrence of filamentous algae, diatoms and detritus matters were encountered in all months eventhough their percentages were very low. Another dominant food item is the bivalve molluscs, which were noticed in all months except in July, the highest percentage (20.92) was recorded in May. The presence of mysids in traces was noticed in all months except in July, August and December. The occurrence of ostracods in scarce quantities was regularly observed, the highest percentage (2.77) was reported in July. The gastropods were found to be present in low percentages in January, April, May, June, July, September, November and December. The occurrence of other reported planktonic forms viz. copepods, cirrepeds, decapod larvae and hirudineans were sporadically represented in the gut contents in traces and were not important food items of adult fishes.

(iv) Feeding intensity:

The percentage occurrence of feeding intensities for *S. filamentosus* is shown in table 7. The percentages of gorged, full and 3/4 full stomachs are less when compared to other categories. Fishes with gorged stomachs were encountered only during March, April and July. Fishes with full stomachs were not represented during January, February, June, September, November and December. The occurrence of fishes with empty stomachs were observed in almost all months except in June and July. The percentage of empty stomachs were relatively high from October to April, the highest percentage (42.85) was encountered in December.

Table 7. Percentage occurrence of stomachs in different degrees of fullness in adults of G. filamentosus during January - December, 1980.

	Gorged	Full	3/4 full	1/2 full	1/4 full	Trace	Empty
January	-	-	14.11	23.53	9.42	16.47	36.47
February	-	-	9.52	6.34	22.22	33.33	28.59
March	4.87	7.31	4.87	19.51	17.07	14.63	31.74
April	6.77	3.38	15.25	10.17	20.34	11.89	32.20
May	-	10.26	17.95	30.77	12.82	7.69	20.51
June	-	-	38.88	19.46	30.55	11.11	-
July	13.95	20.93	11.62	27.90	18.62	6.98	-
August	-	15.38	11.53	32.69	13.46	5.79	21.15
September	-	-	15.00	22.50	10.00	32.50	20.00
October	-	3.39	8.47	23.73	15.25	18.66	30.50
November	-	-	6.56	4.92	14.75	45.90	27.87
December	-	-	1.79	14.29	25.00	16.07	42.85

(v) <u>Feeding in relation to the breeding cycle</u>:

From table 7 it is clear that the feeding activity of *G. filamentosus* gradually reduced into minimum from October onwards and inversely the percentage of empty stomachs were found to increase during this period. The peak spawning season of *G. filamentosus* in Vembanad lake is from October to February (as discussed in section 4.3) and minimum feeding activity has been observed during the above months. In juveniles, during the above period, the feeding intensity was relatively high and the diminished feeding activity observed in mature fishes can be correlated to the spawning activity of the fish.

The food composition of *G. filamentosus* included demersal group of organisms and were mainly represented by amphipods, isopods, polychaetes, juvenile crabs, bivalve molluscs, filamentosus algae, diatoms and detritus matter, eventhough the fishes consumed a variety of food materials. The mouth is highly protrusible and is adapted for browsing on epiphytic animals and plants of the environment. It has also the power of picking up of the other benthic animals like polychaetes, bivalves and gastropods. The stomach is not well developed and hence cannot accommodate bigger sized organisms.

Job (1940) gave an account of food of G. *filamentosus* along with the food of other perches from Madras coast and reported that 40% of food composed of crustaceans. Chacko (1949) reported that the food of G. *filamentosus* comprised of amphipods and gastropods. Prabhakara Rao (1968) observed that the food composition of G. *filamentosus* of Pulicat lake is dominantly represented by amphipods, polychaetes bivalves, detritus and decapod crustaceans. It can be stated that there is much agreement between the food habits of G. *filamentosus* of Pulicat lake and Vembanad lake. The main differences noticed in the diet composition of G. *filamentosus* of Vembanad lake from those inhabiting in Pulicat lake is that juvenile crabs and isopods were found to be consumed much by the former ones than the latter. The occurrence of juvenile crabs, isopods, ostracods, mysids and hirudineans were recorded anew besides those reported earlier from the stomach contents of G. *filamentosus*, during the present investigation.

On comparison of the food habit of G. *filamentosus* with that of other Gerrids, it is observed that there exist some variation in the nature of food consumed by this species with that of other related species of the family Gerridae. Chacko (1949) observed the presence of only sea weeds in the gut contents of G. *oyena* collected from the Gulf of Mannar. Basheeruddin and Nagappan Nayar (1961) has encountered only crustacean remains in the food of *G. setifer* from Madras coast. Prabhakara Rao (1968) conducted a detailed study on the food and feeding habits of the three species of Gerrids viz. *G. oyena*, *G. filamentosus* and *G. limbatus* of Pulicat lake and concluded that all the species have identical food habits consuming the same food items, eventhough the extend to which any particular item is consumed differ among the different species. The most dominant food items of the Gerrids of Pulicat lake were reported as amphipods, detritus, polychaetes and bivalves (Prabhakara Rao, 1968). Patnaik (1971) reported that *G. setifer* of Chilka lake is a bottom feeder, mostly feeding on crustaceans and molluscs and the juvenile showed a planktonic feeding habit. The results of the present study also reveal that the food habits of *G. filamentosus* of Vembanad lake is more or less identical with the food habits of Gerrids of Pulicat and Chilka lakes, as reported by Prabhakara Rao (1968) and Patnaik (1971).

4.2. LENGTH-WEIGHT RELATIONSHIP AND RELATIVE CONDITION FACTOR

4.2.1. LENGTH-WEIGHT RELATIONSHIP

The study of the relationship of weight to length is an important diagnostic indication of the well being of fish and serves two fold purposes (Le Cren, 1951) (1) to provide a mathematical relationship between two variables, length and weight (2) to measure the variations from the expected weight or length of individual fish or groups of fishes as indication of fatness, general well-being or gonadial development. The length-weight relationship in fishes can also be used in setting up yield equations (Beverton and Holt, 1957; Ricker, 1958), in estimating the number of fish landed and in comparing populations in space and time (Sekharan, 1968), growth studies and for comparison of body form of different groups of fishes. Weight of a fish is a function of its length and the general expectation is that the weight of fishes would vary as the cube of length (Brody, 1945; Lagler, 1952; Brown, 1957). But the actual relationship may depart significantly from this (Le Cren, 1951), as fishes normally do not retain the same shape or body outline throughout their life span and the specific gravity of tissues may not remain constant.

4.2.1.1. MATERIAL AND METHODS

A total of 426 *D. albida* and 615 *G. filamentosus* were examined for calculating the length-weight relationship. Fishes were measured and weighed in fresh condition. Standard length was measured from tip of snout to hypural plate and the weight was recorded in gram to the nearest 0.1 milligram. As relationship of each fish can be expressed by the formula

$$W = al^{b}$$

where W = weight, l = standard length and 'a' and 'b' are constants. Logarithmic transformation of the formula given a straight line relationship of the form

$$\text{Log } w = \text{Log } a + b \text{ Log } l$$

where Log w is the dependent variable (y), log l the independent variable (x), b the regression coefficient or slope, and log a the y - intercept. Log a and the regression coefficient (b) were estimated by the usual method of least squares. So for practical purposes this relationship is usually expressed as

$$\text{Log } w = \text{Log } a + b \text{ log } l$$

This linear equation was fitted separately for males, females and indeterminants in *D. albida* and *G. filamentosus*.

Students 't' test (Zar, 1974) was employed for comparing the regression coefficients between males and females, males and indeterminants and females and indeterminants of both the species. The results are given in tables 10 and 11.

4.2.1.2. Results and Discussion

Statistical details regarding length-weight relationship of *D. albida* is summarised in table 8. The logarithmic relationship between length-weight relationship of males, females and indeterminants of *D. albida* are represented in plate 58.1,2 and 3). The logarithmic regression equations obtained are as follows:

For males: Log w = -1.5055+2.8618 Log l;

For females: Log w = -0.9260+2.4089 Log l;

For indeterminants: Log w = -1.7188+3.0616 Log l.

Table 9 shows the details of the statistical analysis of length-weight relationship of *G. filamentosus*. Plate 58.4,5 and 6 represent the logarithmic relationship between length and weight of males, females and indeterminants of *G. filamentosus*. The logarithmic regression equations obtained are as follows:

For males: $\text{Log } w = -1.3224+2.8740 \text{ Log } l$;

For females: $\text{Log } w = -1.2874+2.8381 \text{ Log } l$;

For indeterminants: $\text{Log } w = -0.8167+2.2558 \text{ Log } l$.

The regression equations of males, females and indeterminants of the above two species were subjected to students 't' test for comparison of regression coefficients.

In D. albida (Table 10) the regression coefficients between males and females, males and indeterminants and females and indeterminants, significant difference could be noted. Table 11 represents the comparison of regression coefficients between males and females, males and indeterminants and females and indeterminants of S. filamentosus. It is found that the regression coefficients between males and females are insignificant at 5% level. Significant differences were obtained between males and indeterminants and females and indeterminants.

In D. albida the regression coefficient of female is found as lowest when compared to males and indeterminants. Relatively high 'b' value is noticed in indeterminants. From the relationship it may be presumed that indeterminants gained more weight with increase in length compared to

Table 8. Statistical details showing number (N), regression coefficient (b), y intercept (log *a*) standard error of b (Sb), correlation coefficient (r), student t (t) and its probability (P) in the length-weight relationship of *D. albida*.

D. albida	N	*b*	log *a*	Sb	r	t	P
Male	162	2.8618	-1.5055	0.0454	0.9804	63.0352	<0.001
Female	167	2.4089	-0.9260	0.0510	0.9624	47.2333	<0.001
Indeterminant	97	3.0616	-1.7188	0.0507	0.9872	60.3865	<0.001

Table 9. Statistical details showing number (N), regression coefficient (b), y intercept (log a), standard error of b (Sb), correlation coefficient (r), student t (t) and its probability (P), in the length-weight relationship of *G. filamentosus*.

G. filamentosus	N	b	log a	Sb	r	t	P
Male	164	2.8740	-1.3244	0.0568	0.9701	50.5985	<0.001
Female	287	2.8381	-1.2874	0.0412	0.9711	68.8525	<0.001
Indeterminant	164	2.2558	-0.8167	0.0586	0.9597	38.4948	<0.001

Table 10. Comparison of regression coefficient in the length-weight relationship of *D. albida*

Sl. No.	Comparison	t	d.f	P
1.	Male and Female	6.6330	325	<0.001
2.	Male and Indeterminant	2.9360	255	0.002 <P<0.001
3.	Female and Indeterminant	9.0779	260	<0.001

Table 11. Comparison of regression coefficient in the length-weight relationship of *D. filamentosus*

Sl. No.	Comparison	t	d.f	P
1.	Male and Female	0.5114	447	N.S
2.	Male and Indeterminant	7.5760	324	<0.001
3.	Female and Indeterminant	8.1327	447	<0.001

N.S = Not significant at 5% level

d.f = degrees of freedom

P = Probability

males and females. In *G. filamentosus* highest 'b' value is obtained in males and lowest in indeterminants. The body weight in relation to length increases more rapidly in males than to females and indeterminants.

The theoretical value of b (regression coefficient) in length-weight relationship is reported as 3 when the body form of fish remains constant at different lengths, i.e. the growth is isometric (Allen, 1938). Slope value less than 3.0 indicates that fish become more slender as they increase in length, the slope greater than 3.0 indicate the reverse, i.e. growth is allometric (Grover and Juliano, 1976). But the value of 'b' usually lies between 2.5 and 4.0 (Hile, 1936; Martin, 1949). In the present investigation also, in *D. albida* and *G. filamentosus* the value of 'b' ranged between 2.5–4.0 except in the indeterminant groups of *G. filamentosus* where it is less than 2.5.

4.2.2. RELATIVE CONDITION FACTOR (Kn)

The study on the relative condition factor can be used to compare the plumpness of fish and so permit a fish culturist to compare the weight of fish against a standard calculated weight to determine if the fishes are in better or poorer condition than the standard. In other words, the relative condition factor can be used to compare the 'general well being', 'fatness' or 'the state of development of gonad' (Thomas, 1969). The ponderal index (K) was used for understanding the changes in weight for length assuming that the length weight relationship obeys the cube law. Le Cren (1951) recommended a study on relative condition factor (Kn) in preference to the ponderal index (K) as the latter will be highly influenced by many environmental and biological factors.

The relative condition factor (Kn) is the ratio of observed weight (W) of a fish at a given length to the expected weight ($\bar{W}$) of a fish of the same length as calculated from the length weight regression (Le Cren, 1951). The equation is

$$Kn = W/\bar{W}$$

The relative condition factor 'Kn' for _D. albida_ and _G. filamentosus_ has been calculated separately for males and females using the above formula for the year 1980 (Plate 59).

4.2.2.1. Results and Discussion

In _D. albida_ (Plate 59.1) the Kn values were relatively higher for females from August to November when the percentage frequency of fully riped females were higher in the lake. From November onwards the steep infection was noticed upto March when spent females were encountered from the lake. This inflection of the Kn values may be due to the spawning activity of the fish. A second peak in 'Kn' values were observed in April followed by a sudden inflection in May. This peak is not due to the presence of fully riped females and may be due to some other factors. From June to August the 'Kn' values remained more or less steadily. The fluctuation of 'Kn' values of males also denote more or less similar trend to that of females. Comparatively high 'Kn' values were recorded during August and September when the percentage of fully riped males were higher. A steep inflection in 'Kn' value was noticed in October and it may indicates the beginning of spawning. Low 'Kn' values were seen from October to January in males when the spent males were encountered from the lake. A second peak in 'Kn' value was observed in June and it was not due to the occurrence of fully riped male fishes and so it may be due to some other factors.

In G. filamentosus (Plate 59.2) 'Kn' values of both females and males followed a similar trend with rise in 'Kn' from August to January, highest value in female was recorded in December and in male in October. The higher 'Kn' values in both sexes during the above period may be due to the active maturation of gonads. A steep inflection in 'Kn' value were noticed in February when the percentage frequency of spent fishes were relatively high in the lake and so it may be presumed that the inflection of 'Kn' values may be due to the spawning activity of the fish.

The value of 'Kn' depends on physiological factors like maturity and spawning and environmental factors like the availability of food (Brown, 1957). Fluctuations in the condition factor of the fish during different months have been attributed to a variety of reasons (Hickling, 1945; Qasim, 1957). Venkataramani (1979) stated that a study of changes in 'Kn' during various months of the year may reflect the spawning cycle in fish. Thomas (1969) concluded that in _Upeneus tragula_ the changes in the condition do not appear at least to be related to sexual cycle or feeding intensity but be due to some other factors. In _Trichiurus lepturus_, Narasimham (1970) recorded the peak 'Kn' values in those months when feeding intensity was very high and so he concluded that sexual cycle does not seem to influence the 'Kn' values to any perceptible degree.

In the present studies on the relative condition factor of _D. albida_ and _G. filamentosus_, high 'Kn' values were recorded during the spawning season of these two species and so it can be inferred that the sexual cycle can definitely influence the 'Kn' values to a perceptible degree. But in some non-spawning season also high 'Kn' values were observed in _D. albida_ and hence it may be presumed that 'Kn' values were not only influenced by sexual cycle but also due to feeding intensity or some other unknown factors.

4.3. BREEDING

4.3.1. INTRODUCTION

Studies on the reproductive biology of fishes of the Vembanad lake are very few (Sunny, 1975; Kurup and Samuel, 1981f). A detailed knowledge of the spawning seasons forms an integral part of biological investigation that is essentially needed for understanding the changes in fish population. Such studies are an essential prerequisite for understanding the rate of regeneration of the stock, determination of ecological factors which lead to the synchronization of breeding activity and for successful fish farming practices.

Literature on the reproductive biology of *D. albida* and *G. filamentosus* are not available. However, pertinent literature on the reproductive biology of related species of the family Sciaenidae and Gerridae are available. These two species constitute a thriving fishery in Vembanad lake and also have considerable importance due to their suitability for fish farming ventures. So the present study was undertaken to understand in detail some of the important aspects such as spawning periodicity, spawning season, minimum size at first maturity, fecundity and sex ratio of *D. albida* and *G. filamentosus*.

4.3.2. MATERIAL AND METHODS

The material for the present study was collected every fortnight during the period between January and December 1980, from the different types of fishing gears (as described in section 3.5) of Vembanad lake. The specimens were brought to the laboratory in fresh condition, weighed accurately and the standard length, sex, condition of gonads of each specimen was recorded. The stage of maturity of the gonad was recognized by using ICES scale (Loven and Wood, 1937) with suitable modifications suggested by Qasim (1973) for tropical and subtropical fishes. Measurements of ova diameter were taken from ovaries at different stages of maturity using the method adopted by Clark (1934), Hickling and Rutenburg (1936), De Jong (1939), Prabhu (1956), Ramanathan and Natarajan (1979), Venkataramani (1979) and James and Baragi (1980). The ovaries were treated with modified Gilsons fluid (Simpson, 1951) for the studies on ova diameter and fecundity. Ova taken from anterior, middle and posterior regions of a few ovaries at different stages of maturity indicated a more or less uniform pattern of distribution (Prabhakara Rao, 1970b; Baragi and James, 1980). Hence 300 ova were measured from ovaries at different stages of maturity using an ocular micrometer. The spawning season was determined from the percentages occurrence of different maturity stages of gonads during different months of the year and confirmed by the gonado-somatic indices. The spawning periodicity was determined by ova diameter studies. Sex ratio was calculated and the homogeneity in the distribution of males and females were tested by applying Chi-square formula. The fecundity was estimated using the method adopted by Holden and Raitt (1974).

4.3.3. Classification of maturity stages

The maturity stages were determined on the basis of the colour, shape, size and microscopic structure of the gonads. Five stages of maturity were adopted as suggested by Qasim (1973) for tropical and sub-tropical fishes.

A. D. albida (Female and Male)

Stage I (Immature): Ovary thin, thread-like, slightly reddish or pink, occupying nearly 1/4 of the body cavity, translucent and jelly-like. Ova not discernible to naked eye, under the microscope small transparent ova visible with a nucleus in the centre.

Testes thread like, white and occupying nearly 1/2 in length of body cavity.

Stage II (Maturing virgin and recovering spent): Ovary flattened, reddish grey, extending nearly 1/2 of body cavity. Maturing group of ova visible to naked eye as very small white spots and appears opaque due to the deposition of yolk, nucleus not visible.

Testes occupying more than 1/2 in length of body cavity, ribbon like and white in appearence.

Stage III (Ripening): Ovary broad, swollen, granular and yellowish, extending 3/4 of the body cavity. Ova visible to naked eye through the ovarian wall. Mature ova irregular and completely opaque due to the thick deposition of yolk. Ova marked by the vacuoles of the yolk.

Testes ribbon-like, broad, creamy white and soft, occupying 3/4 of the body cavity. Outer margin of each lobe irregular.

Stage IV (Ripe): Ovary massive structure, fully occupying the body cavity and encloses the intestine. Ovary fully packed with ova, ovarian wall transparent. Most of the ova completely transparent, delicate, yolk segmented and with a single oil globule. Blood vessels are very prominent above the ovary and conspicuous grooves present on the ventral side of each lobe.

Testes occupying nearly the full of the body cavity, creamy white and very soft, completely opaque, flattened, lobulated, wrinkles very prominent on margin of each lobe. Milt oozes out on gentle pressing.

Stage V (Spent): Ovary shrunken, flabby, blood-shot, translucent, occupying nearly 1/2 of the body cavity. Majority of the ova transparent and invisible to naked eye with a very few yellowish residual eggs.

Testes reddish-white, flabby and shrunken, occupying more than 1/4 in the length of body cavity.

B. G. filamentosus (Female and Male)

Stage I (Immature): Ovary thin, thread like, pale yellow, extending 1/4 of the body cavity, translucent and jelly like. Very small transparent ova with distinct central nucleus discernible when examined under the microscope. Very few eggs with traces of yolk deposition is also seen.

Testes thread like, white, occupying nearly 1/2 in length of body cavity.

Stage II (Maturing virgin and recovering spent): Ovary flattened, pinkish yellow with granular appearence, extending nearly 1/2 of the body cavity. Maturing group of ova with yolk deposition, ova discernible to naked eye as white spots.

Testes ribbon-like, dull white or slightly pinkish, occupying more than 1/2 in length of body cavity.

Stage III (Ripening): Ovary swollen, yellowish, fully packed with irregular opaque eggs, extending 3/4 of the body cavity. Majority of the ova appeared opaque due to the thick deposition of yolk. Nucleus not visible. Venation above the ovary prominent.

Testes slightly flattened, occupying 3/4 in length of body cavity, creamy white, margin of each lobe with slight wrinkles.

Stage IV (Ripe): Ovary as a massive structure, deep yellow or orange red, occupying the full of body cavity with very conspicuous superficial blood vessels. Three groups of mature ova discernible, one group of completely transparent with a single nucleus, another group of ova with peripheral transparent zone and a third group of completely opaque ova. Left lobe of ovary usually slightly longer than right lobe.

Testes flattened and broad, creamy white and very soft, milt produces under gentle pressing, occupying the full length of body cavity. Wrinkles on the margin become very prominent.

Stage V (Spent): Ovary shrunken, flabby, blood-shot and semi-translucent, extending less than 1/2 of the body cavity. Majority of ova immature and transparent and invisible to naked eye with a very few opaque residual eggs.

Testes flaccid, brownish and shrunken, occupying less than 1/2 in length of body cavity.

4.3.4. Results and Discussion

(a) Development of ova to maturity and frequency of spawning:

To study the development of ova and to determine the frequency of spawning, the diameter of intra-ovarian eggs from immature to spent ovaries were recorded, which is the most widely employed method in several fishes (Clark, 1934; June, 1953; Prabhu, 1956; James and Baragi, 1980). The measurements of the intraovarian eggs were recorded with an ocular micrometer at a magnification giving a value of 50µ to each micrometer division. The immature group of ova with the diameter less than one micro div. were present in all stages both in *D. albida* and *N. filamentosus*, were not taken into consideration in all stages of maturity. A total of 93 ovaries of *D. albida* and 120 ovaries of *N. filamentosus* of different maturity stages were examined during the present investigation and the pooled ova diameter frequencies from 3 regions of the ovary are presented in plate 60.

In D. albida (Plate 60.1) during stage I majority of the ova measured between 1–2 micro. div. and only an immature stock of ova were represented with a very prominent mode of 1 micro. div. Very few eggs with 3 micro. div. were also recorded. These immature stock of ova were discernible in all stages and was found to be increasing during the spawning period. In stage II, apart from the immature stock, the shifting of mode from 1 micro. div. to 3 micro. div. was discernible which indicates the passing of the immature ova into maturing ones. After the stage II the development of these ova seem to be very rapid. In stage III a distinct batch of ova get separated out and progress towards maturity and the mode in stage II (3 micro. div.) is shifted to 6 micro. div. forming 27% of the total number of ova. In this stage another minor mode of 5 micro. div. was also observed with 18% of the total number of ova. The most advanced batch of ova were encountered in stage IV and two batches of ova can be clearly demarcated. The most advanced batch with a diameter of 9 micro. div. which constitute 42% of the total number of ova, were fully riped and transparent with a single oil globule and it is presumed that this batch may get spawn firstly. Another batch of opaque maturing ova were also discernible which constitute the minor mode with a micro. div. of 7 and these two batches of maturing and mature eggs were completely separated from the general immature stocks. In spent ovaries the mode again shifted back to 1-2 micro. div. and another very small mode of 8 micro. div. was also discernible.

The ova diameter frequencies of fully ripe ovary shows that there are two batches of mature eggs which are sharply differentiated from the general stock of immature ova. So it can be presumed that there is the indication of two successive spawning and the interval between two successive spawning is short due to the fact that these two groups of mature ova are not sharply differentiated and hence the second batch of opaque eggs may not take much time to ripen. The occurrence of fully spent females in the lake confirms the above inference. Similar observations were also reported in J. carutta (Appa Rao, 1967) from Visakhapatnam and in J. dussumieri (Devadoss, 1967) from Bombay coasts. The ova diameter frequencies of fully riped ovary also indicate that individual fish spawn twice during the spawning season.

In G. filamentosus (Plate 60.2) during I stage only immature ova ranging in diameter 1 to 4 micro. div.

were seen. Majority of the ova were with 1 micro. div. which constitute the only mode. This group of immature ova were found to be present in the ovaries in all stages of development. During the maturation process the immature ova of stage I get separated, with a prominent mode at 4 micro. div. in stage II and the diameter of ova in state II ovaries ranged from 1 to 6 micro. div. In stage III a group of opaque ova with a mode of 6 micro. div. was discernible and besides this major mode, two other minor modes were also observed, one with 5 micro. div. and another with 7 micro. div. These three groups of ova were separated from the immature stock of ova and found to be progressing towards maturity. The maximum size of the ova in stage III is 8 micro. div. In stage IV, the first mode progress further to show a peak at 9 micro. div. and these ova are transparent and are ready for spawning, the second group of ova which are appeared as the highest peak with a diameter of 8 micro. div. are with the peripheral transparent zone and a third batch of opaque ova with a diameter of 7 micro. div. constitute the third peak in a fully riped ovary. These three groups of oocytes are not distinctly differentiated by an evident gap among themselves, so it may be presumed that these three groups of ova may spawn in the ensuing spawning season in three successive batches.

In the ovary of a fully spent adult a large number of ova with 1 micro. div. were discernible, only very few opaque ova with a maximum size of 8 micro. div. were observed. These residual ova are irregular and in the state of resorption.

Based on the ova diameter frequency of the fully riped ovaries, it is clear that three batches of mature ova are not sharply separated and so they may spawn completely in the same spawning season. The ova diameter frequency of spent ovary also reveals that majority of the ova are immature with a very few residual eggs and hence the above inference could be concluded that mature group of eggs in the ripe ovary may shed completely in the same spawning season. Moreover, the completely mature group of ova are not sharply differentiated from the maturing group and hence it may be inferred that the process of maturation is a continuous one and the spawning may take place within a prolonged time. The sporadic occurrence of partly spent females in the lake during October and November may also confirm the above finding. There is only a single peak of mature ova in the fully ripe ovary, so it may be concluded that the individual fish spawn only once within a definite spawning period in an year. The present observation agrees well with that of Prabhakara Rao (1970b) and Patnaik (1971) who noticed that *G. oyena* and *G. setifer* spawn only once in Pulicat and Chilka lakes respectively and the spawning activity is a prolonged one.

(b) Spawning season:

To determine the spawning season of D. albida and G. filamentosus the occurrence of specimens with different maturity stages of gonads during one year was recorded. 5 stage maturity scales was employed to classify them into stages as described in section 4.3.3. The percentage occurrence of maturity stages of ovary and testes during different months of the year 1980 was depicted separately for D. albida (Plate 61.1) and G. filamentosus (Plate 61.2).

It is evident from the plate that the occurrence of maturing and mature gonads (Stage II and III) of D. albida were recorded almost in all months with a higher percentage from January to July. Fully matured ovaries and testes (Stage IV) of D. albida were recorded from May to December with a very high percentage in July to November, the maximum of 55% recorded in August. During January, March and April females of stage IV were encountered in very scarce numbers. Specimens with oozing gonads (ovaries and testes) were not met from the lake during the period of investigation. Spent ovaries and testes were encountered from September to January with higher percentages in October and November. From the above observation it is clear that fishes with fully riped gonads were collected in higher percentages from July to

November, indicates that D. albida may spawn during those months. It may be also presumed that the final stage of maturity is reached in the sea only, so fishes with ripe gonads may migrate to the sea for spawning. The occurrence of specimens with spent ovaries and testes in higher percentages during October to November also confirms that the spawning season of D. albida is from July to November.

Specimens of J. filamentosus with ripe ovaries and testes (Stage IV) occurred from August to April in varying percentages, the maximum percentages were recorded in December and January. The percentage occurrence of ripe males and females were comparatively high from October to February and this indicates that the peak spawning season of J. filamentosus in Vembanad lake may be from October to February. The occurrence of spent fishes in the lake were encountered from October onwards and the percentage frequency of spent fishes were comparatively high from February to April, which also confirms its breeding period during the above months. As in D. albida, fishes with oozing gonads were not obtained from the lake during the period of investigation and hence it is inferred that fishes with fully ripe gonads may migrate to the sea for spawning.

(c) Gonado-somatic index (GSI):

Applying the method of June (1953) and Yuen (1955), the relative weight or the gonado-somatic index of *D. albida* and *G. filamentosus* were calculated by using the formula

$$GSI = \frac{\text{weight of gonad}}{\text{weight of fish}} \times 100$$

The index was calculated for both males and females for each specimen and the monthly mean were calculated separately.

In *D. albida* (Plate 62.1) comparatively high gonado-somatic indices were noticed from August to December indicates intense gonadal activity during these periods. The GSI values were gradually increasing from March when gonads begin to mature, reaching the maximum in September-October when most of the adults are fully mature. From December onwards there is a noticeable fall and it may be due to the discharge of gametes and hence there appears the spent fishes. High GSI values from August to December indicates that majority of the individual have fully riped gonads and spawn during these months.

In *G. filamentosus* (Plate 62.2) the seasonal variation in gonado-somatic indices of both sexes were quiet evident. In males and females high values were recorded from October to February. The pattern of variation in males was similar to that of female. The sudden fall of GSI during March onwards may be due to the liberation of gametes. The GSI values were found to be increasing gradually from May onwards and the maximum GSI values were recorded during December. The comparatively high GSI values obtained from October to February indicates the intense gonadal activity during these periods and can also confirm that the major spawning season of this species is from October to February. Monthly fluctuation of GSI values are due to its prolonged breeding season.

(d) Size at first maturity:

Fishes were grouped into 10 mm Size groups and the percentage occurrence of fishes in various stages of maturity in each size group was calculated. The stage III and above were considered for the purpose of calculating the size at first maturity.

Percentage occurrence of mature males and females of U. albida are shown in plate 63.1 and 2. It can be seen that upto 115-124 mm SL all males are immature and the mature males appeared in 135-144 mm SL group. The percentage of mature male increased upto 215-224 mm SL group. In males one hundred percentage maturity was found in size groups above 215-224 mm SL. In females below 155-164 mm SL group all were found to be immature or maturing.

The percentage occurrence of mature females steadily increased upto 245-254 mm SL group when all females were found to be mature. The 50% level in the maturity curve which may be taken to represent the mean length at which maturity was attained, are 195 mm SL in males and 215 mm SL in females. From the observation it is evident that males attain maturity earlier to females.

In *S. filamentosus* (Plate 63.3 and 4) all fishes upto 55-64 mm SL group are immature in the case of males and 65-74 mm SL group in the case of females. Majority of fishes matured in the 115-124 mm SL group both in the case of males (55%) and females (58%). From this group onwards, mature fishes steadily increased to 100% at 145-154 mm SL group in males and 155-164 mm SL group in females. Based on the observation, the 50% level in maturity curves which may be taken to represent the mean length at which maturity was attained, were 117 mm SL in males and 118 mm SL in females. It is therefore, evident that both the sexes attain maturity probably between 115-120 mm SL group.

Venkatasubba Rao (1963) reported that the size at first maturity of *P. diacanthus* is 85 cm. In *O. ruber* female attain maturity at 200 mm and in *J. dussumieri* it is 160 mm (Devadoss, 1969). Baragi and James (1980) observed that the size at first maturity of *J. osseus* is 125 mm in females and 95 mm in males. But in the present investigation it is observed that in *D. albida* the mean length at which maturity was attained is 195 mm SL in males and 215 mm SL in females. On comparison with other Sciaenids it is clear that *D. albida* attains maturity only the big size groups in both the sexes.

Among the Gerrids, Prabhakara Rao (1970b) fixed the size at first maturity of *G. oyena* of Pulicat lake as 164 mm and 189 mm for males and females respectively. Similarly, Patnaik (1971) reported that 75% of the female were matured in the size group 81–90 mm and 50% males were matured in the size group 71–80 mm in *G. setifer* of Chilka lake. But in the present study the size at first maturity of *G. filamentosus* is found to be 116 mm SL in males and 117 mm SL in females. The result of the present study agrees with the earlier reports that the male attains maturity earlier to their female counterparts.

(e) Fecundity:

For this study, ovaries of fully ripe fishes were used. The total number of eggs in the ovary was enumerated by adopting Holden and Raitt's (1974) formula, $F = \frac{nG}{g}$ where F = fecundity, n = number of eggs in subsample, G = total weight of the ovary, g = weight of subsample in the same units.

The fecundity of *D. albida* was studied in 31 ovaries. The number of ova varied from 1,08,864 to 13,87,940 in the size range 198–520 mm SL. The number of ova increased with an increase in standard length of the fish. The regression was calculated by the method of least squares and represented in plate 64. A straight line relationship was obtained between fecundity and standard length (plate 64.1). The regression equation after logarithmic transformaion of the variables, can be expressed as

$$\log F = -0.2979+2.3751 \log L$$

(where F = fecundity in thousands of ova, log L = standard length in mm).

The correlation coefficient (r) between fecundity and standard length was found to be 0.9419 which showed a high degree of correlation.

The weight of *D. albida* also showed a straight line relationship (Plate 64.2) with fecundity. The correlation coefficient (r) between fecundity and body weight was found to be 0.9602 which showed that a high degree of correlation. The relationship between body weight of the fish and fecundity is expressed in the regression line as

$$\log F = 3.3419 + 0.8220 \log W$$

(where F = fecundity in thousands of ova, log W = weight of fish in grams).

Venkatasubba Rao (1963) reported that the fecundity of P. diacanthus varied from 17,43,000 to 48,26,775 eggs in the size range 93–106 mm length. Similarly Devadoss (1969) observed that the number of ova in J. ruber ranged from 44,621 to 1,79,659 eggs in the size range 188–290 mm length and in J. dussumieri the ova numbered 1,42,005 to 2,25,988 in the size ranges of 195–235 mm length. On comparison the fecundity of other Sciaenids, it is evident that in D. albida also the number of ova was found to be increasing with an increase in size and weight, as reported in other Sciaenids mentioned above.

The fecundity of G. filamentosus was studied in 27 fishes. The number of ova was found to be ranging from 54,720 to 61,376 in the size ranges of 100–148 mm SL. As in D. albida, the number of ova were found to be increasing with an increase in standard length of the fish and a straight line relationship was observed between fecundity and standard length. The regression was calculated by the method of least squares and represented in plate 64.3. The regression equation after logarithmic transformation of the variables, can be expressed as

$$\log F = -2.110+3.2563 \log L$$

(where F = fecundity in thousands of ova, L = standard length in mm).

The correlation coefficient (r) between fecundity and standard length was found to be 0.7178.

The number of ova was also found to be increasing with an increase in body weight and a straight line relationship could be found between weight of the fish and fecundity (Plate 64.4). The regression equation after logarithmic transformation of the variables can be expressed as

$$\log F = 2.8917+0.9896 \log W$$

(where F = fecundity in thousands of eggs, W = weight of fish in grams).

The correlation coefficient between fecundity and body weight of the fish was found to be 0.6906.

Prabhakara Rao (1970b) observed that the fecundity of _G. oyena_ varied from 1,04,211 to 14,43,785 eggs in the size ranges from 148-282 mm. The correlation coefficients between fecundity and length and weight were reported as 0.5306 and 0.4421 respectively. Similarly, Patnaik (1971) observed that the fecundity of _G. setifer_ varied from 17,293 to 1,61,505 eggs in the size ranges 88-193 mm. On comparison with other Gerrids, it is clear that the fecundity of _G. filamentosus_ is relatively less than that of _G. oyena_ and _G. setifer_.

The exponential value is usually reported as '3' when fecundity is related to length and '1' when fecundity is related to weight (Bagenal, 1978). But in the present studies, the exponential value is less than cube in _D. albida_ but it is greater than cube in _G. filamentosus_, when fecundity is related to standard length. Moreover, the exponential value is found to be less than '1' in _D. albida_ and _G. filamentosus_ when fecundity in related to weight. The difference in exponential value and fecundity may be due to age, season, environment (Polder and Ziglstra, 1959; Antony Raja, 1971; Ziglstra, 1973). According to Bagenal (1978) the changes in the environment may also result in significant changes in fecundity.

(f) _Sex ratio_:

Because of the absence of any external character to distinguish the two sexes in _D. albida_ and _G. filamentosus_, the sexes were determined after examining the gonads to determine the occurrence of males and females. Tables

12 and 13 show the monthly distribution of the two sexes of *D. albida* and *G. filamentosus* in Vembanad lake. The ratio was tested by Chi-square ($X^2 = \Sigma \frac{(O-E)^2}{E}$) analysis for difference from the hypothetical 1:1 ratio or null hypothesis (Snedecor, 1961).

In *D. albida* the sex ratio was not skewed much in all months of the year 1980 and the sex ratio nearly conformed with the expected 1:1 ratio for all months. The mean ratio of males to females were 1.00:1.07 for the year 1980 and the Chi-square value for the year was 0.87 which showed that the variation is insignificant.

The ratio in *G. filamentosus* for the year 1980 was found to be deviate from the normal expected value 1:1 ratio. The sex ratio was significantly different in January, March, June and November. The chi-square value for the year was 21.73 and the mean ratio of males to females were 1.00:1.39. The skewed sex ratio was due to the ponderence of females over males.

Qasim (1966) suggested that the ponderence of one sex in a population is because of sexual differences in growth rate, the faster growth rate leads increasingly to less loss from predation and this may influence the sex ratio. In *G. filamentosus* also the maximum size was recorded in the outnumbered sex. Reynolds (1974)

Table 12. Sex ratio of *D. albida* in different months showing Chi-square values

1980 Months	Male	Female	% of males	% of females	Chi-Square Value	Probability	F:M
January	35	46	43.20	56.79	1.49	0.10<P<0.25	1.31:1.00
February	20	24	45.45	54.54	0.36	0.50<P<0.75	1.20:1.00
March	27	21	56.25	43.75	0.75	0.25<P<0.50	1.00:1.29
April	32	24	57.14	42.85	1.14	0.25<P<0.50	1.00:1.33
May	27	28	49.09	50.90	0.03	0.15<P<0.90	1.03:1.00
June	42	39	51.85	48.15	0.11	0.50<P<0.75	1.00:1.08
July	16	25	39.02	60.98	1.97	0.10<P<0.25	1.56:1.00
August	20	24	45.45	54.55	0.36	0.50<P<0.75	1.20:1.00
September	18	27	40.00	60.00	1.80	0.10<P<0.25	1.50:1.00
October	22	25	46.80	53.20	0.19	0.50<P<0.75	1.14:1.00
November	33	29	53.23	46.77	0.25	0.50<P<0.75	1.00:1.13
December	26	30	46.43	53.57	0.28	0.50<P<0.75	1.03:1.00
Total	318	342	48.18	51.82	0.87	0.25<P<0.50	1.07:1.00

Table 13. Sex ratio of *G. filamentosus* in different months showing Chi-square values.

1980 Months	Male	Female	% of males	% of females	Chi-Square value	Probability	F:M
January	32	54	37.20	62.79	5.63	0.01<P<0.025*	1.68:1.00
February	30	34	46.86	53.12	0.25	0.50<P<0.75	1.13:1.00
March	29	49	37.18	62.82	5.13	0.01<P<0.025*	1.68:1.00
April	30	25	54.55	45.45	0.50	0.25<P<0.50	1.00:1.20
May	17	26	39.53	60.47	1.88	0.10<P<0.25	1.52:1.00
June	22	42	34.38	65.62	6.25	0.01<P<0.025*	1.90:1.00
July	30	33	47.62	52.38	0.14	0.75<P<0.90	1.10:1.00
August	25	36	40.98	59.02	1.98	0.10<P<0.25	1.44:1.00
September	30	38	44.12	55.88	0.94	0.25<P<0.50	1.26:1.00
October	26	34	43.33	56.67	1.06	0.25<P<0.50	1.30:1.00
November	38	58	39.58	60.42	6.67	0.005<P<0.01*	1.52:1.00
December	26	38	40.63	59.37	2.25	0.10<P<0.25	1.46:1.00
Total	335	467	41.77	58.23	21.73	<0.001*	1.39:1.00

*Significant at 5% level.

suggested that the diversity in the sex ratio may be due to the partial segregation of mature forms, either through habitat preference or because of school formation, then rendering one sex to be more easily caught than the other. During the peak spawning season females were more compared to males and such preponderence could be due to behavioural differences between the two sexes (Polonsky and Tormosova, 1969).

4.3.5. General Remarks:

Detailed studies on the reproductive biology of *D. albida* is not available; so there is no scope of comparison. However, pertinent literature on the reproductive biology of related species of the family Sciaenidae from Indian waters are available (Venkatasubba Rao, 1963; Rajan, 1964; Annegiri, 1967; Kutty, 1967; Appa Rao, 1967; Devadoss, 1969; Baragi and James, 1980). In *P. diacanthus* the breeding season extends from June to August along the Bombay coast (Venkatasubba Rao, 1963). Rajan (1964) reported that *P. coibor* breeds in the northern part of Chilka lake from May to August. The breeding season of *O. ruber* extends from July to October along the Bombay coasts (Appa Rao, 1967). *J. dussumieri* breeds twice, one in December to January and the other June to September in Bombay coast (Appa Rao, 1967). Annegiri (1967) observed that the breeding season of *O. argenteus* extends from October to January at Mangalore. Recently, Baragi and James (1980) reported that the spawning season of *J. osseus* extends throughout the year along the South Kanara coast. Gopinath (1942) observed that postlarval forms of *S. albida* along the Trivandrum coast from November to March.

The breeding biology of fishes of the family Gerridae of Pulicat and Chilka lakes have been investigated by Jhingran and Natarajan (1969), Prabhakara Rao (1970b) and Patnaik (1971). In Chilka lake, Jones and Sujansingani (1954) observed the male specimens of *G. setifer* in ripe condition with flowing milt and females with ovary almost in ripe condition but they were not able to say whether the species breeds in the lake or not. Jhingran and Natarajan (1969) observed the occurrence of males and females of *G. setifer* with oozing gonads in the southern sector of the Chilka lake. Prabhakara Rao (1970b) stated that *G. oyena* with oozing gonads were not encountered from Pulicat lake and so he presumed that the final stage of maturity of this species is attained only in the sea. Fishes with fully matured gonads were occurred throughout the year and hence he concluded that *G. oyena* breeds in the east coast of India in the year round. Patnaik (1971) noticed that *G. setifer* breeds in Chilka lake from May to September and unlike *G. oyena* the outwardly spawning migration of this species from Chilka lake is not been taking place. But in the present study also, specimens of G. filamentosus with oozing gonads were not encountered from the Vembanad lake and hence it may be inferred that the final stage of maturity is attained only in the sea. From November to January the fishes collected from the barmouth areas of the lake showed a higher degree of maturity than those specimens collected from adjacent areas and hence it can be presumed that the fully ripe fishes may undergo migrations to the nearby coastal areas for the purpose of spawning. A similar observation was also reported by Prabhakara Rao (1970b) in G. oyena of Pulicat lake.

The multiplicity of modes in the mature ovary of D. albida and G. filamentosus denotes its repeated spawning. The multiplicity of modes of the ovarian eggs in the frequency curves suggest three possibilities:

(1) that either the fish spawn more than once during a spawning period or the spawning season may be a prolonged one and the process of maturation may be continuous

(2) that the secondary mode represents the eggs which are to be carried over to the next spawning season

(3) that they comprise eggs which never ripen but will degenerate and be resorbed at the close of breeding season (Clark, 1934).

But in _D. albida_ and _G. filamentosus_ no maturing ova were present in ovaries between two successive spawning interval, hence the possibility of being carried over to the next season can be ruled out. Similarly the percentage of degenerating ova in spent fishes of _D. albida_ and _G. filamentosus_ are very low and so the possibility of complete degeneration or resorption of secondary and tertiary modes can also be ruled out. So the first possibility can be taken for granted as far as _D. albida_ and _G. filamentosus_ are concerned but this conclusion disagrees with Clark's (1934) statement that if several groups of maturing ova are present in an ovary, but only one batch of egg is spawned by each female in one breeding season, the number of eggs in maturing group is expected to maintain a constant ratio to the number of eggs in the mature group throughout the entire breeding season. Venkataramani (1979) stated that in _C. malabaricus_ and _A. kalla_, the minor mode which appeared in advanced maturity stages may get reabsorbed or may probably be extruded along with fully mature ova, as nourishing eggs.

On comparing the reproductive biology of _D. albida_ and _G. filamentosus_ in Vembanad lake, it is noticed that

G. *filamentosus* has a prolonged breeding period than D. *albida*. The spawning season of D. *albida* extending from May to December and that of G. *filamentosus* from August to April. The fishes with oozing gonads were not collected in any of the species and hence it may be presumed that in both species, the final stage of maturity is attained only after reaching the sea. But the related species of D. *albida* and G. *filamentosus* were reported to be breeding in Chilka lake (Jhingran and Natarajan, 1969; Patnaik, 1971). The seaward migration of lacustrine fishes for spawning purposes have been already reported (Jhingran, 1958; Thompson, 1966; Prabhakara Rao, 1970b; Kurup and Samuel, 1981f).

While reviewing the spawning habits of Indian teleosts, Qasim (1973) found that along the east coast of India, fishes spawn mostly in pre-monsoon months and along the west coast during the monsoon and post-monsoon periods. The present observation on the spawning period of D. *albida* and G. *filamentosus* from the south west coast of India are in full agreement with the above mentioned view eventhough the spawning period of G. *filamentosus* was found to be overlapping even in the pre-monsoon period.

Plate 58. Length-weight relationships of

D. albida (1,2 and 3)

and

[illegible]. filamentosus (4,5 and 6)

PLATE 58

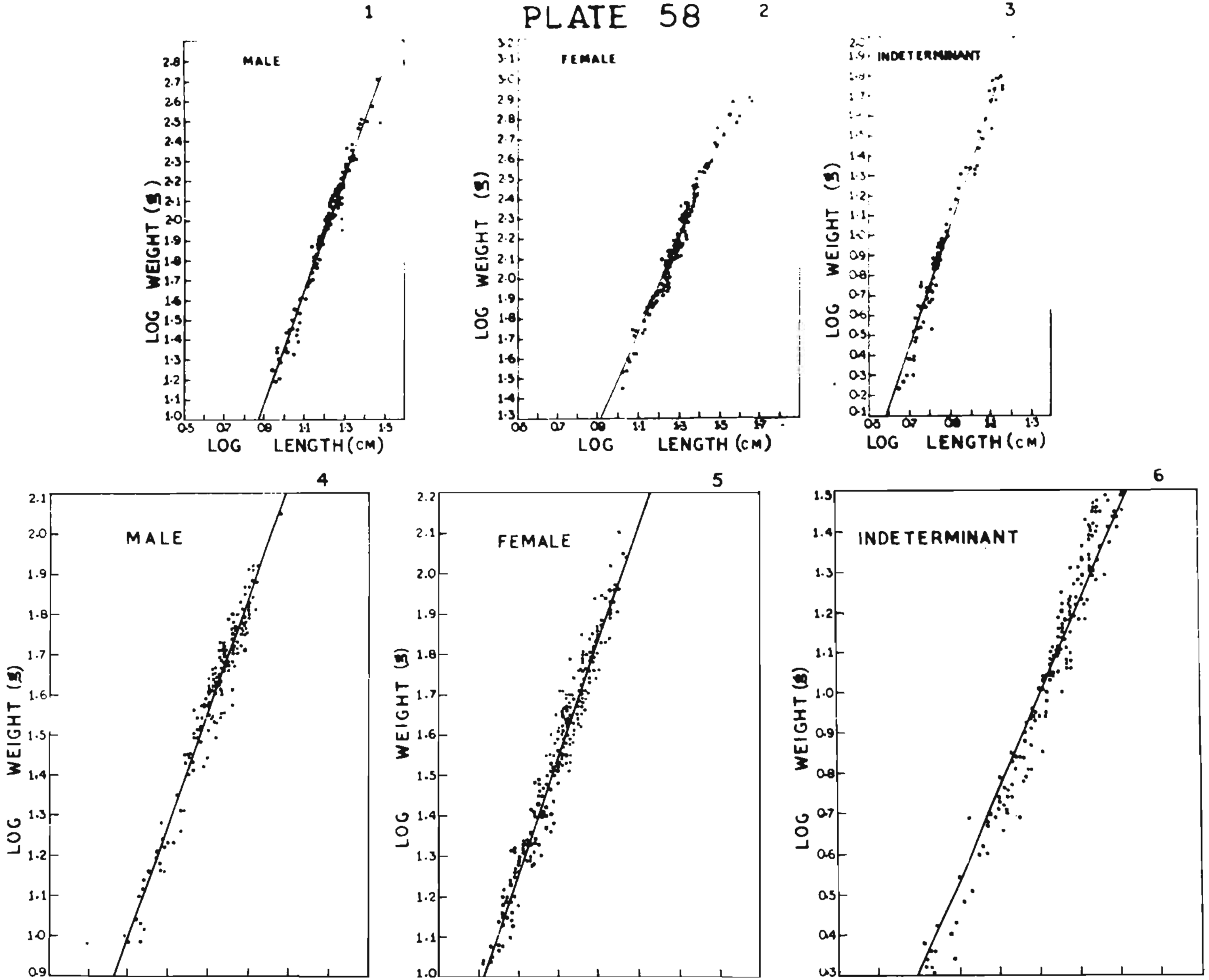

1
MALE
LOG WEIGHT (g)
LOG LENGTH (cm)
2
FEMALE
LOG WEIGHT (g)
LOG LENGTH (cm)
3
INDETERMINANT
LOG WEIGHT (g)
LOG LENGTH (cm)
4
MALE
LOG WEIGHT (g)
5
FEMALE
LOG WEIGHT (g)
6
INDETERMINANT
LOG WEIGHT (g)

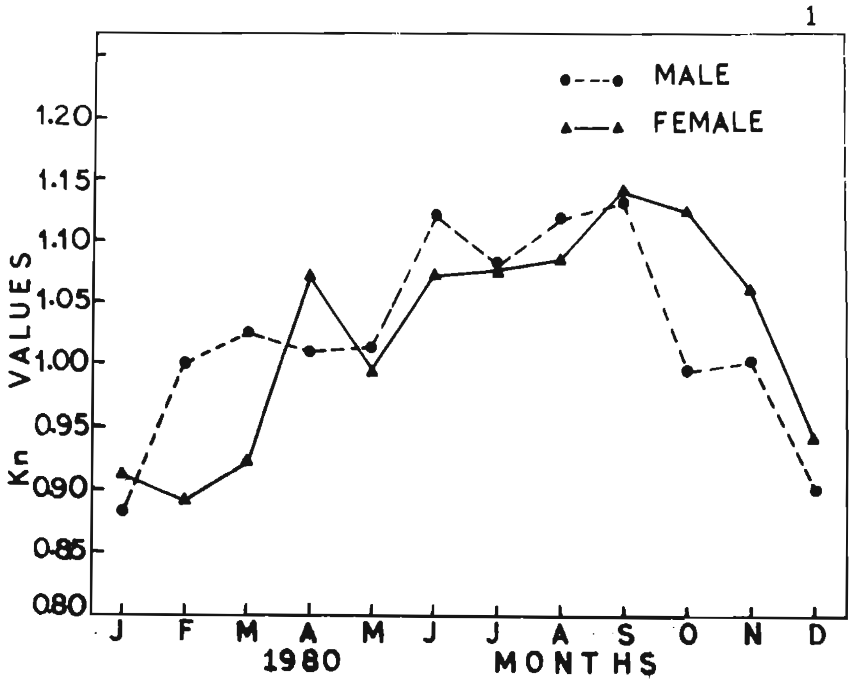
Plate 59. Relative condition factor (Kn) values of

1. *O. albida*

2. *[illegible]. filamentosus*

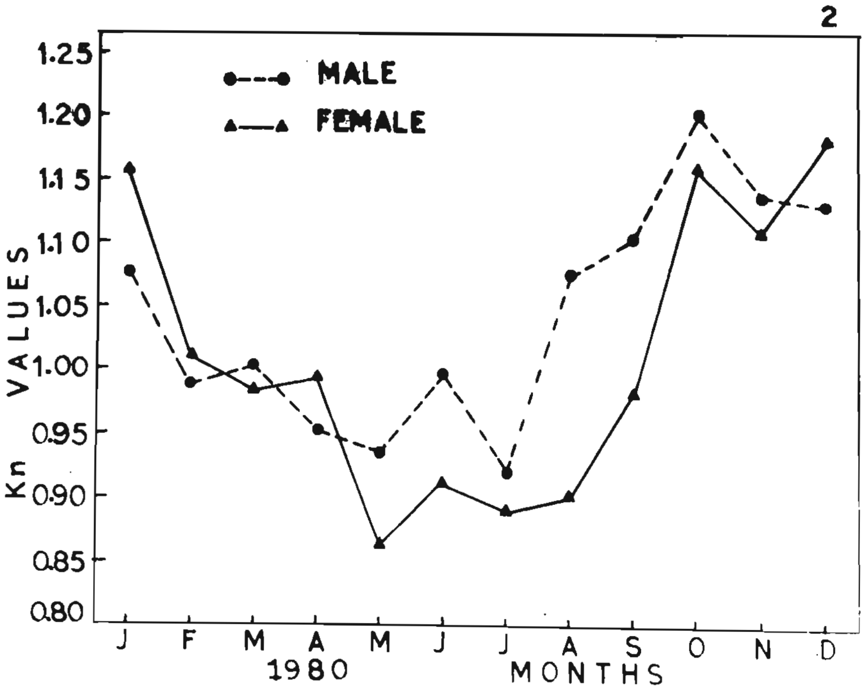
PLATE 59

1



MALE
FEMALE
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
Kn VALUES
J F M A M J J A S O N D
1980
MONTHS

2



MALE
FEMALE
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
Kn VALUES
J F M A M J J A S O N D
1980
MONTHS

Plate 60. The percentage frequency of ova diameter

1. *D. albida*

2. *[illegible]. filamentosus*

in various stages of maturity

PLATE 60

2

STAGE V

FREQUENCY

50
40
30
20
10

50
40
30
20
10

30
20
10

PERCENTAGE

30
20
10

90
80
70
60
50
40
30
20
10

1 2
MICROMETER DIVIS

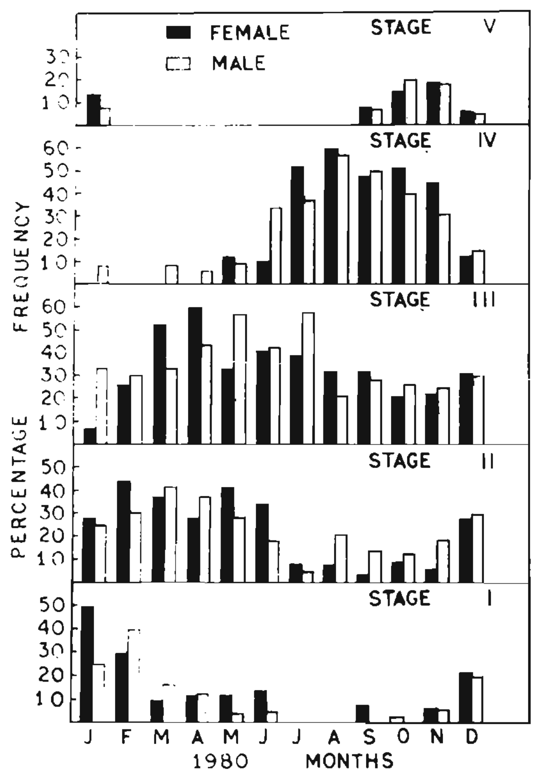
4 5 6 7 8 9 10
OMETER DIVISIONS

Plate 61. The monthly percentage occurrence of different stages of maturity of adult

1. *D. albida*
2. *D. filamentosus*

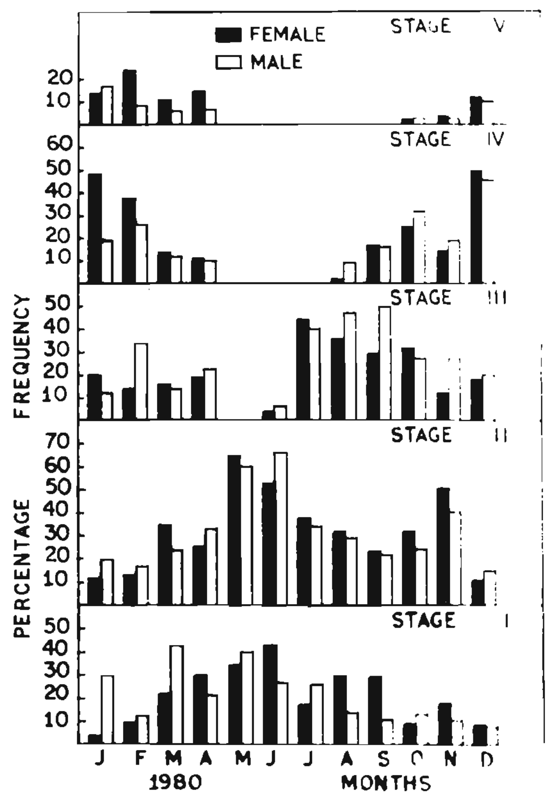
PLATE 61

1



FEMALE
MALE
STAGE V
STAGE IV
STAGE III
STAGE II
STAGE I
FREQUENCY PERCENTAGE
J F M A M J J A S O N D
1980 MONTHS

2



FEMALE
MALE
STAGE V
STAGE IV
STAGE III
STAGE II
STAGE I
FREQUENCY PERCENTAGE
J F M A M J J A S O N D
1980 MONTHS

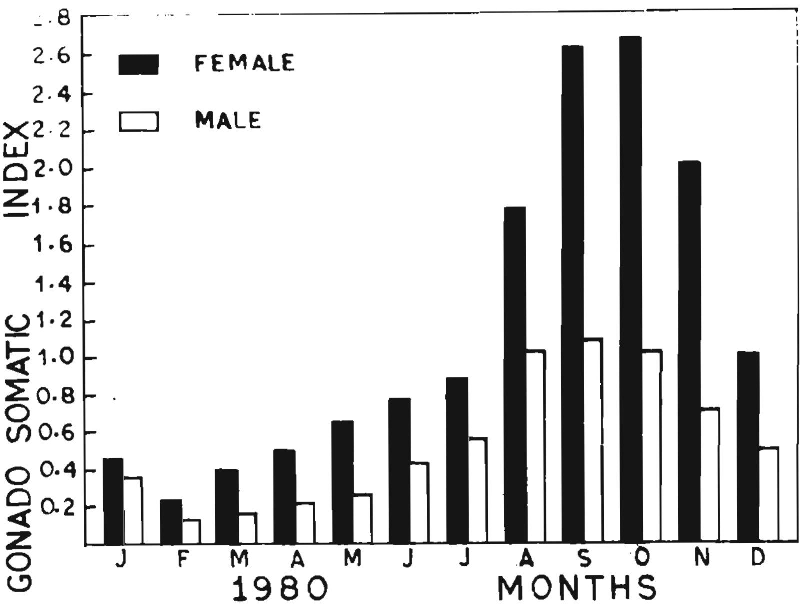
Plate 62. Gonado-somatic indices

1. *D. albida*

2. *G. filamentosus*

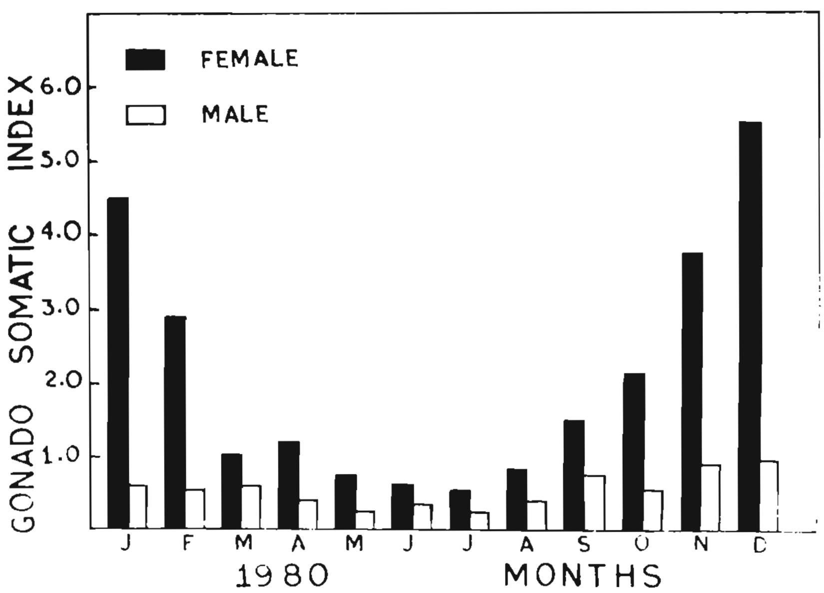
PLATE 62

1



FEMALE
MALE
GONADO SOMATIC INDEX
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
J F M A M J J A S O N D
1980 MONTHS

2



FEMALE
MALE
GONADO SOMATIC INDEX
6.0
5.0
4.0
3.0
2.0
1.0
J F M A M J J A S O N D
1980 MONTHS

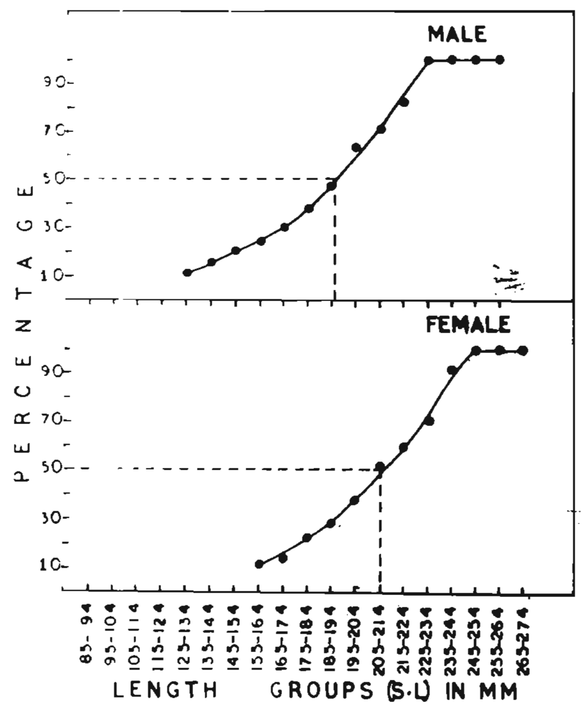
Plate 63.1. Size at first maturity in males of *D. albida*

2. Size at first maturity in females of *D. albida*

3. Size at first maturity in males of *D. filamentosus*

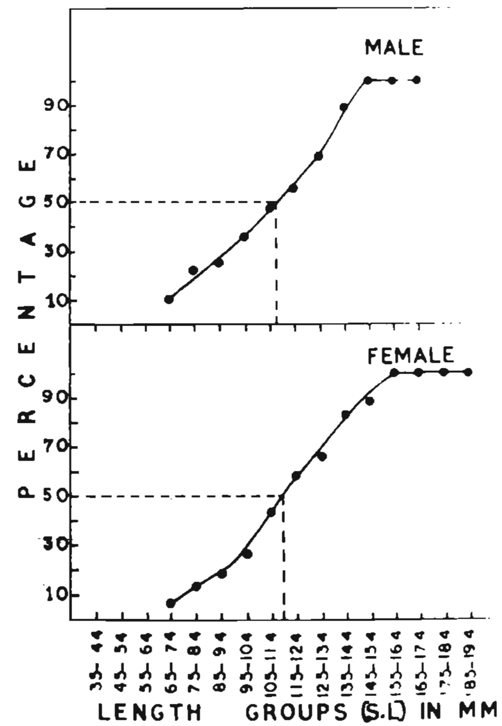
4. Size at first maturity in females of *D. filamentosus*

PLATE 63



1

2



3

4

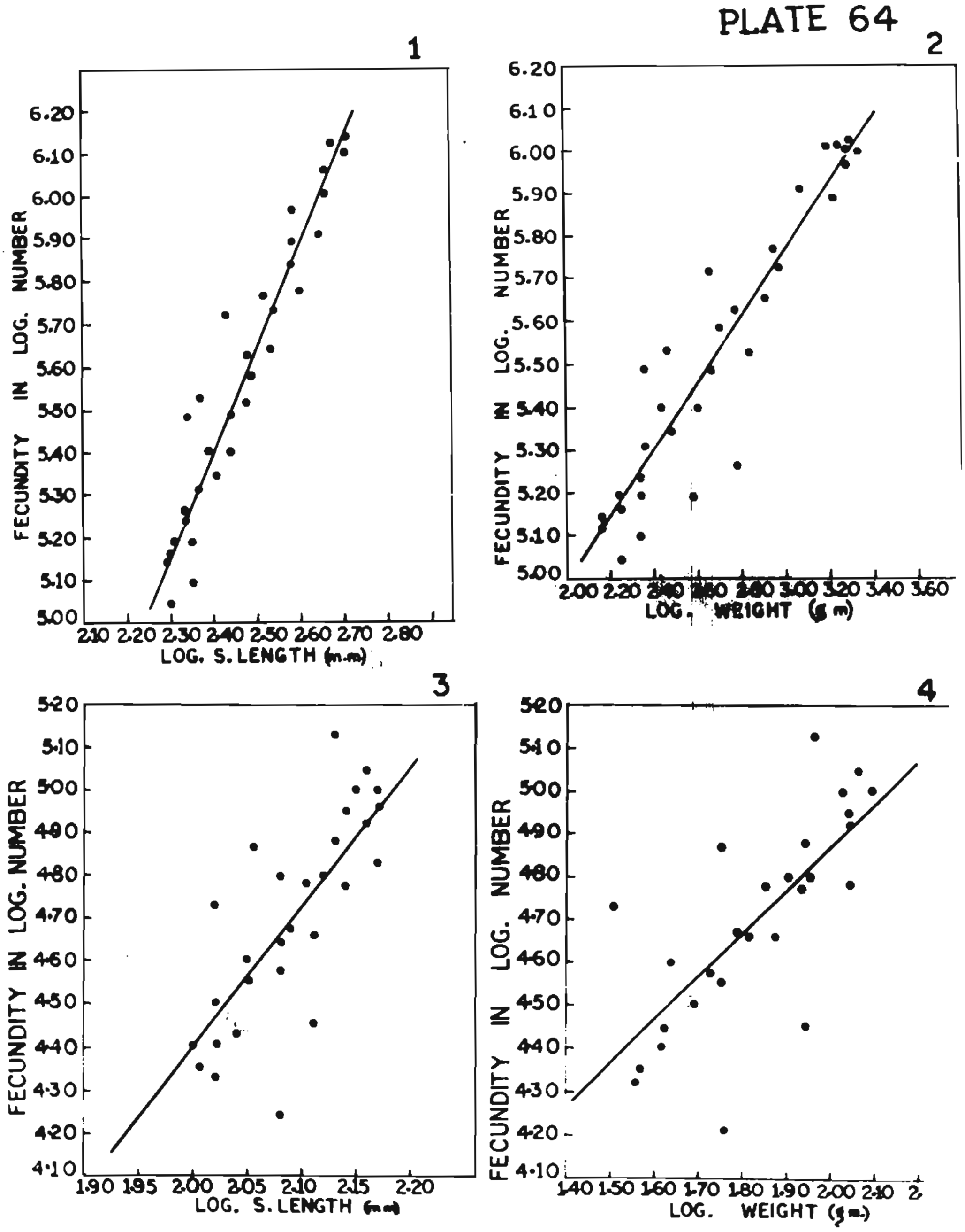
Plate 64.1. Fecundity - standard length relationship in *D. albida*

2. Fecundity - body weight relationship in *D. albida*

3. Fecundity - standard length relationship in *S. filamentosus*

4. Fecundity - body weight relationship in *S. filamentosus*

PLATE 64


1
FECUNDITY IN LOG. NUMBER
LOG. S. LENGTH (m.m)
2
FECUNDITY IN LOG. NUMBER
LOG. WEIGHT (g m)
3
FECUNDITY IN LOG. NUMBER
LOG. S. LENGTH (m.m)
4
FECUNDITY IN LOG. NUMBER
LOG. WEIGHT (g m.)

SUMMARY

SUMMARY

A detailed investigation on the Systematics, Distribution and Ecology of all fish species of the Vembanad lake was carried out during the period from October 1978 to September 1980 and biological studies were conducted on selected species of commercially important fishes of the lake during the period from January to December, 1980. Fish sampling surveys were conducted from all types of fishing methods and gears of the lake at monthly intervals during 1978-1980 and water samples for hydrographical observations were collected from 20 fixed stations in the lake to study the effect of physico-chemical factors on the distribution and abundance of fish species in the lake. Fish specimens for the biological study were sampled at fortnightly intervals from different stations of the lake.

150 species of fishes belonging to 100 genera and 56 families were identified from the Vembanad lake. The classification adopted in the present study is that of Compagno (1973) and Greenwood (1975). A taxonomic list of Vembanad lake fishes is given. The systematic descriptions, ecology, distribution and abundance in the lake of the fish species of the sub-family Pellonulinae

(Family: Clupeidae) and the family Leiognathidae of the Vembanad lake were published by the author and hence the above accounts of these fish species were not incorporated in this account. 139 species of fishes belonging to 95 genera under 55 families are fully described and illustrated. Identification keys are provided for all genera and species (except for monogeneric groups and monotypic species of the Indo-Pacific area).

Of the 150 species of fishes recorded from the lake during the present investigation, 108 species belonging to 66 genera are reported from Vembanad lake for the first time. Stolephorus waitei and Siganus lineatus are recorded for the first time in Indian waters. Gambusia affinis patruelis and Oxyurichthys nilsseni are new records from the west coast of India. 4 species viz. Dayella malabarica, Hyporhamphus (Hyporhamphus) xanthopterus, Ambassis dayi and Stenogobius malabaricus are re-discovered from Vembanad lake and it seems to be endemic species to this lake since there is no positive report of these fish species from other parts of India or world. The re-description of the following species are essentially needed since most of them are not described in recent times with adequate number of fresh specimens: Dayella malabarica, Ehirava fluviatilis, Ilisha sirishai, Stolephorus waitei, Amblypharyngodon mola, Mystus (Mystus) malabaricus, Mystus (Mystus) oculatus, Horabagrus brachysoma, Austrobatrachus dussumieri, Zenarchopterus dispar, Hyporhamphus (Hyporhamphus) xanthopterus, H. (H.) limbatus, Gambusia affinis patruelis, Ambassis dayi, A. thomassi, Nandus marmoratus, Stenogobius malabaricus, Oxyurichthys nijsseni, Gobiopsis macrostomus, Taenioides buchanani, Siganus lineatus, Mastacembelus guentheri and Tetraodon leopardus. Sexually dimorphic forms of Oxyurichthys nijsseni are described for the first time from the present collections.

Among the physico-chemical parameters studied, the pattern of the variation of temperature was bimodal. A steady and steep increase in the temperature was noticed from February to April, the maximum temperature during 1978-1979 was recorded in March (33.6°C) and in April (33.4°C) during 1979-'80. From June onwards, the temperature began to decrease due to the onset of southwest monsoon, the lowest temperature (25.8°C) was recorded in August in both the years. Salinity has shown to be the most fluctuating parameter in the lake. The highest salinity values (33.68 and 33.02‰) were recorded from station No.2 in April in 1978-1979 and 1979-1980 respectively. The pre-monsoon season is dry and invariably high salinity values were recorded from most of the stations.

With the onset of the southwest monsoon, the salinity values were steeply declining and during the peak monsoon months, the lake became completely filled with fresh water. The salinity values of the northern sector were relatively higher than those of other sectors. The salinity values did not reach even 5.0‰ in the area south east of Thannirmukkom due to the closure of the Thannirmukkom bund during the pre-monsoon season. The highest dissolved oxygen value (5.73 ml/l) was recorded from station No. 19 in June during 1978-1979 and in August (5.80 ml/l) from Station No. 20. during 1979-1980. The lowest dissolved oxygen values (1.88 and 1.91 ml/l) were recorded from station No.5 in the month of April in both the years.

The fishing methods of Vembanad lake were classified under 3 major categories - viz. gear fishing, line fishing and miscellaneous methods. 5 major categories of gears were observed from the lake viz. gill nets, cast nets, drag nets, bag nets and fixed nets. The different types of fishing gears under each major head are described. Details regarding the catch composition of all gears and fishing methods, their sector-wise distribution and the season of their operation etc. are incorporated.

The occurrence, season and frequency of the 139 species of fishes recorded from the lake are presented.

Of the 139 species, 45 (32.37%) can be considered as residents, 68 (48.94%) are marine migrants, 9 (6.47%) are migrants from the adjoining rivers and 17 (12.23%) species accidentally enter the lake either from the adjoining sea or from the river. 42 species of fishes of the lake are found to be commercially important.

Based on the salinity characteristics, tidal regimes and nature of fish fauna, the entire lake system has been divided into three sectors viz. Northern sector (stations 1-12), Central sector (stations 13-17) and Southern sector (stations 18-20). The fish species which inhabit the different sectors of the lake are classified according to the scheme of McLusky (1974) as follows:

i) 22 species can be characterized as oligohaline fish species which inhabit the fresh water zone and are capable of tolerating salinity upto 5‰ .

ii) 35 species are true estuarine fishes of which 10 species inhabit all the zones of the lake irrespective of the salinity distribution. 14 species are found to occupy high saline areas of the lake and 11 species were found to be strictly confined to the gradient zone and they are true brackish water species.

iii) 82 species of fishes are of marine origin, of which 39 species are euryhaline and 43 species are stenohaline.

The euryhaline fishes found to be dominating the catches from the northern and central sectors of the lake during pre-monsoon and the post-monsoon seasons and their occurrence are noticed from all the stations except those in the fresh water zone. The frequency of occurrence of stenohaline fishes in the lake are very sporadic and irregular and is rather confined to the mouth and adjacent areas of the lake.

An attempt was made to correlate the distribution and abundance of fishes with the fluctuating physico-chemical parameters of the lake. The result shows that salinity is the most significant controlling factor on the type of fish fauna of the lake and their distribution and abundance, both seasonally and geographically. Temperature has some bearing on the distribution of some of the species of fishes whereas the dissolved oxygen content does not limit fish distribution in the Vembanad lake.

Mass mortality of fishes were frequently observed from Eloor-Varapuzha regions of the lake during February to May. This part of the lake is found to be virtually a barren contaminated zone where very few fish species were observed. The species which are undergoing mass mortality are the following: Stolephorus commersonii, Tachysurus maculatus, Mystus (M.) gulio, Etroplus suratensi

Ambassis gymnocephalus, Puntius filamentosus, Gerres filamentosus, Ehirava fluviatilis and Hyphorhamphus (H.) limbatus. The reason for the mass mortalities of fishes during the pre-monsoon season may be the reduction in the water discharge from the adjoining rivers with the result that the effluents dumped from the factories may not get diluted and washed away as in the monsoon season.

A general appraisal on the detrimental factors which are affecting the fisheries resources of the lake is presented. The impact due to (1) various kinds of pollution (2) Thannirmukkom bund (3) periodic dredging of the Cochin navigation channel (4) prolific spreading of Salvinia auriculata and other macrovegetations and (5) stake net fishing on the fisheries resources of the lake are discussed. Some measures of conservation are also suggested.

The biology of the two commercially important fish species of Vembanad lake viz. Daysciaena albida (Cuvier) and Gerres filamentosus Cuvier are investigated.

The analyses of the food and feeding habits of D. albida of the lake reveal that prawns, teleosts, juvenile crabs, amphipods and isopods formed the major part of the diet. The juveniles have a preference for planktonic forms like post larvae of prawns, crab larvae, amphipods, isopods and nereid polychaetes. Prawns of the genera Metapenaeus,

Penaeus and *Acetes* are represented in the gut contents. Four species of teleosts are identified from the food items viz. *Stolephorus* spp., *Thryssa* spp., *Trypauchen* spp. and *Cynoglossus* spp. Other items of food identified were cumaceans, mysids bivalve molluscs, *Squilla* spp., stomatopod larvae, higher aquatic plants, diatoms and *Lucifer* spp. No difference in the food of males and females could be seen. Seasonal variation in the food of juveniles and adults are given. To sum up, *D. albida* can be characterized as a macrophagous carnivore and it feeds on both subsurface and bottom dwelling organisms. The feeding intensity calculated for the year 1980 showed that the percentages of gorged, full and 3/4 full stomachs were less in most of the months when compared to 1/2 full, 1/4 full, traces and empty. The occurrence of empty stomachs were encountered in most of the months except in March and the percentage of empty stomachs were comparatively high from July to November, which is the peak spawning period of *D. albida* in Vembanad lake.

The food of *J. filamentosus* was represented mainly by amphipods, isopods, polychaetes, juvenile crabs, filamentous algae and diatoms. Juvenile fishes have a liking towards small planktonic forms. The percentage occurrence of diatoms, ostracods, mysids, copepods and decapod larvae were found to be higher in juvenile fishes than adults. Amphipods, isopods, polychaetes, juvenile crabs, bivalve molluscs and detritus matters were found to be consumed much by adults. Other food items which were identified from the gut contents of _G. filamentosus_ in traces were hirudinea, mysids, gastropods and cirripeds. No differences could be seen between males and females in their food. Seasonal variation in the food of juveniles and adults are given. The mouth of _G. filamentosus_ is highly protrusible and is adapted for browsing on epiphytic animals and plants of the environment. It also has the power of picking up other benthic animals like polychaetes, bivalve molluscs and gastropods. To sum up, _G. filamentosus_ can be characterized as a microphagous omnivore and it feeds on demersal organisms. The feeding intensity calculated for the year 1980 showed that the percentage of gorged, full and 3/4 full stomachs are less when compared to other categories. Fishes with empty stomachs were encountered in almost all months except in June and July. During the peak spawning season (October to February) the percentage of empty stomachs were very high. The stomachs of the fully mature female specimens of _D. albida_ and _G. filamentosus_ may get pressed by the dialated ripe ovaries and it may be the reason why the fully mature female specimens always had empty stomachs.

The length-weight relationship of *D. albida* and *G. filamentosus* were worked out.

The logarithmic regression equations obtained for the above two species are as follows:

D. albida (based on 162 males, 167 females and 97 indeterminants)

For Males: Log w = -1.5055+2.8618 Log l

For Females: Log w = -0.9260+2.4089 Log l

For indeterminants: Log w = -1.7188+3.0616 Log l.

G. filamentosus (based on 164 males, 287 females and 164 indeterminants)

For Males: Log w = -1.3244+2.8740 Log l

For Females: Log w = -1.2874+2.8381 Log l

For indeterminants: Log w = -0.8167+2.2558 Log l.

The regression equations of males, females and indeterminants of *D. albida* and *G. filamentosus* were subjected to students 't' test for comparison of their regression coefficients.

In *D. albida*, the regression coefficients between males and females, males and indeterminants and females and indeterminants showed significant differences.

In *G. filamentosus*, the regression coefficients between males and females are insignificant at 5% level. Significant differences were observed between males and indeterminants and females and indeterminants.

The relative condition factor (kn) was calculated for *D. albida* and *G. filamentosus* for the year 1980. In females of *D. albida*, high 'kn' values were noticed in April and from August to November. In males, high 'kn' values were observed in June, August and September. In *G. filamentosus*, the 'Kn' values of both females and males followed a similar trend with rise in 'Kn' value from August to January, highest value in females was recorded in December and males in October. In *D. albida* and *G. filamentosus*, high 'Kn' values were recorded during the spawning season and so it can be presumed that the sexual cycle can definitely influence the 'Kn' values to a perceptible degree. But in some non-spawning months also high 'Kn' values were observed in *D. albida* and hence it may be inferred that the 'Kn' values were not only influenced by the sexual cycle but also by feeding intensity or by some other unknown factors.

The breeding biology of *D. albida* and *G. filamentosus* of Vembanad lake was studied. A 5-stage maturity scale was employed for classifying the maturity stages in both the species.

The ova-diameter frequencies of fully ripe ovary of D. albida shows that there are two batches of mature eggs (9 micro. div. and 7 micro. div.) which are sharply differentiated from the general stock of immature ova and it is the indication of two successive spawning. The interval between two spawning is short due to the fact that these groups of mature ova are not sharply differentiated. The occurrence of fully spent fishes also confirm the above inference. The spawning season of D. albida was found to be during the months from July to November. This is confirmed by the percentage occurrence of fully mature specimens and high GSI values.

The ova diameter frequencies of the fully ripe ovaries of G. filamentosus showed three batches of mature ova (9 micro. div., 8 micro. div. and 7 micro. div.), which are not sharply differentiated among themselves and so it can be inferred that they may spawn completely in the same spawning season. But the processes of maturation is a continuous one and spawning may take place within a prolonged period. The peak spawning season of G. filamentosus is from October to February. This is confirmed by the percentage occurrence of fully ripe specimens and GSI values.

Individuals of D. albida and G. filamentosus spawn only once within a definite spawning period. Specimens with oozing gonads were not encountered from the lake, hence it may be presumed that the final stage of maturity of D. albida and G. filamentosus are attained only after reaching the sea.

The size at first maturity in D. albida at 50% level was found to be 195.0 mm SL in males and 215.0 mm SL in females.

The size at maturity in G. filamentosus at 50% level was found to be 117.0 mm SL in males and 118.0 mm SL in females.

The fecundity of D. albida was studied from 31 ovaries from the fishes ranging in size 198.0–520.0 mm SL. The number of ova were found to be varying from 1,08,864 to 13,87,940. The number of ova increased with an increase in standard length and body weight of the fish. A straight line relationship could be noticed between fecundity and standard length/weight of the fish. The resultant equation for the relationship between standard length and fecundity i

$$\log F = -0.2979 + 2.3751 \log l$$

and between body weight and fecundity is

$$\log F = 3.3419 + 0.8220 \log w.$$

The 'r' values were 0.9419 for standard length and 0.9602 for body weight.

The fecundity of *G. filamentosus* has been studied in 27 specimens ranging in size 100.0-148.0 mm SL. The number of ova were found to be ranging from 54,720 to 61,376. The number of ova were found to be increasing with an increase in standard length and body weight. A straight line relationship could be noticed between fecundity and standard length/body weight. The resultant equation for the relationship between standard length and fecundity is

$$\log F = -2.110 + 3.2563 \log l$$

and between body weight of fish and fecundity is

$$\log F = 2.8917 + 0.9896 \log w.$$

The 'r' values were 0.7178 for standard length and 0.6906 for body weight.

In *D. albida*, the sex ratio does not skew much in all the months of the year 1980 and the sex ratio nearly conformed with the expected 1:1 ratio (Based on chi-square values). In *G. filamentosus*, the expected 1:1 ratio was recorded only during 8 months of the year (based an chi-square values). The sex ratio was significantly different in January, March, June and November. The skewed sex ratio was due to the ponderance of females over males.

REFERENCES

REFERENCES

(*not referred to in original)

Allen, K.R. 1938. Some observations on the biology of the trout (Salmo trutta) in Windermere. J. Anim. Ecol., 7: 333-349.

Al-Nasiri, K. Sufian and S.M. Shamsul Hoda. 1975. Some notes on the larvae and juveniles of halfbeak, Hemirhamphus xanthopterus (Val.) in Iraqi waters. Bull. Basrah Nat. Hist. Mus., 2: 3-12.

Annandale, N. 1908. A new sting ray of the genus Trygon from Bay of Bengal. Rec. Indian Mus., 2: 393-394.

Annegiri, G.G. 1967. Maturation of the intraovarian eggs and the spawning periodicities in few fishes of Mangalore area based on ova-diameter measurements. Indian J. Fish., 10(1): 23-32.

Antony Raja, B.T. 1971. Fecundity fluctuations in the oil-sardine, Sardinella longiceps Val. Indian J. Fish., 18(1 - 2): 84-98.

Appa Rao, T. 1967. Maturity and spawning habits of some sciaenids in offshore waters at Visakhapatnam. Indian J. Fish., 11(1)A: 121-126.

Aziz, P.K. Abdul and N.B. Nair, 1978. The nature of pollution in the retting zones of the backwaters of Kerala. Aqua. Biol., 3: 41-62.

Babu Rao, M. 1966. A new species of Stolephorus Lacepede from the east coast of India (Pisces: Engraulidae). Ann. Mag. nat. Hist., (13) 9: 101-110.

Babu Rao, M. 1971. A new anchovy, *Thryssa gutamiensis* n. sp. (Pisces: Engraulidae), from the Godavari river, India. *Copeia*, No.3: 479-483.

Babu Rao, M. 1973. Clupeoid fishes of Godavari estuary, with some ecological observations. *J. Inland Fish. Soc. India*, 5: 1-8.

Babu Rao, M. 1976. Clupeoid fishes of Godavari estuary. A systematic account. *Matsya*, 2: 32-37.

Babu Rao, M. and K.N. Sinha. 1966. A new record of *Johnius novae hollandiae* (Steindachner) (Pisces: Sciaenidae) from India. *J. mar. biol. Ass. India*, 8(2): 370-372.

Babu, N. and N.B. Nair. 1978. On a new species of *Amblypharyngodon* (Cyprininae - Cyprinidae) from Trivandrum (Kerala-India). *Aqua. Biol.*, 3: 121-127.

Bagenal, T.B. 1978. Fecundity. pp. 166-178. In: T.B. Bagenal (ed.). *Methods for Assessment of Fish Production in Fresh waters*, IBP Handbook No.3. Blackwell, Oxford.

Bal, D.V. and S.V. Bapat. 1949. The food habits of some young sciaenids. *Proc. Indian Acad. Sci.*, 36: 3-17.

Balakrishnan, A. 1957. Variation of salinity and temperature in Ernakulam channel. *Bull. cent. Res. Univ. Kerala*, 5: 7-9.

Balakrishnan, K.P. and C.S. Shynamma. 1976. Diel variations in hydrographic conditions during different seasons in the Cochin harbour (Cochin backwater). *Indian J. Mar. Sci.*, 5: 190-195.

Baragi M. Vijayakumar and P.S.B.R. James. 1980. Reproductive biology of Sciaenid Fish, *Johnieops osseus* (Day), from the South Kanara Coast. *Indian J. Mar. Sci.*, 9(1): 19-24.

Barnes, H. 1959. *Apparatus and Methods of Oceanography*. Part-1. George Allen and Unwin, London.

Barnes, R.S.K. 1976. *Estuarine Biology*. Edward Arnold Limited, London. 73 pp.

Basheeruddin, S. and K. Nagappan Nayar. 1961. A preliminary study of the juvenile fishes of the coastal waters off the Madras city. *Indian J. Fish.*, 8(1): 169-188.

Beaufort, L.F. de and L.M. Chapman. 1951. *The fishes of the Indo-Australian Archipelago* Vol. 9, Leiden. E.J. Brill. 484 pp.

Beaufort, L.F. de and John C. Briggs. 1962. *The fishes of the Indo-Australian Archipelago*. Vol. 11, Leiden. E.J. Brill. 481 pp.

Ben-Yami, M. and T. Glaser. 1974. The invasion of *Saurida undosquamis*, (Richardson) in the Levant Basin. An example of biological effect on inter-oceanic canals. *Fish. Bull.*, 72(2): 359-373.

Beverton, R.J.H. and S.J. Holt. 1957. On the dynamics of exploited fish populations. *Fish Invest. Lond.*, *Ser.*2, 19: 533 pp.

Brody, S. 1945. *Bioenergetics and growth*. Reinhold Publishing Corporation, New York, 1023 pp.

Brown, M.E. 1957. Experimental studies on growth. In: *Physiology of fishes*, pp. 361–400. M.E. Brown (Ed.), Academic Press, New York.

*Carr, A.M. 1907. Report of the Northumberland sea fish communication for 1907. pp. 68–71.

Chacko, P.I. 1949. Food and feeding habits of fishes of the Gulf of Mannar. *Proc. Indian Acad. Sci.*, 29B: 83–97.

Chacko, P.I., I.G. Abraham and R. Andal. 1953. Report on a survey of flora, fauna and fisheries of Pulicat lake, Madras State, India (1951–1952). *Contr. Fish. biol. Stn. Madras*, (8): 20 pp.

Chan, W.L. 1965. A systematic revision of the Indo-Pacific clupeoid fishes of the *Sardinella* (Family: Clupeidae). *Jap. J. Ichthyol.*, 12(3–6): 104–118.

Chandra, Ravish. 1966. On the occurrence of *Anchoviella baganensis* Hardenberg in the Hooghly Matlah estuarine system. *Sci. Cult.*, 32(5): 270–271.

Chandy, M. 1953. A key for the identification of the Cat fishes of the genus *Tachysurus* Lacepede with a catalogue of the specimens in the collection of the Indian Museum (Zool. Surv.): *Rec. Indian Mus.*, 51(1): 1–18.

Chatterjee, T.K. 1978. Systematic study of Gobiid fishes of India with special reference to those of Gangetic delta. Ph.D. Thesis, Calcutta University. 335 pp.

Chatterjee, T.K. and S.Z. Siddiqi. 1976. *Periophthalmus weberi* Eggert (Pisces: Gobiidae) a rare gobioid from Indian waters. *Matsya*, 1: 82.

Chaudhuri, B.L. 1912. Description of some new species of freshwater fishes from North India. Rec. Indian Mus., 7: 437.

Chaudhuri, B.L. 1916a. Fauna of Chilka lake. Fish, part I. Mem. Indian Mus., 5(4): 403-439.

Chaudhuri, B.L. 1916b. Fauna of Chilka lake. Fish, Part II. Mem. Indian Mus., 5(5): 441-459.

Chaudhuri, B.L. 1917. Fauna of Chilka lake. Fish, Part III. Mem. Indian Mus., 5(6): 491-508.

Chaudhuri, B.L. 1923. Fauna of Chilka lake. Fish, Part IV. Mem. Indian Mus., 5(11): 711-736.

Cheriyan, P.V. 1967. Hydrological studies on and around the Cochin harbour. Bull. Dept. Mar. biol. Oceanogr. Univ. Kerala, 3: 9-17.

Chu, Y.T. and W.L. Cheng. 1958. Descriptions of two new species of carangoid fishes from the South sea of China. Acta Zoologica Sinica, 10(3): 316-321.

Chu, Y.T., Y.L. Lo and H.L. Wu. 1963. A study on the classification of the sciaenoid fishes of China with description of new genera and species. Monogr. Fish. China, Shanghai Fisheries Institute, Shanghai, 1-100.

Clark, F.N. 1934. Maturity of California sardine (Sardina caerulea) determined by ova diameter measurements. Fish Bull. Sacramento, 42: 1-49.

Collette, Bruce B. 1962. Hemiramphus bermudensis, a new halfbeak from Bermuda, with a survey of endemism in Bermudian shore fishes. Bull. Mar. Sci. Gulf Carib., 12(3): 432-449.

Collette, Bruce B. 1965. Hemiramphidae (Pisces: Synentognathi) from tropical West Africa. Atlantide Rep., No.8: 217-235.

Collette, Bruce B. 1973. *Hyporhamphus australis* x *Hy. melanochir*, a hybrid halfbeak (Hemiramphidae) from Australia. U.S. Dept. Comm. Fish. Bull., 71(1): 318-321.

Collette, Bruce B. 1974. The garfishes (Hemiramphidae) of Australia and New Zealand. Rec. Australian Mus., 29(2): 11-105.

Collette, Bruce B. 1976. Indo-West Pacific halfbeaks (Hemiramphidae) of the genus *Rhynchorhamphus* with descriptions of two new species. Bull. Mar. Sci., 26(1): 72-98.

Collette, Bruce B. and F.H. Berry. 1965. Recent studies on the needlefishes (Belonidae): An evaluation, Copeia, No.3: 386-392.

Collette, Bruce B. and F.H. Berry. 1966. Proposed supression of three *nomina oblita* in the family Belonidae (Pisces). Z.N.(S) 1723. Bull. Zool. Nomencl., 22(5/6): 325-329.

Collette, Bruce B. and N.V. Parin. 1970. Needlefishes (Belonidae) of the Eastern Atlantic Ocean. Atlantide Rep. No. 11: 7-60.

Collette, Bruce B. and L.N. Chao. 1975. Systematics and morphology of the Bonitos (*Sarda*) and their relatives (Scombridae: Sardini). Fish. Bull., 73(3): 516-625.

Collette, Bruce B. and N.V. Parin. 1978. Five new species of halfbeaks (Hemiramphidae) from the Indo-West Pacific. Proc. Biol. Soc. Wash., 91(3): 731-747.

Compagno, L.J.V. 1973. Interrelationships of living elasmobranchs. In: _Interrelationships of fishes_ (Greenwood, P.H., R.S. Miles and C. Patterson, Eds.). Academic Press, London and New York.

*Cuvier, G. 1829. '_Regne Animal_' 2nd Ed., 406 pp. Paris.

*Cuvier, G. and A. Valenciennes. 1844. _Hist. Nat. Poiss._, Paris, 17: 497 pp.

David, A. 1954. A preliminary survey of the fish and fisheries of a five-mile stretch of the Hooghly river near Barrackpore. _Indian J. Fish._, 1(1 and 2): 231-255.

*Davison, R.C., W.P. Breese, C.E. Warren and P. Doudoroff. 1959. Experiments on the dissolved oxygen requirements of cold-water fishes. _Sewage Ind. Wastes_, August: 950-966.

Day, F. 1865. _The fishes of Malabar_. William Dawson and Sons, London. 293 pp.

Day, F. 1878. _The fishes of India; being a natural history of the fishes known to inhabit the seas and fresh waters of India, Burma and Ceylon_. Reproduced in 1958. William Dawson and Sons, London. 1: 778 pp. 2: 195 pls.

Day, F. 1889. _The fauna of British India, including Ceylon and Burma_. Fishes, London. Vol.I and II. 548 and 509 pp.

De Jong, J.K. 1939. A preliminary investigations of the spawning habits of some fishes of Java Sea. _Treubia_, 17: 307-327.

Desai, B.N. and M. Krishnan Kutty. 1967. Studies on the benthic fauna of Cochin backwaters. Proc. Indian Acad. Sci., 66: 123-142.

Devadoss, P. 1969. Maturity and spawning in Otolithus ruber (Schn.) and Johnius dussumieri (C.and V.). Indian J. Fish., 16 (1 and 2): 117-128.

Devanesan, D.W. 1943. A brief investigation into the causes of fluctuation of the annual fishery of the oil sardine of Malabar, Sardinella longiceps Cuv. and Val., determination of its age and an account of the discovery of its eggs and spawning grounds. Madras Fish. Bull. 28: 1.

Devanesan, D.W. and K. Chidambaram. 1943. On the alleged existence of races in population of oil sardine Sardinella longiceps in the Arabian Sea. Proc. 30th Indian Sci. Congr., Pt. III, 60.

Devasundaram, M.P. 1951. Systematics of Chilka mullets with a key for their identification. J. Zool. Soc. India, 3: 9-29.

Devasundaram, M.P. 1954. A report on the fisheries of the Chilka lake from 1948 to 1952. Government Press, Cuttack.

Dhanze, J.R. and K.C. Jayaram. 1979. The family of catfishes of the genus 'Arius' (Siluriformes). Curr. Sci., 48 (22): 1008.

Dutt, S. 1961. A new record of the anchovy Thrissocles vitirostris Gilchrist and Thompson from Indian waters. Curr. Sci., 30: 104.

Dutt, S. 1967. Fishes of the genus Ilisha Richardson, 1846 from Visakhapatnam. Proc. Indian Acad. Sci., 66(5): 206-213.

Dutt, S. 1971. On *Kowala thoracata* Cuvier and Valenciennes of Cantor. *J. mar. biol. Ass. India*, 13(1): 146-147.

Dutt, S. 1973. Synodidae: correct name for Lizard fish family. *J. mar. biol. Ass. India*, 15(1): 450-451.

Dutt, S. 1975. The true identity of the White Sardine '*Kowala coval* Cuvier, 1829'. In: *Estuarine Biology*. pp. 231-236. Hindustan Publishing Corporation, Delhi.

Dutt, S. and M. Babu Rao. 1959. Occurrence of *Anchoviella baganensis* Hardenberg off east coast of India. *Curr. Sci.*, 28: 160-161.

Dutt, S. and V. Thankam. 1968. The Sciaenidae of the coastal waters of Visakhapatnam. *J. Bombay nat. Hist. Soc.*, 65(2): 335-348.

Dutt, S. and A. Shameem. 1976. A new record of *Caranx williamsi* Smith. *Matsya*, 2: 63-65.

Dutt, S. and K. Sujatha. 1980. On the seven species of fishes of the family Sillaginidae from Indian waters. *Mahasagar - Bull. Nat. Inst. Oceano.*, 13(4): 371-375.

Fischer, W. and P.J.P. Whitehead (Eds.).1974. *FAO species identification sheets for fishery purposes*. Eastern Indian Ocean - Fishing Area 57 and Western Central Pacific Fishing Area 71. Rome: FAO Vols. 1-4.

*Forel, F.A. 1892. *Le Leman*. Monographic limnologique Lausanne.

Fowler, H.W. 1928. The fishes of Oceania. *Mem. Bernice P. Bishop Mus.*, 10: 540 p.

Fowler, H.W. 1941. Contributions to the biology of the Philippine Archipelago and adjacent regions. *Bull. U.S. Nat. Mus.* 100(13): 650-663.

Fowler, H.W. and H. Steinitz. 1956. Fishes from Cyprus, Iran, Iraq, Israel and Oman. Bull. Res. Counc. Israel., Sect. 5B (3-4): 260-292.

Frey, Hans. 1961. Illustrated dictionary of tropical fishes. TFH Publications, U.S.A. pp. 351-353.

Gawel, M. and D.J. Woodland. 1974. Siganus (Lo) uspi, a new species from Fiji, and a comparison with the nominal species, S. vulpina and S. unimaculatus. Copeia, (4): 855-861.

George, K.C. 1958. On the occurrence of Anchoviella baganensis (Hardenberg) and A. bataviensis (Hardenberg) along the South-east and South-West Coasts of India. Indian J. Fish., 5(2): 348-356.

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

George, K.C. 1968. Notes on two species of flatheads (Platycephalidae: Pisces) from the trawl grounds of the south-west coast of India. J. mar. biol. Ass. India, 10(2): 354-356.

George, M.J. 1958. Observations on the plankton of the Cochin Backwater. Indian J. Fish., 5: 374-401.

George, M.J. 1962. Observations on the size groups of Penaeus indicus (M. Edw.) in the commercial catches of different nets from the backwater of Cochin. Indian J. Fish., 9(2): 468-475.

George, M.J. and K.N. Kartha. 1963. Surface salinity of the Cochin backwaters with reference to tide. J. mar. biol. Ass. India, 5(2): 178-184.

Gopalakrishnan, V. 1971. The biology of the Hooghly - Matlah estuarine system (West Bengal, India) with special reference to its fisheries. J. mar. biol. Ass. India, 13(2): 182-194.

Gopalakrishnan, V. 1973. Fishery resources of the Hooghly - Matlah estuarine system and its relation to fisheries of Bay of Bengal. Proc. Symp. Living Resources of the Seas around India, Spl. Publication, CMFRI. pp. 373-386.

Gopalakrishnan, V., P. Ray and B.B. Ghosh. 1973. Present status of pollution in the Hooghly estuary with special reference to the adverse effects observed on the fishery resources. In: Proc. Symp. on Environmental Pollution. CPHERI, Nagpur. 1-8.

Gopinath, K. 1942. Distribution and feeding of the post-larval fishes of the Trivandrum coast. Curr. Sci., 11: 337.

Gopinath, K. 1953. Some interesting methods of fishing in the backwaters of Travancore. J. Bombay nat. Hist. Soc., 51: 466-471.

Gopinathan, C.P. 1972. Seasonal abundance of phytoplankton in the Cochin backwater. J. mar. biol. Ass. India, 14(2): 568-577.

Gopinathan, C.K. and S.Z. Qasim. 1971. Silting in the navigational channels of the Cochin harbour area. J. mar. biol. Ass. India, 13: 14-26.

Gore, P.S., O. Raveendran and R.V. Unnithan. 1979. Pollution in the Cochin backwaters with reference to indicator bacteria. Indian J. Mar. Sci., 8: 43-46.

Greenwood, P.H. 1975. Classification and Pedigrees: Living Fishes. pp. 371-396. In: J.R. Norman, A History of Fishes, 3rd edn. E. Benn, London.

Greenwood, P.H., D.E. Rosen, S.H. Weitzman and G.S.Myers. 1966. Phyletic studies of teleostean fishes with a provisional classification of living forms. Bull. Amer. Mus. nat. Hist., 131: 339-456.

Grover, H. John and Rogelio O. Juliano. 1976. Length-weight relationship of pond-raised milkfish in the Philippines. Aquaculture, 7(1976): 339-346.

Gunther, A. 1859-1870. Catalogue of the Acanthopterygian Fishes in the collection of the British Museum (Reproduced in 1937). Taylor and Francis, London. Vols. 1-8.

Hamilton-Buchanan, F. 1822. An account of the fishes of the Ganges. Edinburgh. 405 pp.

Hardenberg, J.D.F. 1933. New Stolephorus species of the Indo-Australian seas. Natuurk Tijdschr Ned. Indie, 93(2): 258-263.

Hardenberg, J.D.F. 1934. Some remarks on the genus Stolephorus Lacepede in the Indo-Australian Archipelago. Treubia, 14(3): 313-375.

Hardenberg, J.D.F. 1936. Some new or rare fishes of the Indo-Australian Archipelago, 5. Treubia, 15: 367-378.

Haridas, P., M. Madhupratap and T.S.S.Rao. 1973. Salinity, temperature and zooplankton biomass of the backwaters from Cochin to Alleppey. Indian J. Mar. Sci., 2: 94-102.

Herre, A.W.C.T. and H.R. Montalban. 1928. The Goat fishes or Mullidae of the Philippines. Philippine J. Sci., 36(1): 95-136.

Hickling, C.F. 1945. The seasonal cycle in the cornish pilchard, Sardina pilchardus Walburn. J. mar. biol. Ass. U.K., 26: 125-138.

Hickling, C.F. and R. Rutenburg. 1936. The ovary as an indication of spawning period in fishes. J. Mar. biol. Ass. U.K., 21: 311-317.

Hile, R. 1936. Age and growth of the cisco, Leucichthys artedi (Le Sueur) in the lakes of the north-eastern high lands, Wisconsin. Bull U.S. Bur. Fish., 48: 311-317.

Holden, M.J. 1967. The systematics of the genus Lates (Teleostei: Centropomidae) in Lake Albert, East Africa. J. Zool. Soc. London, 151: 329-342.

Holden, M.J. and D.F.S. Raitt (Eds). 1974. Manual of fisheries science. Part -2. Methods of resources investigation and their application. FAO Fish. Tech. Pap., 115, Rev.1: 224 pp.

Hora, S.L. 1923. Fauna of Chilka lake. Fish, Part V. Mem. Indian Mus., 5(11): 737-769.

Hora, S.L. 1934. Brackish water animals of the Gangetic delta. Curr. Sci., 2: 426-427.

Hora, S.L. 1936. Siluroid Fishes of India, Burma and Ceylon.
II Fishes of the genus Akysis Bleeker
III Fishes of the genus Olyra Mc Clelland
IV On the use of generic name Wallago Bleeker
V Fishes of the genus Heteropneustes Muller
Rec. Indian Mus., 38(2): 199-210.

Hora, S.L. 1937a. Notes on fishes of the Indian Museum. 28. On three collections of fish from Mysore and Coorg, South India. Rec. Indian Mus., 39(1): 5-28.

Hora, S.L. 1937b. Notes on fishes in the Indian Museum. 28. On three collections of fish from Mysore and Coorg, South India. Rec. Indian Mus., 43: 233-256.

Hora, S.L. 1943. Evidence of distribution of fishes regarding rise in salinity of the river Hooghly. Curr. Sci., 13(3): 89-90.

Hora, S.L. 1953a. Further evidence from fish distribution of the rise in salinity of river Hooghly. Curr. Sci., 22(2): 49-50.

Hora, S.L. 1953b. Rising salinity of the Hooghly river. Fishes provide evidences. Indian J. Pur. River Vall. Dev.,3(6): 12-15.

Hora, S.L. and K.S. Misra. 1938. Fishes of Deolali. I. J. Bombay nat. Hist. Soc. Bombay, 40: 20-38.

Hora, S.L. and K.K.Nair. 1941. New records of freshwater fishes from Travancore. Rec. Indian Mus., XLIII: 389-392.

Hora, S.L. and N.C. Law. 1941. The freshwater fishes of Travancore. Rec. Indian Mus., 43(2): 233-256.

Hornell, J. 1925. The fishin methods of Madras Presidency. Part I. The Coromandel coast. Madras Fish. Bull., 18(2): 59-110.

Hornell, J. 1938. The fishing methods of Madras Presidency. Part II. The Malabar coast. Madras Fish. Bull., 27(1): 1-69.

Hornell. J. 1950. Fishing in many waters. Univ. Pr., Cambridge.

Hutchins, J.B. 1981. Nomenclatural status of the Toad fishes of India. Copeia, 1981(2): 336-341.

Jacob, J. and K. Rangarajan. 1960. Callogobius seshaiyai the name proposed for the gobiid from the Vellar estuary, Porto Novo. J. Zool. Soc. India, 12(1): 20-21.

James, P.S.B.R. and Vijayakumar M. Baragi. 1980. Ovary as an indicator of frequency of spawning in fishes. Proc. Indian Natn. Acad., B 46(4): 479-489.

Jayaprakash, A.A. 1974. Food and feeding habits of juveniles of 'Koth' Otolithoides brunneus (Day) in Bombay in Bombay waters. Indian J. Fish., 21(1): 127-140.

Jayaprakash, A.A. 1975. A record of Nibea chui Trewavas from India. Indian J. Fish., 22(1 and 2): 259-261.

Jayaram, K.C. 1952. Taxonomic notes on the fish Pseudobagrus chryseus Day 1865. Ann. Mag. nat. Hist. London, 5(12): 980-983.

Jayaram, K.C. 1953. Siluroid fishes of India, Burma and Ceylon. 14. Fishes of the genus Mystus Scopoli. Rec. Indian Mus., 51(4): 527-558.

Jayaram, K.C. 1955. A preliminary review of the genera of the family Bagridae. Proc. natn. Inst. Sci. India, 21B(3): 120-128.

Jayaram, K.C. 1956. Systematic position of fishes described under Bagrus by Valenciennes, 1839. Rec. Indian Mus., 54(1 and 2): 53-59.

Jayaram, K.C. 1960a. The nomenclatural status of Mystus, Macrones, Aoria and other names for a genus of Asiatic siluroid fishes. Proc. 1st all India Congr. Zool. Calcutta, 2: 632-635.

Jayaram, K.C. 1960b. The proper generic names for some common Indian Fishes of commercial importance. J. Zool. Soc. India, 12(2): 239-242.

Jayaram, K.C. 1965. On a new species of fish of the family Bagridae. Bull. Syst. Zool. Calcutta, 1(1): 8-9.

Jayaram, K.C. 1966. Contributions to the study of Bagrid fishes (Siluroidea: Bagridae). 1. systematic account of the genera Rita Bleeker, Mystus Scopoli, and Horabagrus Jayaram. Int. Rev. ges. Hydrobiol. Leipzig, 51(3): 433-450.

Jayaram, K.C. 1971. Contributions to the study of Bagrid fishes. 4. Nomenclatural status and systematic position of the fishes of the subgenus Osteobagrus Jayaram (Siluroidea: Bagridae). Rec. zool. Surv. India, 63(1-4): 185-194.

Jayaram, K.C. 1973. Contributions to the study of Bagrid fishes. 9. Generic status of Leiocassis Wu (Siluroidea) Proc. zool. Soc. Calcutta, 24: 149-156.

Jayaram, K.C. 1977a. Aids to the identification of the Siluroid fishes of India, Burma, Ceylon, Pakistan and Bangladesh. 1. Bagridae. Occ. papers zool. Surv. India, 8. 41 p.

Jayaram, K.C. 1977b. Aid to the identification of the Siluroid fishes of India, Burma, Ceylon, Pakistan and Bangladesh. 2. Siluridae, Schilbeidae, Pangasiidae, Amblycipitidae, Akysidae. Occ. papers zool. Surv. India, 10: 33 p.

Jayaram, K.C. 1977c. Year of publication and type locality of Ompok bimaculatus (Bloch). Zool. Surv. India, Newsl. 3(1): 50-51.

Jayaram, K.C. 1978. Contributions to the study of Bagrid fishes. 14. The systematic position of the species of Mystus Scopoli known from China. Proc. Indian Acad. Sci., 87(B): 221-228.

Jayaram, K.C. and J.R. Dhanze. 1978a. Siluroid fishes of India, Burma and Ceylon. 21. A note on the systematic position of Tachysurus serratus (Day) (Ariidae). Bull. zool. Surv. India, 1(2): 203-205.

Jayaram, K.C. and J.R. Dhanze. 1978b. Siluroid fishes of India, Burma and Ceylon. 22*. A preliminary review of the genera of the family Ariidae (Pisces: Siluroidea). Matsya, 4: 42-51.

Jhingran, V.G. 1958. Observation on the seaward migration of Mugil cephalus from the Lake Chilka for breeding. Curr. Sci., 27: 181-182.

Jhingran, V.G. 1982. Fish and Fisheries of India. (Revised and Enlarged Second Edition) Hindustan Publishing Corporation, Delhi. 666 pp.

Jhingran, V.G. and A.V. Natarajan. 1969. A study of the Fisheries of fish populations of the Chilka lake during the period 1957-'65. J. Inland Fish. Soc. India, 1: 49-126.

Jhingran, V.G. and A.V. Natarajan. 1973. Fishery resources of the Chilka lake and its bearing on fisheries in adjacent areas of Bay of Bengal. Proc. Symp. living resources of the seas around India. Spl. Publ. CMFRI: 365-372.

Jhingran, V.G. and V. Gopalakrishnan. 1973. Estuarine fisheries resources of India in relation to adjacent seas. J. mar. biol. Ass. India, 15(1): 323-334.

Job, T.J. 1940. An investigation on the nutrition of the perches of the Madras coast. Rec. Indian Mus., 42: 289-364.

Joglekara, A. and P.K. Talwar. 1970. The occurrence of Pennahia macrocephalus (Tang) (Pisces: Sciaenidae) in Indian Seas. J. Bombay nat. Hist. Soc., 67: 575-577.

John, C.C. 1936. Freshwater Fish and Fisheries of Travancore. J. Bombay nat. Hist. Soc., 38: 702-733.

Jones, S. and K.H. Sujansingani. 1954. Fish and fisheries of the Chilka lake with statistics of fish catches for the years 1948-1950. Indian J. Fish., 1(1 and 2): 256-344.

Jones, S. and M. Kumaran. 1964. New records of fishes from the seas around India - Part 1. J. mar. biol. Ass. India, 6(2): 285-308.

Jones, S. and M. Kumaran. 1965. New records of fishes from the seas around India - Part II. J. mar. biol. Ass. India, 7(1): 108-123.

Jones, S. and M. Kumaran. 1966. New records of fishes from the seas around India.-Part IV. J. mar. biol. Ass. India, 8: 163-180.

Jones, S. and M. Kumaran. 1967. New records of fishes from the seas around India - Part III. J. mar. biol. Ass. India, 7(2): 381-400.

Jones, S. and M. Kumaran. 1968. New records of fishes from the seas around India - Part V. J. mar. biol. Ass. India, 9: 1-12.

Jones, S. and M. Kumaran. 1970. New records of fishes from the seas around India - Part VI. J. mar. biol. Ass. India, 10(2): 321-331.

Jones, S. and M. Kumaran. 1971. New records of fishes from the seas around India - Part VII. J. mar. biol. Ass. India, 12(1-2): 167-196.

Jones, S. and M. Kumaran. 1980. Fishes of the Laccadive Archipelago. The Nature Conservation and Aquatic Science Service Santinivas, Nanthancode, Trivandrum.

Jordan, D.S. and E.C. Starks. 1906. A review of the Founders and Soles of Japan. Proc. U.S. Nat. Mus., 31: 161-246.

Josanto, V. 1971. The bottom salinity characteristics and the factors that influence the salt water penetration in the Vembanad Lake. Bull. Dept. Mar. Biol. Oceanogr., 5: 1-16.

Joseph, K.J. and V. Kunjukrishna Pillai. 1975. Seasonal and spatial distribution of phytoplankters in Cochin backwaters. Bull. Dept. Mar. Sci. Univ. Cochin, 7(1): 171-180.

June, F.C. 1953. Spawning of yellow fin tuna in Hawaiian waters. U.S. Fish. Wildl. Serv. Fish. Bull., 54: 47-64.

Karandikar, K.R. and S.S. Thakur. 1951. Sciaenoides brunneus Day (anatomy with notes on distribution and bionomics). Zool. Mem. Univ. Bombay, 3:1-89.

Kathirvel, M., K.N. Gopalakrishnan and C. Nalini. 1976. On the occurrence of Metapenaeopsis hilarula (de Man) and P. penicillatus Alcock (Dec. - Penaeidae) in Cochin backwater. Indian J. Fish., 23(1 and 2): 236-237.

Kinne, O. 1966. Physiological aspects of animal life in estuaries with special reference to salinity. Neth. J. Sea. Res., 3: 222-224.

Koumans, F.P. 1941. Gobioid fishes of India. *Mem. Indian Mus.*, 13(3): 205-329.

Koumans, F.P. 1953. Gobioidea. *The fishes of the Indo-Australian Archipelago*, 10: 423 pp.

Krishnamurthy K. N. and A.V. Prabhakara Rao. 1970. Fishing methods of Pulicat lake. *J. Inland Fish. Soc. India*, 2: 1-15.

K.S.S.P. (Kerala Sastra Sahitya Parishat). 1978. Problems of Kuttanad, a study report. 73 pp. (in Malayalam)

Kumaran, S. and T.S.S.Rao. 1975. Phytoplankton distribution and abundance in the Cochin Backwaters during 1971-1972. *Bull. Dept. Mar. Sci. Univ. Cochin*, 7(4): 791-799.

Kurup, B.M. and C.T.Samuel. 1979. Notes on a specimen of *Ambassis dayi* Bleeker with morphological abnormalities. *Matsya*, 5: 76-78.

Kurup, B.M. and C.T.Samuel. 1980a. Fishes of the subfamily Pellonulinae (Pisces: Clupeidae) from Vembanad lake, Kerala, South India. *Bull. Dept. Mar. Sci. Univ. Cochin*, 11(1): 85-98.

Kurup, B.M. and C.T.Samuel. 1980b. On the little known fish *Hyporhamphus* (*Hyporhamphus*) *xanthopterus* (Valenciennes) from the Vembanad Lake (Kerala), with a key for identification of halfbeaks (Pisces: Hemiramphidae) of the Vembanad Lake. *Bull. Dept. Mar. Sci. Univ. Cochin*, 11(2): 1-9.

Kurup, B.M. and C.T.Samuel. 1981a. On the occurrence of *Oxyurichthys nijsseni* Menon and Govindan (Pisces: Gobiidae) in Vembanad lake, Kerala. *Matsya*, 7: 91-93.

Kurup, B.M. and C.T.Samuel. 1981b. Sexual dimorphism in *Oxyurichthys nilsseni* Menon and Govindan. *Curr. Sci.*, 50(19): 873.

Kurup, B.M. and C.T.Samuel. 1981c. Systematics and distribution of fishes of the family Leiognathidae (Pisces) of the Vembanad lake, Kerala (S.India). *Rec. Zool. Surv. India* (in press).

Kurup, B.M. and C.T.Samuel. 1981d. On the occurrence of *Ilisha sirishai* Seshagiri Rao (Pisces: Clupeidae) in Vembanad lake, Kerala, South West Coast of India. *J. Inland Fish. Soc. India*, (in press).

Kurup, B.M. and C.T.Samuel. 1981e. A re-description of the little known rabbit fish *Siganus lineatus* Cuv. and Val. (Pisces: Siganidae) with notes on Siganid fishes of Vembanad lake, Southern India. Abstract no.88. Biol. Sci., 51 Ann. Ses. *Nat. Acad. Sci. India*.

Kurup, B.M. and C.T.Samuel. 1981f. Observation on the spawning biology and ecology of *Liza parsia* (Ham. Buch.) in a tropical estuary. Abstract no.73. *Seminar on Estuaries*, NIO, Goa.

Kutty, M. Narayanan. 1967. A note on the biology of the 'Koth' *Otolithoides brunneus* (Day). *J. mar. biol. Ass. India*, 9(1): 197-198.

Kuttyamma, V.J. and A. Antony. 1975. Observations on the relative abundance, size variation and sex difference on the penaeid prawns in the Cochin backwaters. *Bull. Dept. Mar. Sci. Univ. Cochin*, 7(3): 503-510.

Lachnr, E.A. 1954. A revision of the goat fish genus *Upeneus* with descriptions of two new species. *Proc. U.S. Nat. Mus.*, 103: 497-532.

Lachnr, E.A. 1960. Fishes of Marshall and Marianas Islands, Family Mullidae. Goat fishes. U.S. Nat. Mus. Bull., 202, 2: 1-46.

Lagler, K.F. 1952. Freshwater fishery biology. Wm. C. Brown Company, Dubuque, Iowa.

Lam, T.J. 1974. Siganids: their biology and mariculture potential. Aquaculture, 3: 325-354.

Le Cren, E.D. 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in perch (Perca fluviatilis). J. Anim. Ecol., 20(2): 201-219.

Lele, S.H. 1924. Studies in Bombay fish. I Revision of the genus Drepane Cuv. Val. J. Proc. Asiat. Soc. Bengal, 20: 274-288.

Lenous, V. 1968. Morphology of the skull in Tachysurus maculatus (Thunberg). Bull. Dept. mar. biol. Oceanogr., 3: 45-60.

Lovern, J.A. and H. Wood. 1937. Variations in the chemical composition of herring. J. Mar. Biol. Ass. U.K., 22: 281-293.

Lowe-McConnell. 1978. Identification of fresh water fishes. pp. 48-83. In: T.B. Bagenal (ed.) Methods for Assessment of Fish Production in Fresh Waters, IBP Handbook No.3. Blackwell, Oxford.

Luther, G. 1971. Ulna mandibularis (Macleay) (Carangidae: Pisces), a new record from the Indian seas. Indian J. Fish., 15(1 and 2): 180-187.

Luther, G. 1974. On the little known mullet Valamugil buchanani (Bleeker) (Mugilidae: Pisces) in the Indian waters. J. mar. biol. Ass. India, 16(1): 290-291.

Madhupratap, M. 1980. Ecology of the coexisting copepod species in Cochin Backwaters. Mahasagar - Bull. Nat. Inst. Ocean., 13(1): 45-52.

Madhupratap, M. and P. Haridas. 1975. Composition and variations in the abundance of zooplankton of the backwaters from Cochin to Alleppey. Indian J. Mar. Sci., 4: 77-85.

Madhupratap, M., T.S.S.Rao and P. Haridas. 1977. Secondary production in the Cochin backwaters, a tropical monsoonal estuary. Proc. Symp. Warm. Water Zoopl. Spl. Publ. UNESCO/NIO: 515-519.

Malhotra, Y.R. and S.P. Singh Dutta. 1975. On a new fish species from Jammu along with a check list of fishes inhabiting Jammu division of J and K State - India. Proc. Nat. Acad. Sci. India, 45(B), 3: 153-162.

Margalef, R. 1963. On certain unifying principles in ecology. Amer. Natur., 97: 357-374.

Marine Fisheries Information Service (C.M.F.R.I.) 1980. Ser. No.23: 1-17.

Martin, W. R. 1949. The mechanics of environmental control of body form in fishes. Univ. Toronto Stud. Biol., 58, Ont. Fish. Res. Lab., 70: 1-91.

Mckay, J.R. 1976. The fishes of the family Sillaginidae from India with a description of a new species. J. mar. biol. Ass. India, 18(2): 375-385.

McLusky, S. Donald. 1974. Ecology of Estuaries. Heinemann Educational Books, London. 144 pp.

Mees, G.F. 1962. A preliminary revision of the Belonidae. Zool. Verhand. No.54: 96 pp.

Mees, G.F. 1964. Further revisional notes on the Belonidae. Zool. Meded. 39: 311-326.

Menon, A.G.K. 1961. *Bascanichthys deraniyagalai*, a new eel from the Coromandel coast of India with a key to the Indian Ophichthyidae. *J. zool Soc. India*, 12(2): 13-15.

Menon, A.G.K. 1963a. Subspecies of the cyprinid fish *Puntius sarana* (Ham.) with the description of *P. s. spilurus* (Gunther) from Ceylon. *Spolia zeylanica*, 30 (Part 1): 65-70.

Menon, A.G.K. 1963b. Taxonomy of the Indian frog fishes (Family: Batrachoididae). *Labdev. Jour. Sci.* and *Tech.*, 1: 1-2.

Menon, A.G.K. 1967. Taxonomy of *Puntius filamentosus* (Val.) a cyprinid fish of South India and Ceylon. *Ichthyologica* - the Aquarium Journal: 147-153.

Menon, A.G.K. 1971. On the specific identity of the Malabar sole. *J. mar. biol. Ass. India*, 11(1 and 2): 311-315.

Menon, A.G.K. 1974. A check list of fishes of the Himalayan and the Indo-Gangetic plains. Spl. Publication No.1. *Inland Fish. Soc. India*, pp. 21.

Menon, A.G.K. 1977. A systematic monograph of the tongue soles of the genus *Cynoglossus* Hamilton Buchanan (Pisces: Cynoglossidae). *Smithson. Contr. Zool.*, 238: 1-28.

Menon, A.G.K. and T.K. Chatterjee. 1974. *Callogobius andamanensis*, a new gobioid fish from Curlow Island, Middle Andamans, with a key to species of *Callogobius* of the seas of India and Malay Archipelago. *Curr. Sci.*, 43(4): 126-128.

Menon, A.G.K. and T.K. Chatterjee. 1976. *Callogobius trifasciatus* a new gobioid fish from Mayabunder, Middle Andaman Island. *Mahasagar*, 7(3-4): 205-207.

Menon, A.G.K. and V. Govindan. 1976. *Oxyurichthys nijsseni*, a new gobioid fish from Ennore estuary, east coast of India, with a key to the identification of the Indo-West Pacific species of the genus *Oxyurichthys*. *Matsya*, 2: 13-15.

Menon, A.G.K. and K. Rema Devi. 1980. *Acentrogobius ennorensis*, a new gobioid fish from Ennore estuary, Madras. *Matsya*, 6: 54-57.

Menon, C.A. 1913. *Cochin State Manual*. Mangalodayam Company, Trichur. pp. 1-688.

Menon, M.D.S. 1961. On a collection of fish from lake Chilka, Orissa. *Rec. Indian Mus.*, 59(1 and 2): 41-69.

Menon, M.K. and K. Raman. 1961. Observations on the prawn fishery of the Cochin backwaters with special reference to the stake net catches. *Indian J. Fish.*, 8(1): 1-23.

Menon, N.R., P. Venugopal and S.C. Goswamy. 1972. Total biomass and faunastic composition of the zooplankton in the Cochin Backwaters. *J. mar. biol. Ass. India*, 13(2): 220-225.

Misra, K.S. 1949. A check list of the fishes of India, Burma and Ceylon. I. Elasmobranchii and Holocephali. *Rec. Indian Mus.*, 45: 1-46.

Misra, K.S. 1952. An aid to the identification of the fishes of India, Burma and Ceylon. I. Elasmobranchii and Holocephali. *Rec. Indian Mus.*, 49: 87-137.

Misra, K.S. 1959. An aid to the identification of the common commercial fishes of India and Pakistan. Rec. Indian Mus., 57(1-4): 1-320.

Misra, K.S. 1962. An aid to the identification of common Commercial fishes of India and Pakistan. Rec. Indian Mus., 57(1959): 1-320.

Misra, K.S. 1969. The fauna of India and adjacent countries. Pisces, I. Elasmobranchii and Holocephali. 276 pp. Govt. of India Press, Faridabad.

Misra, K.S. 1976. The fauna of India and the adjacent countries. Pisces, 3: 367 pp. 2nd Ed. Govt. of India Press, Faridabad.

Misra, K.S. and M.A.S.Menon. 1958. On the distribution of the Elasmobranchs and Chimaeras of the Indian region in relation to the mean annual isotherms. Rec. Indian Mus., 53: 73-86.

Mohan, R.S. Lal. 1969a. On three new genera of sciaenid fishes (Pisces: Sciaenidae) from India. Curr. Sci., 38: 295-296.

Mohan, R.S. Lal. 1969b. A new species of sciaenid fish Johnius mannarensis from the south-east coast of India. J. mar. biol. Ass. India, 11(1 and 2): 320-323.

Mohan, R.S. Lal. 1972. A synopsis to the Indian genera of the fishes of the family Sciaenidae. Indian J. Fish., 16(1-2) (1969): 82-98.

Mohan, R.S.Lal. 1975. Two new species of Sciaenid fishes Johnius elongatus and Johnieops macrorhynus from India. Matsya, 1:19-25.

Mookerjee, H.K., D.N. Ganguly and T.C. Mazumdar. 1946. On the food of estuarine fish of Bengal. Sci. Cult., 10: 564-565.

Moor, H.B. 1958. Marine ecology. John Wiley and Sons, New York.

Munechico Iwata. 1975. Population identification of Walleye Pollock, Theragra chalcogramma (Pallas) in the vicinity of Japan. Mem. Fac. Fish. Hokkaido Univ., 22(2): 193-258.

Munro, I.S.R. 1955. The marine and freshwater fishes of Ceylon. Dept. External Affairs, Canberra, 349 pp.

Murty, V. Sriramachandra. 1968. On some interesting and new records of marine fishes from India. J. mar. biol. Ass. India, 10(1): 126-132.

Murty, V. Sriramachandra. 1969. Catalogue of fishes (excluding from Laccadives) in the reference collections of the Central Marine Fisheries Research Institute. Bull. Cent. mar. Fish. Res. Inst., 10: 1-36.

Mutsaddi, K.V. and D.V.Bal. 1973. Gobies from the intertidal region of Bombay. Indian J. Fish., 20(2): 475-496.

Nagabushanam, A.K. and K.V.Rama Rao. 1970. A review of the taxonomy of the Indian frog-fishes (Family: Batrachoididae). J. Bombay Nat. Hist. Soc., 67: 339-344.

Nair, R.V. 1953. Key for the field identification of the common clupeoid fishes of India. J. zool.Soc. India, 5(1): 136-138.

Nair, R.V. 1973. Indian Sardines. CSIR Zoo. Monograph No.2. Publ. Inform. Dire. C.S.I.R., New Delhi. 107 pp.

Nair, N.B. 1965. Seasonal settlement of marine wood boring animals in Cochin Backwaters, South West of India. Int. Revueges Hydrobiol., 50: 411-420.

Nair, N.B. and B. Sobhana. 1980. Food and feeding habits of Puntius sarana subnasutus. Proc. Indian natn. Sci. Acad., B. 46(1): 33-40.

Nair, R. Vijayalakshmi. 1972. Seasonal fluctuations of chaetognaths in the Cochin Backwater. J. mar. biol. Ass. India, 13(2): 226-233.

Nair, K.K.C. and D.J. Tranter. 1972. Zooplankton distribution along salinity gradient in the Cochin backwaters before and after monsoon. J. mar. biol. Ass. India, 13(2): 203-210.

Nanda, R.R. 1980. Studies on Lizard fishes of Porto Novo. waters (Scopeliformes: Synodidae). Ph.D. Thesis, Annamalai University.

Narasimham, K.A. 1970. On the length-weight relationship and relative condition in Trichiurus lepturus Linnaeus. Indian J. Fish., 17 (1 and 2): 90-96.

Natarajan, A.V. and V.G. Jhingran. 1962. 'Index of preponderance' a method of grading the food elements in the stomach analysis of fishes. Indian J. Fish., 8: 54-59.

Natarajan, A.V. and S. Patnaik. 1971. Observations on the breeding ground and development of Chilka mullet Liza macrolepis (Smith). J. Bombay Nat. Hist. Soc., 67: 577-578.

Natarajan, R. and K. Subrahmanyam. 1975. New records of gobioid fishes from Porto Novo (S. India). J. mar. biol. Ass. India, 16(1): 182-190.

Nielsen, J.G. and W. Klausewitz. 1968. Siganus Forsskal, 1775 (Pisces, Siganidae): proposed validation under the plenary powers. Bull. Zool. Nomencl., 25: 26-28.

Nijssen, H. 1966. The occurrence of Cynoglossus browni Chabanaud, 1949, in the North Sea. Beaufortia, 13: 87-90.

Nikolsky, G.V. 1963. The ecology of fishes. Academic Press, London and New York. 1-352 pp. (Translated from Russian)

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.

Norman, J.R. 1923. A revision of the clupeoid fishes of the genus Ilisha and allied genera. Ann. Mag. nat. Hist., 11: 1-22.

Norman, J.R. 1928. The flat fishes (Heterosomata) of India, with a list of the specimens in the Indian Museum. Rec. Indian Mus., 30( ): 178-215, figs. 1-30, pls. 1-4.

Norman, J.R. 1934. A systematic Monograph of the Flat-fishes (Heterosomata). Vol. I. London: British Museum (Natural History). 459 pp.

Norman, J.R. 1935. A revision of the Lizard fishes of the genus Synodus, Trachinocephalus and Saurida. Part I. Proc. Zool. Soc. London, 99-135.

Odum, P. Eugene. 1957. The ecosystem approach in the teaching ecology illustrated with sample class data. Ecol., 38: 531-535.

Oshima, M. 1927. List of Flounders and Soles found in the waters of Formosa, with the descriptions of hitherto unrecorded species. Jap. J. Zool., 1: 177-204.

Palekar, V.C. and D.V. Bal. 1955. Occurrence of *Sillago chondropus* Blkr. in the seas of India. Curr. Sci., 24: 128.

Panikkar, N.K. 1937. The prawn industry of the Malabar coast. J. Bombay nat. Hist. Soc., 39(2): 343-353.

Panikkar, N.K. 1952. Fisheries Research in India. Journ. Bombay nat. Hist. Soc., 50: 741-765.

Panikkar, N.K. 1969. New perspectives in estuarine biology. Inaugural address, First all India symposium on estuarine biology, Tambaram, Madras.

Parin, N.V. 1967. Review of marine needlefishes of the West Pacific and Indian Oceans. Trudy Inst. Okean, 84: 3-83. (in English translation)

Parin, N.V., Bruce B. Collette and Yu. N. Shcherbachev. 1980. Preliminary review of the marine halfbeaks (Hemiramphidae, Beloniformes) of the tropical Indo-west Pacific. In beloniform fishes of the world Ocean, Trudy Institute of Oceanologii, 97: 7-173.

Patnaik, S. 1971. Observations on the fishery and biology of Chilka Jagilâ, *Gerres setifer* (Hamilton). J. Inland. Fish. Soc. India, 3: 25-43.

Pearse, A.S. and G. Gunter. 1957. Salinity. Mem. Geol. Soc. Am., 67: 129-157.

Pillai, N.G.K. 1977. Distribution and seasonal abundance of macrobenthos of the Cochin Backwaters. Indian J. Mar. Sci., 6: 1-5.

Pillai, N.G.K. 1978. Macrobenthos of a tropical estuary. Ph.D. Thesis, University of Cochin. 133 pp.

Pillay, R.S.N. 1929. A list of fishes taken in Travancore from 1901-1915. J. Bombay nat. Hist. Soc., 33: 347-379.

Pillay, R. Sarojini. 1962a. A revision of Indian Mugilidae. Part I. J. Bombay nat. Hist. Soc., 59(1): 254-270.

Pillay, R. Sarojini. 1962b. A revision of Indian Mugilidae. Part II. J. Bombay nat. Hist. Soc., 59(2): 547-573.

Pillay, T.V.R. 1952. A preliminary note on the food and feeding habits of the Bombay duck, Harpodon nehereus (Ham.) in the river Matlah. Sci. Cult. 17(6): 262.

Pillay, T.V.R. 1960. On the occurrence of hilsa, Hilsa ilisha (Hamilton) in the Vembanad backwaters (Kerala). Sci. Cult., 26(1): 48.

Pillay, T.V.R. 1967. Estuarine Fisheries of the Indian Ocean Coastal Zone. In: Estuaries (ed.) G.H. Lauff, American Association for the Advancement of Science. pp. 647-657.

Pillay, P. Parameswaran. 1972. Studies on the estuarine copepods of India. J. mar. biol. Ass. India, 13(2): 162-172.

Pillai, P. Parameswaran, S.Z. Qasim and A.K.K. Nair. 1973. Copepod component of zooplankton in a tropical estuary. Indian J. Mar. Sci., 2(2): 38-46.

Pillay, V. Kunjukrishna, K.J. Joseph and A.K. Kesavan Nair. 1975. The plankton production in the Vembanad lake and adjacent waters in relation to the environmental parameters. Bull. Dept. Mar. Sci. Univ. Cochin, 7(1): 137-150.

Polder, J.J.W. and J.J.Zijlstra. 1959. Fecundity in the North Sea herring. ICES, C.M., 1959. Doc. hr., 84.

Polonsky, A.S. and I.D. Tormosova. 1969. The spawning of the jack mackerel of the north east Atlantic and the distribution of its eggs and larvae. Trudy atlant. nauchno-issled. Inst. morsk. ryb. khoz. Okeanogr., 23: 27-48.

Prabhakara Rao, A.V. 1968. Observations on the food and feeding habits of Gerres oyena (Forskal) and Gerres filamentosus Cuvier from the Pulicat lake with notes on the food of allied species. J. mar. biol. Ass. India, 10(2): 332-346.

Prabhakara Rao, A.V. 1970a. On the seasonal abundance of larvae and juveniles of cultivable brackish water fishes in the Pulicat lake. Indo-Pacific Fish. Counc. 14th Session IPFC/C70/Sym.30: 23 p.

Prabhakara Rao, A.V. 1970b. Observations on some aspects of the biology of Gerres oyena (Forskal) with notes on the fishery of Silver biddies of Pulicat lake. J. Inland Fish. Soc. India, 2: 85-100.

Prabhakara Rao, A.V. 1971. Observations on the larval ingress of the milk fish Chanos chanos (Forskal) into the Pulicat lake. J. mar. biol. Ass. India, 13(2): 249-257.

Prabhu, M.S. 1956. Maturation of intra-ovarian eggs and spawning periodicities in some fishes. Indian J. Fish., 3: 59-90.

Pradhan, M.J. 1964. A preliminary account of the Flat - fishes (Heterosomata) found along the Bombay coast. J. Bombay Nat. Hist. Soc., 61(2): 456-458.

Pritchard, D.W. 1967. What is an estuary. Physical view point, pp. 3-6. In: Estuaries (ed.) George H. Lauff. Publication No. 83. Washington, D.C. American Association for the Advancement of Science.

Punpoka, S. 1964. A review of the flat - fishes (Pleuronectiformes - Heterosomata) of the Gulf of Thailand and its tributaries in Thailand. Bull. Fish. Res., Kasetsart Univ., 1: 1-86.

Qasim, S.Z. 1957. The biology of Blennius pholis L. (Teleostei). Proc. Zool.Soc.London, 128(2): 161-208.

Qasim, S.Z. 1966. Sex ratio in fish population as a function of sexual difference in growth rate. Curr. Sci., 35: 140-142.

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.

Qasim, S.Z. and C.K. Gopinathan. 1969. Tidal cycle and the environmental features of Cochin backwaters (A tropical estuary). Proc. Ind. Acad. Sci., 69(6): 336-348.

Qasim, S.Z., S. Wellershaus, P.M.A. Bhattathiri and S.A.H. Abdi. 1969. Organic production in a tropical estuary. Proc. Indian Acad. B., 69: 51-94.

Qasim, S.Z., Sumitra Vijayaraghavan, K.J.Joseph and V.K.Balachandran. 1974. Contribution of Microplankton and Nannoplankton in the waters of a tropical estuary. Indian J. Mar. Sci., 3: 146-149.

Qasim, S.Z. and M. Madhupratap. 1979. Changing ecology of Cochin backwaters. Contributions to Marine Sciences. Published by Prof. Kurian's Shashtyabdhapoorthi Felicitation Committee. pp. 137-142.

Radhakrishnan, C.K., B.M. Kurup and C.T.Samuel. 1982. Distribution and ecology of the crustacean population of the Vembanad lake (S.India). J. Inland Fish. Soc., (in press).

Raj, S. 1941. Two new cyprinid fishes from Travancore, S. India, with remarks on Barbus (Puntius) micropogon Cuv. and Val. Rec. Indian Mus., XXLIII: 378-386.

Rajan, S. 1964. The biology and fishery of Pseudosciaena coibor (Hamilton) from the Chilka Lake. Indian J. Fish., 11: 639-662.

Ramaiyan, V. and P.J.P. Whitehead. 1975. Notes on Indian species of Ilisha (Pisces: Clupeidae). J. mar. biol. Ass. India, 17(1): 187-198.

Ramaiyan, V. and R. Natarajan. 1975. Studies on taxonomy of the Indian shad Ilisha Richardson. Bull. Dept. Mar. Sci. Univ. Cochin, 7(4): 953-963.

Ramaiyan, V. and R. Natarajan. 1980. Systematic revision of the Indian species of Ilisha Richardson, 1846. (Pisces: Clupeiformes). Proc. Indian natn. Sci. Acad. B 46(1): 8-22.

Ramamohana Rao and K. Janardhana Rao. 1971. On the occurrence of juveniles of Trichiurus lepturus Linnaeus in lake Pulicat. J. Inland. Fish. Soc. India, 3: 138.

Ramamritham, C.P. and R. Jayaraman. 1963. Some aspects of the hydrographical conditions of the backwaters around Willington island (Cochin). <u>J. mar. biol. Ass. India</u>, 5(2): 170-177.

Ramanathan, N. and R. Natarajan. 1979. Breeding biology of <u>Psettodes erumei</u> (Bloch and Schn.) and <u>Pseudorhombus arsius</u> (Ham. Buch.) (Pisces: Pleuronectiformes) along Porto Novo Coasts (S.India). <u>Aquaculture</u>, 18: 269-282.

Ramanathan, N. and R.Natarajan. 1980. The flat fishes of Porto Novo (India) Pisces: Pleuronectiformes). <u>Bull. zool. M.s. Univ. Amsterdam</u>, 7(10): 89-116.

Rangarajan, K. 1970. A new species of <u>Callogobius</u> (Family Gobiidae: Pisces) from Gulf of Mannar, India. <u>J. mar. biol. Ass. India</u>, 10(2): 347-353.

Rangaswamy, C.P. 1978. On the appearance of certain diagnostic characters in fry of <u>Mugil cephalus</u> Linnaeus. <u>Matsya</u>, 4: 11-14.

Rao, T.S.S., M. Madhupratap and P. Haridas. 1975. Distribution of zooplankton in space and time in a tropical estuary. <u>Bull. Dept. Mar. Sci. Univ. Cochin</u>, 7(4): 695-704.

Rasalam, E.J. and M.J.Sebastian. 1976. The lime-shell fisheries of the Vembanad lake, Kerala. <u>J. mar. biol. Ass. India</u>, 18(2): 323-335.

Rasmussen, Erik. 1973. Systematics and ecology of the Isefjord marine fauna (Denmark). <u>Ophelia</u>, 11:1-495.

Reddy, P.B. 1978. Studies on the taxonomy of Indian species of family Channidae (Pisces: Teleostei) and some aspects of the biology of <u>Channa punctata</u> (Bloch, 1793) from Guntur, Andhra Pradesh. Ph.D. Thesis, Abstract. <u>Matsya</u>, 4: 95-96.

Reddy, P.S. 1977. Bio-systematic studies in mullets (Family: Mugilidae) of Porto Novo (Tamil Nadu, India). Ph.D. Thesis, Annamalai University (S.India), 1-282 pp.

Reghu, R. 1973. Migration of the juvenile oil sardine, Sardinella longiceps (Val.) into the backwaters of Cochin. Indian J. Fish., 20(2): 655-658.

Rehman, A.K.A. 1979. Occurrence of the snake-eel, Pisodonophis cancrivorus, in Bangladesh, with notes on other eels. Matsya, 4: 88-91.

Reuben, S. 1967. On the occurrence of white mouth crevalle, Uraspis helvola (Forster) in the Bay of Bengal. J. mar. biol. Ass. India, 9(1): 188-190.

Reuben, S. 1968. Uraspis helvola (Forster) (Carangidae: Pisces). A detailed description with remarks on the species of the genus Uraspis Bleeker. J. mar. biol. Ass. India, 10(1): 133-151.

Reynolds, J.D. 1974. Biology of small pelagic fishes in the new Volta lake in Ghana. Part III. Sex and Reproduction. Hydrobiologia, 45(4): 489-508.

* Richardson, J. 1946. Descriptions of six fish (In Stokes, John Lort. Discoveries in Australia). 2 Vols. London.

Ricker, W.E. 1958. Handbook of computation for biological studies of fish populations. Bull. Fish. Res. Bd. Canada, 119: 300 pp.

Rounsefell, G.A. 1975. Ecology, utilization and management of marine fisheries. The C.V. Mosby Company. Saint Louis. 516 pp.

Rounsefell, G.A. and W.H. Everhart. 1953. Fishery science. John Wiley and Sons, Inc., New York. 444 pp.

Roy, J.C. and N. Sahoo. 1957. Additions to the fish fauna of the Chilka lake. J. Bombay nat. Hist. Soc., 54: 949-952.

Russell, P. 1803. Descriptions and figures of 200 fishes collected at Vizagapatnam on the coast of Coromandel. 2 Vols. London. W. Bulmer and Co.

Samuel, C.T. 1962. Morphology of the eels and eel-like fishes. Ph.D. Thesis, Kerala University.

Samuel, Sydney, Kuruvila Mathew and A. Antony. 1975. Observations on the African weed, Salvinia auriculata Aublet with special reference to salinity tolerance. Bull. Dept. Mar. Sci. Univ. Cochin, 7(4): 913-917.

Sankaranarayan, V.N. and S.Z.Qasim. 1969. Nutrients of the Cochin backwaters in relation to environmental characteristics. Mar. Biol., 2(3): 236-247.

Saramma, A.U. 1963. Bottom fishes collected by the research vessel 'Conch', off the Kerala coast during 1958-'63. Heterosomata. Bull. Dept. Mar. Biol. Oceanogr., 1: 57-80.

Sarkar, H.L. 1964. On the nomenclatural status of the two subgenera Mystus and Osteobagrus of the genus Mystus Scopoli. Proc. Indian Sci. Congr. Calcutta, 51st and 52nd Session, Part III: 495.

Sarojini, K.K. 1953. Mugil dussumieri Valenciennes as a synonym of Mugil parsia Hamilton - A biometric study. Proc. nat. Inst. Sci. India, 19: 437-445.

Schultz, L.P. 1946. A revision of the genera of mullets, fishes of the family Mugilidae, with descriptions of three new genera. Proc. U.S. Nat. Mus., 96: 377-395.

Sekharan, K.V. 1968. Length-weight relationship in *Sardinella albella* (Val.) and *S. gibbosa* (Bleek.) *Indian J. Fish.*, 15(1 and 2): 166-174.

Selvanathan, M. and M. Kaliyamurthy. 1969. On some new records of fishes from the Pulicat lake. *Rec. zool. Surv. India*, 67(1-4): 367-371.

Seshagiri Rao, B.V. 1972. Identify of Clupeid fishes, *Ilisha megaloptera* and *Ilisha indica*. *Copeia*: 881-882.

Seshagiri Rao, B.V. 1973. Re-description of the Clupeid fishes, *Ilisha megaloptera* and *Ilisha melastoma*. *Copeia*: 735-739.

Seshagiri Rao, B.V. 1975a. A new record of the Clupeid fish *Ilisha kampeni* (Weber and de Beaufort) from the Bay of Bengal. *Curr. Sci.*, 44(7): 233-234.

Seshagiri Rao, B.V. 1975b. Two new records of Clupeid fishes, *Ilisha kampeni* and *I. sirishai* from the Arabian sea. *Curr. Sci.*, 44(14): 526-527.

Seshagiri Rao, B.V. 1975c. A new species of Clupeid fish, *Ilisha sirishai* from Visakhapatnam, India. *Hydrobiologia*, 47(3-4): 463-468.

Seshagiri Rao, B.V. 1976. Notes on the Indo-West Pacific species of the Clupeid fish genus *Ilisha*, with a key to their identification. *Copeia*, 503-509.

Seshagiri Rao, B.V. 1981. Systematic studies on *Ilisha kampeni* (Weber and de Beaufort 1913) (Pisces: Clupeidae) and a biometric comparison of stocks from two localities. *Hydrobiologia*, 78: 73-79.

Seshappa, G. 1972. Some morphometric studies on five species of *Cynoglossus* (Family: Cynoglossidae, order Heterosomata) from the West Coast. *Indian J. Fish.*, 17(1): 149-158.

Shahul Hameed, M. and B.M.Kurup. 1981. Comparative studies on the populations of the Indian Sand Whiting *Sillago sihama* (Forsk.) (Pisces: Sillaginidae) from the East and West coast of India. *J. Inland Fish. Soc. India*, (in press).

Shen, S. 1967. Studies on Flat-fishes (Pleuronectiformes or Heterosomata) in the adjacent waters of Hongkong. *Quart. J. Taiwan M.s.*, 20(1,2): 150-281.

Shen, S. 1969. Additions to the study on the Flat-fishes in the adjacent waters of Hongkong. *Rep. Inst. Fish. Biol.*, 2: 19-27.

Shetty, H.P.C. 1965. Observations on the fish and fisheries of the Vembanad Backwaters, Kerala. *Proc. nat. Acad. Sci. India*, 35(1): 115-130.

Shynamma, C.S. and K.P.Balakrishnan. 1973. Diurnal variation of some physico-chemical factors in Cochin backwater during southwest monsoon. *J. mar. biol. Ass. India*, 15(1): 391-398.

Silas, E.G. 1949. On a collection of fish from Travancore. *J. Bombay nat. Hist. Soc.*, 48(5): 792-797.

Silas, E.G. 1951. Fishes from the high ranges of Travancore. *J. Bombay nat. Hist. Soc.*, 50: 367-370.

Silas, E.G. and H.S. Toor. 1961. On some new records of Pigface Breams (Family: Lethrinidae: Pisces) from the Andaman Sea. *J. mar. biol. Ass. India*, 3(1 and 2): 203-214.

Silas, E.G. and H.S.Toor. 1962. Lethrinella conchyliatus Smith (Lethrinidae: Pisces), a new record for Indian seas. J. mar. biol. Ass. India, 4(1): 243-245.

Silas, E.G. and P. Parameswaran Pillai. 1975. Dynamics of zooplankton in a tropical estuary (Cochin backwater), with a review on the plankton fauna of the environment. Bull. Dept. Mar. Sci. Univ. Cochin, 7(2): 329-355.

Simpson, A.C. 1951. The fecundity of the plaice. Fish. Invest. Ministr. Agric. Fish. Food (G.B) Ser. Salmon fresh water fish., 11 17(5): 1-27.

Smith, J.L.B. 1948. A generic revision of the mugilid fishes of South Africa. Ann. S. Afr. Mus., 30(19): 587-644.

Smith, J.L.B. 1949. The Sea Fishes of Southern Africa. Central News Agency, Ltd., South Africa. 550 pp.

Smith, J.L.B. 1956. The fishes of the family Sphyraenidae in the western Indian ocean. Ichthyol. Bull. Rhodes. Univ., (3): 37-46.

Smith, J.L.B. 1962. Fishes of the family Gaterinidae of the western Indian ocean and the Red Sea with a resume of all known Indo-Pacific species. Ichthyol. Bull. Rhodes. Univ., (25): 469-502, figs. 1-22. pls. 69-72.

Smith, J.L.B.1967a. Studies in Carangid fishes. No.I. Naked thoracic areas. Occ. Pap., Rhodes. Univ. Dept. Ichthyol., (12): 139-141, pls. 30,31.

Smith, J.L.B.1967b. Studies in Carangid fishes. No.2. The identity of Scomber malabaricus Bloch-Schneider, 1801. Occ. Pap., Dept. Ichthyol., Rhodes. Univ., No.13: 143-153.

Smith, J.L.B. 1967c. Studies in Carangid fishes. No.3. The genus Trachinotus Lacepede, in the western Indian Ocean. Occ. Pap., Dept. Ichthyol., Rhodes. Univ., No.14: 157-166.

Smith, J.L.B. 1968. Studies in Carangid fishes. No.4. The identity of Scomber sansum Forskal, 1775. Occ. Pap., Dept. Ichthyol., Rhodes. Univ., No.15: 173-184.

Smith, J.L.B. 1970. Studies in Carangid fishes. No.5. The genus Chorinemus Cuvier, 1831 in the Western Indian Ocean. Occ. Pap., Dept. Ichthyol., Rhodes. Univ., No.17: 217-228.

Smith, M.M. 1972. Studies in Carangid fishes. No. 6. Key to the Western Indian Ocean species of the genus Carangoides Bleeker, 1851, with a description of Carangoides nitidus Smith. Occ. Pap.Rhodes. Univ. Dept. Ichthyol., (18): 229-239. pls. 30,31,44.

Smith, M.M. 1973. Identity of Caranx armatus (Pisces: Carangidae). Copeia, 1973 (2): 352-354.

Smith-Vaniz, L.F. and J.C.Staiger. 1973. Comparative revision of Scombroides oligoplites parona and Hypacanthus with comments on the phylogenetic position of Campogramma (Pisces: Carangidae). Proc. U.S. Nat. Mus., 122(3582): 1-150, figs 1-11, pls. 1-30.

Snedecor, G.W. 1961. Statistical methods applied to experiments in agriculture and biology. Allied Pacific Pvt. Ltd., Bombay.

Snyder, J.O. 1907. A review of the Mullidae, surmullets, or Goatfishes of the shores of Japan. Proc. U.S. Nat. Mus., 32(1513): 87-102.

Sobhana, B. 1976. Studies on certain cyprinid fishes of Kerala. Ph.D. Thesis, University of Kerala, 453 pp.

*Srinivasachar, H.R. 1958. Development of the skull in catfishes. Gegenbaurus Ep., 99: 986-1016.

Sreenivasan, P.V. 1975. On two new records of Carangid fishes from Indian seas. Indian J. Fish., 21(1): 20-28.

Sreenivasna, P.V. 1976. Records of six species of Carangids from the South West Coast of India. Indian J. Fish., 23(1 and 2): 41-56.

Strickland, J.D. and T.R. Parsons. 1965. A Manual of Sea Water Analysis. Bull. Fish. Res. Bd. Canada, 125: 1-185.

Steindachner, Franz. 1902. Fische aus Sudarabian und Sokotra. Denks. Akad. Wiss. Wien., 71(1): 123-168.

Sterba, Gunther, 1962. Freshwater fishes of the world. Vista Books, London, 878 pp.

Subba Rao, K.V. 1977. Systematics and comparative osteology of Indian Lizard fishes (Saurida spp.) Indian J. Fish., 24(1 and 2): 143-171.

Subba Rao, K.V. 1964. On the occurrence of Saurida undosquamis (Richardson) off Visakhapatnam. J. mar. biol. Ass. India, 6(2): 265-267.

Sufi, S.M.K. 1956. A revision of the Oriental fishes of the family Mastacembelidae. Bull. Raffles Mus., No.27; 92-146 pls. 13-26.

Sunny, K. G. 1975. Studies on the morphology, Biology and Development of the mullets of Kerala. Ph.D. Thesis, University of Cochin.

Suseelan, C. and K.V. Somasekharan Nair. 1969. Food and feeding habits of the demersal fishes off Bombay. Indian J. Fish., 16(1 and 2): 56-74.

Swynnerton, G.H. and E.B. Worthington. 1940. Note on the food of fish in Haweswater (Westmorland). J. Anim. Ecol., 9: 183-187.

Sylva De Donald. 1973. Barracudas (Pisces: Sphyraenidae) of the Indian Ocean and adjacent seas. A preliminary review of their Systematics and Ecology. J. mar. biol. Ass. India, 15(1): 74-94.

Talwar, P.K. 1968. Taxonomic status of *Sphyraena acutipinnis* Day, 1876 (Sphyraenidae - Pisces). J. nat. Hist., 2: 197-200.

Talwar, P.K. 1969a. Systematic status of *Carangoides malabaricus* (Bl. and Schn.) and *Carangoides coeruleopinnatus* (Rupp.) (Pisces: Carangidae). J. Bombay nat. Hist. Soc., 16a(3): 518-522.

Talwar, P.K. 1969b. The generic relationship and identity of *Sciaena osseus* Day, 1876 (Pisces: Sciaenidae). J. mar. biol. Ass. India, 11(1 and 2): 324-328.

Talwar, P.K. 1969c. Miscellaneous note 18. *Oxyurichthys jaarmani* Weber (Gobiidae: Pisces). A rare gobioid from Indian waters. J. Bombay nat. Hist. Soc., 65(3): 794-795.

Talwar, P.K. 1970a. Taxonomic status and identity of *Corvina albida* Cuvier, 1830 (Pisces: Sciaenidae). Proc. Indian Acad. Sci., 72B: 201-206.

Talwar, P.K. 1970b. On the taxonomic position of the genus *Bola* Hamilton, 1822 (Pisces: Sciaenidae). Proc. Indian Acad. Sci., 72B: 266-269.

Talwar, P.K. 1970c. A new generic name for a Sciaenid fish from India. Proc. zool. Soc. Calcutta, 23: 67-7

Talwar, P.K. 1970d. Taxonomic position of Corvina albida Cuvier, 1830 (Pisces: Sciaenidae). Proc. zool. Soc. Calcutta, 23: 191-193.

Talwar, P.K. 1971a. A note on the taxonomy of a species of Tachysurus Lacepede (Pisces: Tachysuridae). J. Bombay nat. Hist. Soc., 68(2): 473-476.

Talwar, P.K. 1971b. The taxonomic position of Umbrina dussumieri Valenciennes, 1833 and Umbrina macroptera Bleeker, 1853 (Pisces: Sciaenidae). J. Inland Fish. Soc. India, 3: 22-24.

Talwar, P.K. 1976. A contribution to the systematics of Arius tenuispinis Day (Pisces: Ariidae). Rec. zool. Surv. India, 69: 291-294.

Talwar, P.K. and A. Joglekar. 1968. The taxonomic position of Corvina axillaris Cuvier, 1830 (Sciaenidae: Pisces). J. mar. biol. Ass. India, 10(2): 361-365.

Talwar, P.K. and A. Joglekar. 1969. On a new species of Wak Lin, 1938 (Pisces: Sciaenidae) from Hooghly Estuary. J. Inland Fish. Soc. India, 1: 32-36.

Talwar, P.K. and A. Joglekar. 1970. The taxonomic position of Corvina axillaris Cuvier 1830 (Sciaenidae: Pisces). J. mar. biol. Ass. India, 10: 361-365.

Talwar, P.K. and A. Joglekar. 1972a. Systematic status and identity of Otolithus vogleri Bleeker, 1835 (Pisces: Sciaenidae). Rec. zool. Surv. India, 66(1-4) (1968): 229-236.

Talwar, P.K. and A. Joglekar. 1972b. Systematics status of Sciaena bleekeri Day, 1876 (Sciaenidae: Pisces). Rec. zool. Surv. India, 66(1-4) (1968): 1-6.

Talwar, P.K. and P.J.P. Whitehead. 1971. The Clupeoid fishes described by Francis Day. Bull. Brit. Mus. Nat. Hist. (Zool.), 22: 57-85.

Talwar, P.K. and N.K. Sinha. 1972. Johnius carutta Bloch, 1763 (Sciaenidae: Pisces), description of the neotype. J. Inland Fish. Soc. India, 4: 93-102.

Talwar, P.K. and S. Chakrapany. 1970. Ambassis kopsi Bleeker (Pisces: Ambassidae), a new record from Indian waters. J. mar. biol. Ass. India, 12 (1 and 2): 232-233.

Taylor, W.R. 1970. Comment on the proposed validation of Siganus Forsskal, 1775, and request that the name Teuthis Linnaeus (Pisces) be placed in the official list of generic names in zoology. Bull. Zool. Nomencl., 26: 178-179.

Thobias, M.P. 1974. Observations on the morphological variations in Puntius filamentosus (Val.) (Family: Cyprinidae) with a description of the species. J. Inland Fish. Soc. India, 6: 45-50.

Thomas, P.A. 1967. The occurrence of the red mullet (Goatfish) Upneus luzonius Jordan and Seale, in the Indian seas. J. mar. biol. Ass. India, 7(2): 473-475.

Thomas, P.A. 1969. The Goatfishes (Family: Mullidae) of the Indian seas. Mem., III: 1+174 pp. (M.B.A.I.).

Thompson, J.M. 1966. The grey mullets. Oceanogr. Mar. Biol. Ann. Rev., 4: 301-335.

Todd, R.A. 1915. Report on the feeding behaviour of plaice Pleuronectes platessa. Fish Invest. Lond., Ser. II(1): 1-31.

Toor, H.S. 1972. Taxonomic position of Lethrinus mahsenoides Valenciennes and Lethrinus sanguineus Smith. Res. Bull. Punjab Univ. (Soc).N.S., 22 (3-4) (1971): 375-378.

Trewavas, E. 1962. A basis for classifying the Sciaenid fishes of tropical West Africa. Ann. Mag. nat. Hist., (13) 5: 167-176.

Trewavas, E. 1964. The Sciaenid fishes with a single mental barbel. Copeia No. I: 107-117.

Trewavas, E. 1965. Review of 'A study of the classification of the Sciaenid fishes of China with description of new genera and species by Chu, Lo, and Wu'. Monogr. Fish. China, Shanghai Fisheries Institute, 1963: 1-100, with figures, 1-40 pls. Copeia No.2: 253-254.

Trewavas, E. 1971. The syntypes of the Sciaenid Corvina albida Cuvier and the status of Dendrophysa hooghliensis Sinha and Rao and Nibea coibor nec Hamilton of Chu, Lo and Wu. J. Fish Biol., 3: 453-461.

Trewavas, E. 1972. Ecological studies on crater lakes in West Cameroon. Fishes of Barombi Mbo. J. Zool., Lond., 167: 41-95.

Trewavas, E. 1973. On the Cichlid fishes of the genus Pelmatochromis with proposal of a new genus for P. congicus; on the relationship between Pelmatochromis and Tilapia and the recognition of Sarotherodon as a distinct genus. Bull. Brit. Mus. Nat. Hist. (Zool.), 25: 1-26.

Trewavas, E. 1977. The Sciaenid fishes (Croakers or Drums) of the Indo-West Pacific. Trans. zool. Soc. London, 33: 253-541.

Trewavas, E. and S.M. Yazdani. 1965. Chrysochir, a new genus for the sciaenid fish Otolithus aureus Richardson, with consideration of its specific synonyms. Ann. Mag. nat. Hist., (13) 8: 249.

Tuvia Ben, A. 1964. Two Siganid fishes of the Res Sea origin in the eastern Mediterranean. Bull. Sea Fish. Res. Stn. Haifa, 37:1-8.

Tuvia Ben, A. 1966. Red Sea fishes recently found in the Mediterranean. Copeia, (2): 254-275.

Unnithan, R.V., M. Vijayan, E.V. Radhakrishnan and K.N.Ramani. 1977. Incidence of fish mortality from industrial pollution in Cochin backwaters. Indian J. Mar. Sci., 6(1): 81-83.

*Valenciennes, A. 1844. Description de quelques dents fossiles de poissons trouvees aux environs de Staoueli, dan la province d' Alger. Ann. Sci. Nat. (Zool.), 3 Ser.I: 99-104.

Varadarajan, S. 1953. A note on the distribution of Anchoviella heterolobus (Ruppell) and Anchoviella zollingeri (Bleeker) in the Indian seas. J. Bombey nat. Hist. Soc., 51(4): 946-947.

Venkataraman, 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.

Venkataraman, G. and M. Badrudeen. 1975. A new distributional record of Gerres macracanthus Bleeker from Indian waters. Indian J. Fish., 22(1 and 2): 290-293.

Venkataramani, V.K. 1979. Bio-systematic studies in Carangid fishes of Porto Novo coast (Perciformes: Carangidae). Ph.D. Thesis, Annamalai University, 290 pp.

Venkataramani, V.K. and V. Ramaiyan, 1977. A Carangid fish Caranx williamsi (Smith, 1968) (Pisces: Carangidae) Curr. Sci., 46(1): 26.

Venkatasubba Rao, K. 1963. Some aspects of the biology of 'Ghol' *Pseudosciaena diacanthus* (Lacepede). *Indian J. Fish.*, 10A(2): 413-459.

Venkateswarlu, T. and K.V. Rama Rao. 1976. First record of the Gobioid fish *Eleotriodes wardii* Playfair (Pisces: Eleotridae), from the Central Indian Ocean. *Intern. Rev. Hydrobiol.*, 61(4): 551-554.

Visweswara Rao, V. 1966. *Platycephalus bengalensis* sp. nov. from Bay of Bengal. *Ann. Mag. Nat. Hist. Serv.* 13, 9: 123-127.

Visweswara Rao, V. 1968. A new Gobioid fish from Visakhapatnam. *J. nat. Hist.*, 2(1): 17-20.

Visweswara Rao, V. 1971a. *Incara multisquamatus* gen. et. sp. nov. (Family: Eleotridae) from Godavari estuary. *J. mar. biol. Ass. India*, 11(1-2): 329-33.

Visweswara Rao, V. 1971b. *Chiramenu fluviatilis* gen. et. sp. nov. (Family: Gobiidae) from Godavary estuary. *J. mar. biol. Ass. India*, 12(1-2): 183-186.

Visweswara Rao, V. 1971c. New Gobioids from Godavari estuary. *J. zool. Soc. India*, 23(1): 39-54.

Visweswara Rao, V. 1971d. A new fish of the family Gobiidae from Godavari estuary. *J. Bombay nat. Hist. Soc.*, 69(1): 130-133.

Visweswara Rao, V. 1976. The non-clupeoid fishes of Godavari estuary. *Matsya*, 2: 54-62.

Weber, M. and L.F. de Beaufort. 1911-51. *The Fishes of the Indo-Australian Archipelago*. Leiden: E.J. Brill Ltd. Vols. 1-9.

Wellershaus, S. 1969. On the taxonomy of planktonic Copepoda in the Cochin Backwater (A South Indian Estuary). *Veroeff. Inst. Meeresforsch. Bremerhaven*, 11(2): 245-286.

Wellershaus, S. 1973. On the hydrography of the Cochin backwater (A south Indian estuary). J. mar. biol. Ass. India, 14(2): 487-495.

Whitehead, P.J.P. 1962. A review of the Indo-Pacific Gizzard shad genera Nematolosa, Clupanodon and Konosirus (Pisces: Dorosomatidae). Bull. Br. Mus. nat. Hist. (Zool), 9(2): 87-102.

Whitehead, P.J.P. 1963. A revision of the recent round herrings (Pisces: Dussumieriidae). Bull. Br. Mus. nat. Hist. (Zool.), 10(6): 305-380.

Whitehead, P.J.P. 1965. A review of the elopoid and clupeoid fishes of the Red Sea region. Bull. Br. Mus. nat. Hist. (Zool.), 12(7): 225-281.

Whitehead, P.J.P. 1967. The clupeoid fishes described by Lacepede, Cuver and Valenciennes. Bull. Br. Mus. nat. Hist. (Zool.), Suppl. 2:1-180.

Whitehead, P.J.P. 1968. Indian Ocean anchovies collected by the Anton Bruun and Te Vega, 1963-64. J. mar. biol. Ass. India, 9(1): 13-37.

Whitehead, P.J.P. 1970. The Clupeoid fishes described by Steindachner. Bull. Br. Mus. nat. Hist. (Zool.), 17: 261-279.

Whitehead, P.J.P. 1972. A synopsis of the Clupeoid fishes of India. J. mar. biol. Ass. India, 14(1): 160-256.

*Whitehead, P.J.P., M. Boeseman and A.C. Wheeler. 1966. The types of Bleeker's Indo-Pacific elopoid and clupeoid species. Zool. Verhandl. Leiden, 84: 1-152.

Whitfield, K. Alan and J.M.S. Blaber. 1979. The distribution of fresh water cichlid Sorotherodon mossambicus in estuarine systems. Env. Biol. Fish., 4(1): 77-81.

*Whitworth, W.R., and W.H. Irwin. 1961. The minimum oxygen requirements of five species of fish under quiescent conditions. In: Proc. 50th Ann. Conf. Southeastern Assn. Game Fish Commissioners. pp. 226-235.

Williams, F. 1959. The barracudas (Genus Sphyraena) in British East African waters. Ann. Mag. nat. Hist. 13, Ser. 2(14): 92-128.

Williams, F. 1961. Uraspis wakiyai sp. nov. (Pisces: Carangidae) from the western Indian ocean. With a review of the species of Uraspis Blkr. 1855. Ann. Mag. nat. Hist. Ser., 13(4): 65-87.

Williams, F. and V.K. Venkataramani. 1978. Notes on Indo-Pacific Carangid fishes of the genus Carangoides Bleeker. I. The Carangoides malabaricus group. Bull. Mar. Sci., 28(3): 501-511.

Williams, F.P.C.Heemstra and A.Shameem. 1980. Notes on Indo-Pacific Carangid fishes of the genus Carangoides Bleeker. Bull. Mar. Sci., 30(1): 13-20.

Wongratana, T. 1975. A record of a flathead fish Thysanophrys papillolabium Schultz, in the Andaman Sea, with a key to fourteen species of the Platycephalida from Thai waters (Pisces: Platycephalidae). Res. Bull. 7, Phuket Marine Biological Center.

Wongratana, T. 1980. Systematics of clupeoid fishes of the Indo-Pacific region. Ph.D. Thesis, Imperial College, London University. 2 Vols. (432 pp + 334 plates + 126 figures + 17 tables)

Woodland, D.J. 1972. Proposal that the genus name Teuthis Linnaeus (Pisces) be supressed. Bull. Zool. Nomencl., 29(190-193.

Woodland, D.J. 1973. Addendum to the proposal that the genus name _Teuthis_ Linnaeus (Pisces) be suppressed. _Bull. Zool. Nomencl._, 30: 6-7.

Woodland, D.J. and E. Randall. 1979. _Siganus puelloides_ a new species of Rabbitfish from the Indian Ocean. _Copeia_, (3): 390-393.

Yazdani, G.M. 1966. On the systematic position of _Sciaena ophiceps_ with key to the genera of Indian Sciaenidae. _J. zool. Soc. India_, 15(1): 64-65 (1963).

Yuen, H.S.H. 1955. Maturity and fecundity of big eye tuna in the Pacific. _Spec. Sci. Rep. U.S. Fish. Wild. Serv._, 150:30.

ar, H. Jerrold. 1974. _Biostatistical Analysis._ Prentice-Hall, INC Englewood Cliffs, N.J. (ed.). 620 pp.

Zijlstra, J.J. 1973. Egg weight and fecundity in the North Sea herring (_Clupea harengus_). _Neth. J. Sea. Res._, 6(1-2): 173-204.